Contribution ID: **58** Type: **Oral Presentation**

# VisIVO, visualization in different grid environments, from gLite to Desktop Grid

*Wednesday, 13 April 2011 14:30 (30 minutes)*

## Overview

The availability of distributed computing infrastructures has been growing rapidly in the last few years. Many scientific fields can now produce high-resolution numerical simulations with multi-dimensional datasets in the order of several Petabytes. An essential part of modern scientific research is the necessity to employ computer graphics and scientific visualization tools for appropriately displaying such datasets, so as to allow scientists to perform efficient visual discovery. We present VisIVO, a powerful environment for exploring highly complex multi-dimensional astrophysical datasets on the grid.
VisIVO provides an integrated suite of tools and services that can be used in many other scientific fields. VisIVO allows users to visualize meaningfully highly-complex, large-scale datasets and create movies of these visualizations based on distributed infrastructures. The deployment of VisIVO on the DG and gLite is carried out with the support of EDGI and EGI-Inspire projects.

## Impact

The main characteristic of modern astronomical datasets is extremely large sizes, typically requiring storage in a distributed way. Gaining an insight into such datasets requires very powerful statistical and data analysis algorithms that can be fully realised, in a cost-effective manner, only through gateways to grid and cloud infrastructures. Forthcoming astronomical surveys are expected to collect Petabytes of raw data resulting in massively large-scale distributed databases requiring that astronomers interact with them using very high performance data analysis and visualisation tools.
INAF-OACT is involved in numerous grid activities, e.g. the COMETA consortium that is developing a large grid infrastructure, not only for research but also for industrial applications. INAF is also a full partner of the Italian Grid Initiative (IGI) which regards science gateways as an extremely valuable service to be provided to the scientific community. IGI has expressed a strong interest in developing visualization tools on the grid. IGI is also part of the European Grid Infrastructure together with many other European NGIs.
We are also working with science centres on a pilot experiment to identify novel ways for exploiting the functionality of VisIVO using smartphones for large-scale public engagement activities. The use of DG could significantly improve this experiment. Within the activities in the EDGI and EGI-Inspire projects we will port and install our portals in dedicated servers exploiting existing grid infrastructures. We envisage that using smartphones via these portals, potential users (researchers, citizen scientists, science centre vistors) would be able to exploit VisIVO functionality on-the-go, accessing archives of large-scale datasets and generating images/movies by exploiting the power of grid infrastructures.

## Description of the work

VisIVO supports high-performance, multi-dimensional visualization of large-scale astrophysical datasets. Users can rapidly obtain meaningful visualizations while preserving full and intuitive control of the relevant parameters. VisIVO consists of VisiVO Desktop - a stand-alone application for interactive visualization on standard PCs, VisIVO Server - a platform for high performance visualization, VisIVO Web - a custom designed web portal supporting services based on the VisIVO Server functionality and VisIVOSmartphone - a web application allowing modern smartphones to exploit the VisIVOServer functionality.
We are currently in the process of porting VisIVO Server on grid environments. VisIVO Server consists of three core components: VisIVO Importer, VisIVO Filter and VisIVO Viewer respectively. To create customized views of 3D renderings from astrophysical data tables, a two-stage process is necessary. First, VisIVO Importer is used to convert user datasets into VisIVO Binary Tables ((VBTs). Then, VisIVO Viewer is invoked for display. VisIVO Filters are collections of data processing modules able to extract interesting features in datasets for performing visual discovery.
Depending on the structure and size of datasets in consideration, the data exploration process could take several hours of CPU for creating customized views, and the production of movies could potentially last several days. For this reason an MPI parallelized version of VisIVO can play a fundamental role in increasing performance, e.g. it could be deployed automatically on nodes that are MPI aware. A central concept in our development is thus to produce unified code that can run as necessary either on serial nodes or in parallel by using HPC oriented grid nodes. Another important aspect, to obtain as high performance as possible, is the integration of VisIVO processes with grid nodes where GPUs are available. We have selected CUDA for implementing a range of computationally heavy modules.

## URL

http://visivoweb.oact.inaf.it

## Conclusions

Our future work will focus on fully porting VisIVO Server and VisIVO Web to grid environments, more specifically using desktop grids and gLite. The exploitation of grid technologies will enhance performance significantly by supplying the required computational capability. A very exciting possibility is the deployment of this technology for visual discovery in scientific disciplines apart from astrophysics. Furthermore, a pilot application built upon VisIVOSmartphone is underway for public engagement activities in astrophysics. Our ultimate vision is users (researchers, citizen scientists or even science centres visitors) being able to reserve resources for data analysis and visual discovery as required (possibly involving several production grids) and retrieving results on smartphones on-the-go irrespectively of internet access or geographical location.

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**Session Classification:** User Environments

**Track Classification:** User Environments - Applications