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BaSTI: the Virtual Observatory meets the Computational Grid

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Abstract. We present the prototype of the new BaSTI web portal. This portal is a GRID and Virtual Observatory integrated facility that allows to exploit the computational and storage capabilities of the EGEE-II GRID environment from a Virtual Observatory compliant web portal. This facility provides data access to large sets of stellar evolution models, it is also able to create on-the-fly models submitting a large number of jobs on the GRID and collecting the results. This portal is a first example of a service that is able to bridge two different GRID environments: the Virtual Observatory and the EGEE-II computational and data GRID.

1. Introduction

In Astronomy, the availability of a large set of stellar evolution models spanning a wide range of stellar masses and initial chemical composition, is a necessary pre-requisite for any investigation aimed at interpreting observations of Galactic and extra-Galactic stellar populations. FRANEC (Pietrinferni et al. 2004, 2006) is a numerical code designed to address this problem.

In these last years, FRANEC has been extensively used for computing models of Stars for a wide range of mass and chemical composition, and in all their evolutionary stages. Those models have been compared with the most recent empirical data from both ground-based telescopes and space missions such as the Hubble Space Telescope. Recently FRANEC has been updated in many aspects concerning both the numerical scheme for treating the nuclear burnings and the accuracy of the numerics. Also the physical inputs have been improved. This new version of the FRANEC code is used to produce a library of stellar evolutionary predictions: the BaSTI (a Bag of Stellar Tracks and Isochrones) archive (BaSTI 2004).

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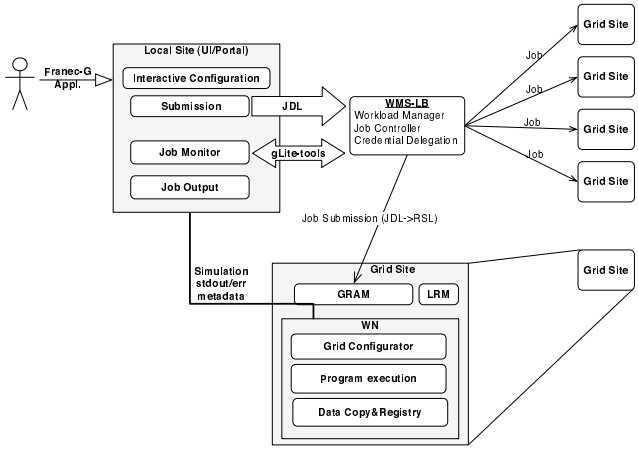

Figure 1. FRANEC on the GRID: application services and their interaction with the GRID services.

BaSTI is the most updated database of stellar models all around the world and it is a formidable tool for population synthesis investigations. In the next future, it will provide also theoretical predictions about integrated colors and magnitudes as well as integrated spectra for complex stellar populations. The BaSTI archive has been setup to satisfy some basic but important criteria: accuracy, homogeneity, completeness and reliability. A successful archive must also be easy to access and queried by the Astronomers. The WEB portal is a simple but efficient solution to provide this service to all the Astronomical community. BaSTI archive has also been identified as a theoretical data center for the Virtual Observatory (VObs), where the standards being defined within the International Virtual Observatory Alliance (IVOA) can be tested and validated.

To fulfill the whole set of requirements it is necessary to produce a number of simulations and extract from the simulated data the informations needed to create the evolutionary tracks. This requires a huge amount of computing power. Moreover, it is crucial to fulfill the requests of astronomers needing a model not already available in the archive with "on-the-fly" runs. We think that GRID computing is an answer to BaSTI data generation and processing needs.

In this paper we present a prototype of the BaSTI WEB portal that is able to use the computational and storage capabilities of the EGEE-II GRID infrastructure to produce new archive data and make them available to the final users.

2. FRANEC-G

FRANEC is a serial code; each instance of this code produces a stellar model for a star of a given mass. To produce an evolutionary track it is necessary to run a number of simulations and to collect the output, which needs to be post-processed.

