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Interconnecting the Virtual Observatory with computational grid infrastructures

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The term 'grid', in the Virtual Observatory (VO) context, has mainly been used to indicate a set of interoperable services, allowing transparent access to a set of geographically distributed and heterogeneous archives and catalogues, data exchange and analysis, etc. The design of the VO has been however mainly geared at allowing users to access *registered services*.

This is rather different from the approach other scientific communities are taking, mainly based on using the grid for computational tasks (e.g., EGEE). The Grid concept is to have a highly controlled 'coordinated resource sharing': individuals and/or institutions defined by the sharing rules form a 'virtual organization'. If the user belongs to one, he/she can run his/her *own applications*.

Within this framework, it appears as extremely important to be able to interconnect the VO and the computational grid infrastructures. This is particularly relevant in the case of massive computational problems connected to the production of theoretical and simulated data. In some countries, there is a well-established and growing community of 'Grid Astronomers'.

To implement this interconnection, on one side, mechanisms are being designed and implemented aimed at allowing VO users to exploit (through registered applications available at the VO data centres) the processing capabilities offered by the computational Grid. This fulfills a 'data centre' type of scenario: a VO user connects to a theory database, asking for a model by specifying a set of parameters: the model is provided if available, a local computation allows to interpolate between available models, while Grid computing is used to build a full-fledged new model.

In another 'user-centered' type of scenario, a user extracts information from the VO, performs heavy batch computations with own code on the Grid, then re-connects to the VO to compare results. If such a scenario is to be supported, high priority needs to be given to the access of VO-compliant archives and databases with the computational Grid using the proper interfaces and standards.

A two-way infrastructural approach is therefore needed for linking Grid-enabled computations with data, and viceversa, within the VO. This approach will allow users not only to run registered VO applications on computational Grids but, if they belong to a Grid Virtual Organization, also their own. Technically, on one side the Common Execution Architecture (CEA) is expected to be expanded to allow access to distributed computing architectures. On the other side, prototype systems are being built, which make use of all relevant VO standards and EGEE Grid middleware, with some extensions to allow VO-compliant access to data. As an example, a Grid middleware component (QE) has been developed by INAF with EGEE/LCG staff at INFN/CNAF, working under Globus Toolkit 2 and interoperable with OGSA-DAI.

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