Monitoring and Remote Control of Scientific Instrumentation through the Grid

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Abstract. Grid infrastructures currently in use for production purposes are strongly computing-oriented, suitable for scientific communities whose applications require intensive computation on a relatively small amount of data. Middleware implementations underlying such infrastructures well support the sharing and distribution of Grid-embedded computational resources but problems arise when trying to use such Grids to satisfy the sharing of data-oriented and services-oriented resources. The Grid middleware model does not allow the embedding of a meta-computing machine. Some scientific communities are strongly limited in using such Grid infrastructures for their applications; they have a wider perception of the Grid and their applications require not only traditional computation but also access to complex data repositories and services as well as mixed distributed computations. The astrophysical community certainly has this perception of the Grid. This work concentrates on the interoperability aspects between the Grid and the scientific instrumentation. The new IE (Instrument Element) Grid Element has been designed, built and tested for this purpose. The IE makes possible to monitor and remotely control any scientific instrumentation. The first implementation of the IE is focused on the monitoring aspects; astronomers having access to a Grid infrastructure through a Grid-UI can interface the observing facility where their observing runs are in progress and check the telemetric data as well as scientific data during their acquisition. Future releases of the IE will be extended to the remote control so that remote working sessions using remote astronomical instrumentation shall also be possible. This work is part of the wider project (including the Query Element) whose goal is to exploit the Grid technology to build a homogeneous astronomical working environment where scientific data are acquired, checked, compared with data coming from other databases, processed and stored.
1. Introduction

Two INAF structures, the Astronomical Observatories of Trieste and Capodimonte (Naples), involved in the Grid.it project (http://www.gird.it) aiming at ‘Enabling platforms for high-performance computational grids orientated to scalable virtual organizations’, explored the possibility of using the Grid technology for monitoring and remote controlling any kind of astronomical instrumentation. The first testbed for grid applications trying to use the Grid in this context is the Italian INFN Production Grid for Scientific Applications based on the LCG-2 distribution.

Because we decided to go on with this project through subsequent refinement steps, within Grid.it we focused our attention on the remote monitoring aspects only. We used as test bed two small Celestron Telescopes installed at the observing branch stations of the Trieste and Naples Astronomical Observatories. The final goal of the project is to extend such capabilities in order to allow users not only the monitoring but also a full remote control of any kind of scientific instrumentation through the Grid.

The Grid infrastructure based on LCG is an extremely stable computational and storage resource; it does not supply however an adequate model for Grid services like monitoring/control of scientific instrumentation, so this Grid infrastructure cannot be used for this purpose. To make the Grid attractive for astronomers, however, they must perceive it as a full comprehensive tool that allow them to carry out their tasks (remote monitoring and control of observing sessions, telemetric and scientific data acquisition, processing such data, cross-correlating them with similar data retrieved from one or more databases, storing raw and processed data in some other database), it is mandatory to fill up this missing point intrinsic of any Globus 2.4 based Grid infrastructure.

For this reason some INAF institutes are collaborating in designing, developing and implementing an architecture to integrate a new grid element, namely the IE (Instrument Element), in the existing Grid infrastructure. New multidisciplinary collaborations, moreover, are now in the startup process to make the IE capable of monitoring and controlling any scientific instrumentation.

In this paper we describe our effort in modeling the Instrument Element (IE) on the LCG based Grid environment.

2. An Instrument Element for LCG

The basic technique used in building the new embedded IE (Instrument Element) is the same used to set up the QE (Query Element), described in Taffoni et al. 2006. In other words our work focused on the definition of an abstract computational model for Grid and a more general meaning of the job-submission phase. The job submission, therefore, is extended, so that it can be used to send queries to a generic instrumentation control system. The IE therefore results in a generalization of the classical Grid CE and its deployment implies both the definition of the information schema (by introducing the set of metadata characterizing the new resource) to advertise on the Grid Monitoring and Discovering System the IE resources as well as an important extension of the Globus Jobmanager. See Taffoni et al. 2006 for further details.
As said above, the result is a Grid Instrument Element (IE) that allows the Grid user to interact with a remote control system to carry on the specified actions

- Publish on the Grid any kind of scientific instrumentation. Telescopes and related astronomical instrumentation are just an example of it.
- Share on the Grid any kind of scientific instrumentation.
- Get access to any kind of scientific instrumentation shared on the Grid infrastructure.
- Perform remote monitoring sessions in which only the Grid technology is used.
- Perform remote control sessions in which only the Grid technology is used.

In building the IE a reference project is the GRIDCC (Grid Enabled Remote Instrumentation with Distributed Control and Computation)\(^1\); our intention is to reuse and take advantage of the experience and results got through GRIDCC for our project.

3. The Integrated Working Environment System

The enhancement of the Grid middleware aiming at making it helpful for a growing number of scientific disciplines, and even in business and social areas is a fundamental step. To make possible a widespread diffusion of the technology, however, a user-friendly Integrated Working Environment System, federating all new capabilities of the Grid is of crucial importance. Through it the user will perceive the Grid as a whole providing what the user needs in carrying out its work: computing power as well as access to complex data repositories and services (e.g. remote monitoring and control). Considering the astronomical case, the final user may use the Grid to access any typical resource of interest; one or more observing structures and their instrumentation to monitor and remotely control observing sessions to acquire new scientific and technical data,

\(^1\)http://www.gridcc.org/
one or more Astronomical Database resources to get data to be compared/cross-
correlated with the new ones (see Taffoni et al. 2006), computing resources to
process both new and database-retrieved data, storage elements and database
resources to store the processing results. One of the main components of the
Integrated System is the Grid-GUI (Grid-Graphical User Interface) that will
be typically installed on the Grid-UI (Grid-User Interface) so that it can easily
interface the Grid infrastructure and access all resources and services sitting
behind it. A first prototype of the Grid-GUI has already been set up (Fig. 2).

4. Conclusion

The IE is a new embedded Grid element going in the direction of fostering a
widespread diffusion of the Grid Technology. The IE makes possible to use the
Grid for all applications dealing with remote monitoring and control of scientific
instrumentation. By combining the new capabilities brought by the IE and
those related with the Integrated Working Environment that federates together
the traditional Grid resources with those recently gridified, the user will be able
to exploit a comfortable and complete working environment, entirely based on
the Grid technology. Through the IE the final user has access to a wide range
of data acquisition facilities spread worldwide with no special software to be
installed on his/her machine. The Integrated Working Environment will drive
the user in accessing and using the whole set of gridified resources in an easy
way. The user is not requested to know anything about how the underlying

technologies operate.

References

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