FRANEC-G is the version of FRANEC code we designed to work on the EGEE-II GRID environment. We rely on the EGEE Resource Brokering capa-

bilities to create parametric jobs in order to run a swarm of FRANEC instances. All the results are stored in the GRID distributed file system and they are accessible using the EGEE file catalogue. Any further post-processing activity can be performed in the GRID environment. FRANEC-G is a command-line application that, starting from a configuration file, automatically runs on the EGEE-II GRID (Figure 1)

FRANEC-G is available for EGEE-II GRID users belonging to the INAF Virtual Organization (VOrg). To run FRANEC, users can login on the EGEE-II GRID and run the code deciding the type and kind of FRANEC simulation they want. A user can decide the physical parameters to use such as the total mass and chemical composition of the stellar models that she/he wishes to compute. The application is designed to hide the complexity of the GRID job submission procedure. The results of the execution are stored in the GRID File System and can be shared with other researchers. Any user can inspect and modify the outputs using a GRID shell. We developed FRANEC-G in a way that allows to exploit more than just the computational capabilities of the GRID: the GRID can be used also as a collaborative tool to allow researchers from different institutes to work together on a particular research activity, sharing files and computations. The FRANEC-G code will be also available for the ASTRO VOrg (Vuerli et al. 2007).

3. BaSTI V 4.0 prototype

FRANEC-G is the foundation of new BaSTI facility. We use the GRID code for two main purposes: to update and complete the archive and to give new functionalities for the users. Using the EGEE Resource Broker intrinsic capability of handling directed acyclic graphs we can create simple workflows that collect all the outputs of the FRANEC-G runs and post-process them to create the evolutionary track. The results are then stored on the GRID and in the BaSTI archive.

The new archive is designed on top of an Oracle 10g database, a relational database giving the possibility to make complex queries via SQL, and is compatible with the VO standard Astronomical Query Language (ADQL). A portal is the front-end to the database. The current portal allows to query for the data already stored in the database; in the new BaSTI portal, in the case data are not available, a batch of jobs is submitted and executed on the EGEE-II GRID infrastructure[1]. The facility is in charge of directing the job execution and control, and of storing the results in the database. The results of GRID simulations are stored both in the databases and in the EGEE-II GRID file system. Data is then available to both GRID and VObs users. The result (ascii files) can be opened using the TOPCAT VObs tools, easily creating the graphics of these quantities; in future will output the data also as VOTables, which will be the new default format. The VObs protocol for accessing data from numerical simulations is currently being defined within IVOA: BaSTI is using interim definitions and its experience will be fed back for the validation of the standards being defined.

The portal provides both database access and GRID access. The GRID component of the portal is based on Engine Frame (2007).

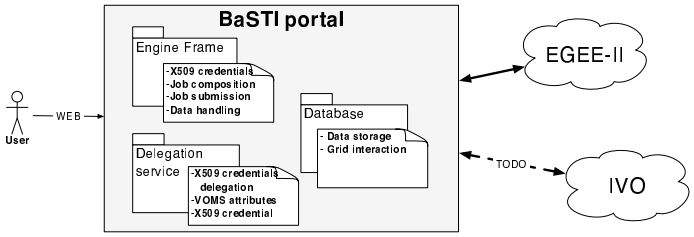

Figure 2. BaSTI portal components. A schematic view of the software components used to setup the portal.

The VObs and EGEE-II interoperation can be done on the basis of common single-sign-on X.509-based credentials to authenticate users on both the VObs resources and the EGEE-II ones (a delegation service with VOMS (Alfieri et al. 2005) attributes is used) and on the possibility of using the EGEE storage system also for VObs data (Taffoni et al 2007).

4. Conclusions

BaSTI V4.0 represents an excellent example of a resource where a database complying with the Virtual Observatory standards is coupled with the computing power provided by a production GRID environment. These mechanisms can be re-used for VObs sites providing numerical simulations on-demand or data processing on-the-fly. Theoretical data are expensive in terms of the CPU time invested to produce them. The VObs is expected to allow them to be reused for different purpose, just as observational data, and at the same time make it easier to compare observations with numerical simulations.

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