MpCCI - A general Coupling Library for Multidisciplinary Simulation

Klaus Wolf
Fraunhofer Institute for Algorithms and Scientific Computing (SCAI)
Schloss Birlinghoven
53754 Sankt Augustin, GERMANY
(Email: Klaus.wolf@scai.fraunhofer.de)

Introduction

During the life cycle at industrial fabrication, prototyping and testing define a significant step on the way towards a new and successful product. For both, prototyping and testing, numerical simulation is more and more a becoming standard working tool.

Many aspects of the product behavior are affected by the interaction of different physical phenomena. Fluid-structure interactions at aircraft wings, ship propellers, or large bridges are some examples. Others are heat transfer from hot flows onto turbine blades, plasma flows interfering with changing electromagnetic fields or interactions between atmosphere, ocean and landscape in climate modeling. In general, there is a growing demand for interdisciplinary solutions in industry as well as in research.

Simulation codes are available for most physical disciplines: computational fluid dynamics codes, structural mechanics codes, thermal codes, plasma codes, electromagnetic codes, climate submodels, etc. However, apart from some very specific and application dependent implementations there is no environment which provides a general solution for multi-disciplinary simulations.

The MpCCI-Concept

To overcome this problem SCAI, has developed the MpCCI (Mesh based parallel Code Coupling Interface) software library, work started in 1996. The basic concepts of MpCCI are:

- to enable interaction between nearly any two physical disciplines,
- to allow the coupling of any two or more simulation codes (Fig. 1),
- to provide a validated coupling numeric, and
- to require only few software changes in the simulation codes themselves.

Technical and Scientific Approach

The basic principle of MpCCI is to provide a software interface, that allows the adaptation of each of simulation codes without knowing anything about the code on the other side of the interface. Each code specifies its coupling area based on its own numerical mesh definitions; multiple meshes per code and any partitioning for parallel programs are allowed. MpCCI automatically computes the mesh neighborhoods of the coupled codes.
Each code states which physical quantities (e.g. pressure, velocity, temperature, etc.) it can provide and which quantities it needs from the other side.

During a simulation run each code presents its own current quantities to MpCCI. Based on the computed mesh neighborhood, MpCCI can interpolate values from the sender mesh onto the receiver mesh (Fig. 3). If there are application specific needs, the user can link his own interpolation rules to MpCCI. Finally MpCCI does the communication of the quantities between the coupled codes.

MpCCI provides a procedural interface to Fortran and C. It is linked to the simulation codes as a library (Fig. 2). MpCCI is currently based on the MPI standard. For parallel codes, the code internal communication is separated from the MpCCI communication due to the MPI communicator concept.

The MpCCI Software Product

The name MpCCI - Mesh-based parallel Code Coupling Interface and its logo are registered trademarks of GMD. Since February 2000, SCAI provides the software solution MpCCI, which is available for binary download from the web (www.mpcci.org). User registration and an electronic license agreement are part of the MpCCI download area. There are ports for nearly all standard UNIX environments and Linux. A full documentation enables basic code-couplings in a do-it-yourself way.

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