CFD-code Architecture for Hybrid Computing Systems

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Classical CFD-package architecture is traditionally a tripartite layout: preprocessor - solver -postprocessor. The component elements of such a package are non-linked and operate independently of one another. This feature often results in problems like difficulty to arrange data exchange among the components, lack of control over the computing process while is still in progress, lack of results monitoring until after the computing run has been completed. To overcome these drawbacks it is necessary to combine the package components. There exist a number of approaches for this problem, the most widely spread one being compilation of all the package components as one executable module. This approach has a number of shortcomings: low flexibility, binding to the actual hardware/software platform, low package portability to other platforms.

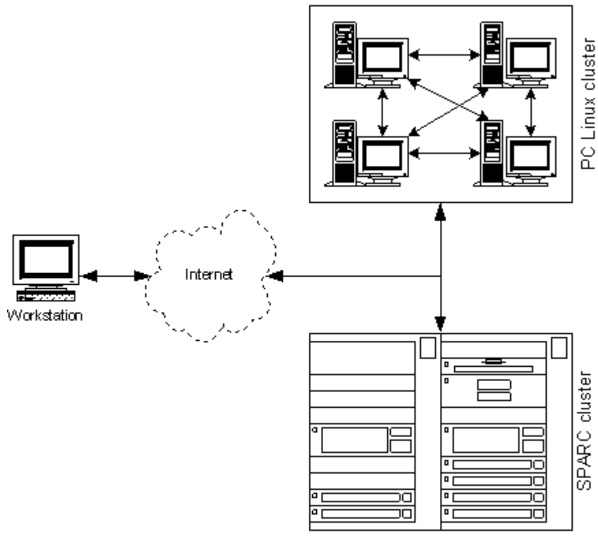

Fig. 1: Chart of package application in hybrid computing environment

This paper offers an alternative approach to building a unified package. The package is compiled from several interacting modules, the interaction protocol being a two-level one. There have been developed transport protocols based both on the network protocol TCP/IP and the MPI specification. The following upper-level protocols have been designed: data exchange among several solvers operating in parallel and a possibility to unify a random number of solvers to collaterally execute large (hundreds of millions cells) problems; interaction between solvers and the control module; and interaction between the control module and the application interface. All the modules have been implemented to be compatible with three operational systems: Win32, Linux, Solaris. For Solaris two types of hardware platforms are supported: UltraSPARC and x86. This architecture allows the user to work with the cluster remotely, for instance via the Internet, with combined advantages of a convenient interface and a high-power cluster. Fig. 1 shows a sample layout of a hybrid computing system.

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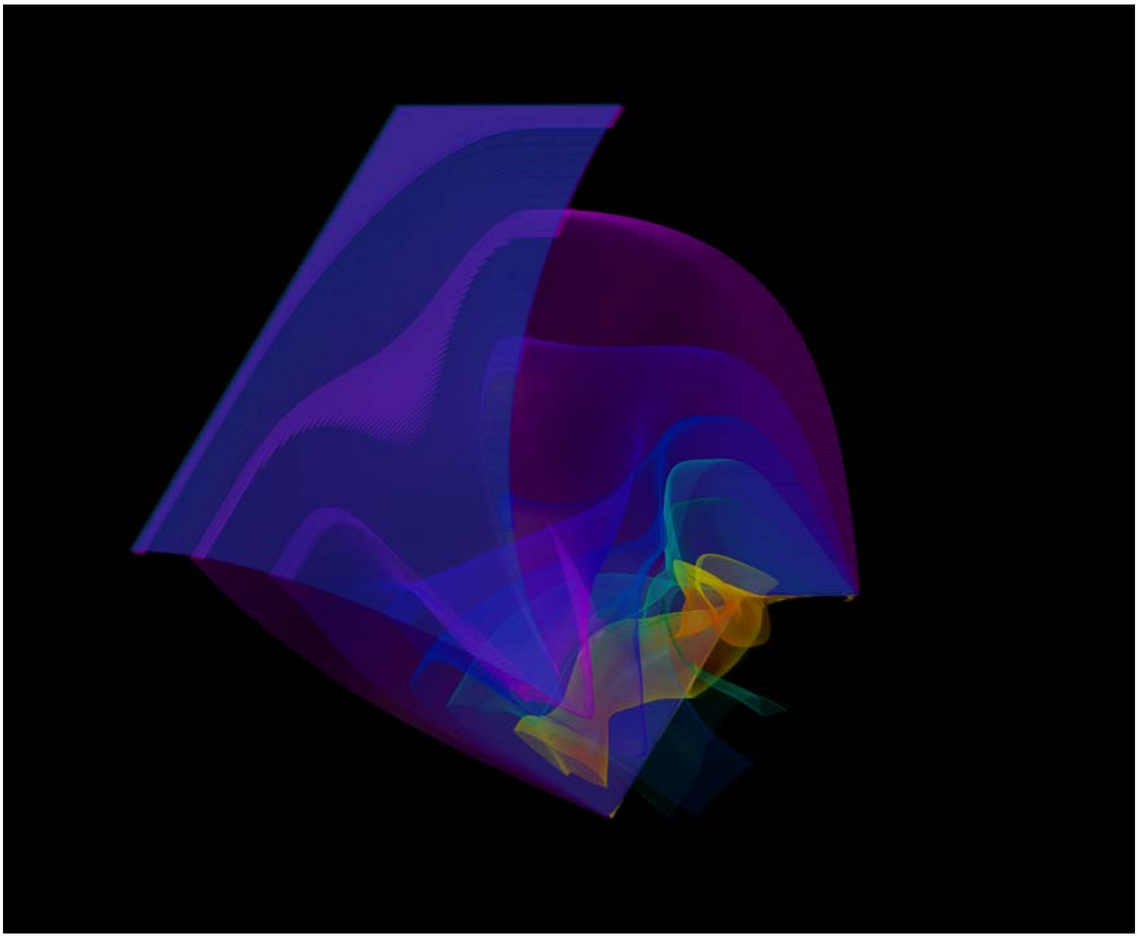

Fig. 2: Semi-transparent pressure iso-surfaces for a strong shock-wave diffraction on a 3D edge.

Fig. 2 illustrates the solution of a problem of shock-wave diffraction on a 3D edge. This solution was executed on a hybrid computing system comprised by a Windows OS double processor PC and two Linux cluster systems. The computation domain for this case problem was of 45 million cells.

Visualization was accomplished with the help of the package Scientific VR, designed by GDT Software Group. This software relies on the use of semi-transparent voxel graphics technique, and is an integral component of the package GasDynamicsTool.