# Scientific Gateway: Grid and Cloud-based Visualization

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***Abstrac*t - The science gateway is important component of many large-scale Earth, astronomical, environmental and natural disasters science projects. Developing the sciences portals and the science gateways looks for us coverage of requirements of large scale sciences such as, Earth science, astronomy and all sciences which are using grid, cloud or cluster computing and high-performance computing infrastructure. We participate on designing and developing an e-Science Environment for Astronomy and Astrophysics. The paper describes the main visualization facilities for Visualization Tool (VT) to qualify them for Scientific Gateway, which have been apply for our design of astronomy Visualization Tool.**

***Keywords-visualization; grig; cloud; gateway.***

## I. INTRODUCTION

Through user-friendly web interfaces such as e-Science gateway integrated into the same environment, researchers and scientists can securely and transparently access computational and data sources, services, tools, sensors, etc. Science gateway is a computational web portal that includes a community-developed set of tools, applications, and data customized to meet the needs of a targeted community. It can hide the complexity of accessing heterogeneous Grid computing resources from scientists and enable them to run scientific simulations, data analysis and *visualization* through their web browsers [5]. Scientific gateways are able to provide a community-centric view, workflow/dataflow services and a strong support in accessing to the cyber infrastructure including grid and cloud based resources. In each of science contexts, scientific gateways play a key role since they allow scientists to transparently access to distributed data repositories (across several domains and institutions) and metadata sources to carry out search & discovery activities, as well as *visualization* and analysis ones, etc. Finally, scientific gateways can play an important role in training students (at the academic level) in the different scientific disciplinas, attract new users and representing a relevant centralized knowledge repository in the sciences context. Our paper deals with the position of *visualization* as one of the main components of scientific gateway. The scientific web portal - gateway cumulate all types of *visualization*.

Since 2004 numerous scientific gateways have been developed. Lot of scientific gateways were funded by the TeraGrid Science Gateways program [1]. The gateway paradigm requires gateway developers to compile and install scientific applications on a variety of HPC clusters available from the resource providers in TeraGrid, to build service middleware for the management of the applications, and to develop web interfaces for delivering the applications to a user's web browser. Consequently many web-service frameworks [2][3] have been designed and applied in building domain-specific science gateways. Some of them enable workflow based on the web services [4], but they commonly don't provide solutions to support web interface generation. Developers was usualy hindered. Usualy they need to spend a lot of time learning web programming, especially JavaScript and AJAX Technologies to implement a user-friendly and interactive web interface to these services.

Developed visualization tools by us take acces on properties to include them to the Scientific gateway. For example our design propose a new web based application framework for astronomy and asttrophysics environment. We start from rich experimences in lot of grid and cloud based project in e-Sciences environment. We start with proposing new framework enables astronomy and astrophysic science gateway dewelopers based on last one web resources. Visualization tool is part of gateway and proposes a new based application framework for astronomy and astrophysics environment. The framework including the can import the astronomy specific workflow scripts easily can generate web appliance for running astronomical applicationworkflows and visualization the outputs results directly from workflow execution, online visualization through their web browsers.

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## II. VISUAL REPRESENTATIONS OF DATASETS WHICH ENABLED SCIENCE GATEWAY

There are some reasons why scientists, including astrophysics, are using visual representations of datasets

- for a visual control of the execution proces
- for know-how discovery and for presentations the academics research results
- for formal publication of research results
- for a directly visual education form

*A. VT architecture, and visual control of the execution process*

Simulation and execution with a huge date usually spend long execution time. Good solution for execution is represented by grid and actually on cloud computing. In both infrastructures get *visualization* has the main position as a way to control the execution proces**s.** Visual control has in all infrastructure very useful position. The modal parametric studies applications include, for example, astronomical simulations on which we tested our submission tool as on-line visualization tool. The simulation was realized as a sequence of parameter studies, where each sub-simulation was submitted to the grid as a separate parameter study. The job management was rather time consuming due to the analysis of failed jobs and to their re-submission.

*Visualization* is included as a visual control process. The visualization tool is designed as a plug in the module. Client asks for visualization is as a “visualization client”. Output data on the storage element are the inputs data for visualization jobs. Visualization workers are to modify data to the formats, which can be visualized but also to prepare the typical visualization scenes. Client can render such scenes on the browser, can make the visual control and modify executions. For example, to immediately understand immediately the evolution of the investigated proto-planetary disc we have developed a Visualization Tool (VT). The VT is composed of several modules, which are responsible for creating scenes and converting data to the the “visualize” format. The VT is designed as a plug-in module. The components generating rendering scenes are easy to exchange, according to the requirements of the given application. In case of our “gridified” application the output data of the simulation located on the SE can be used directly as the input for the VT. The final product of the VT includes a set of files containing data in the VRML (Virtual Reality Modeling Language) format. These output files can be rendered by many available VRML web-browsers. The whole visualization process is maintained through a visualization script, whose basic function is invoking the individual VT components in successive steps, transferring data, and handling error events. The script is written using the Bourne shell scripts and all VT modules are implemented in the C++ language. The VT can be embedded into the framework described above, or can be used separately as a stand-alone program. By using the on-line VT the client can stop the execution process, change the input parameters and restart the execution process ones again. In grid environment. such architecture can be used for all applications from different sciences spheres which have the character of a parametric study.

Actually the research community needs not only “traditional” batch computations of huge bunches of data but also the ability to perform complex data processing and this requires capabilities like on-line access to databases, interactivity, fine real-time job control, sophisticated *visualization* and data management tools (also in real-time), remote control and monitoring. The user can completely control the job during execution and change the input parameters, while the execution is still running. Both tools, the tool for submission designed before and continued sequential visualization tool - provided complete solution of the specific main problem in Grid environment. The position of the visualization tool as a visual control process is shown in Figure 1. Astrophysics scientists are able to run scientific simulations, data analysis, and visualization through the web browsers. Through astronomical science gateway can scientists to import they sofisticated scripts by which the VT he can activated as well, as the output from workflow executions without writing any web related code [6].

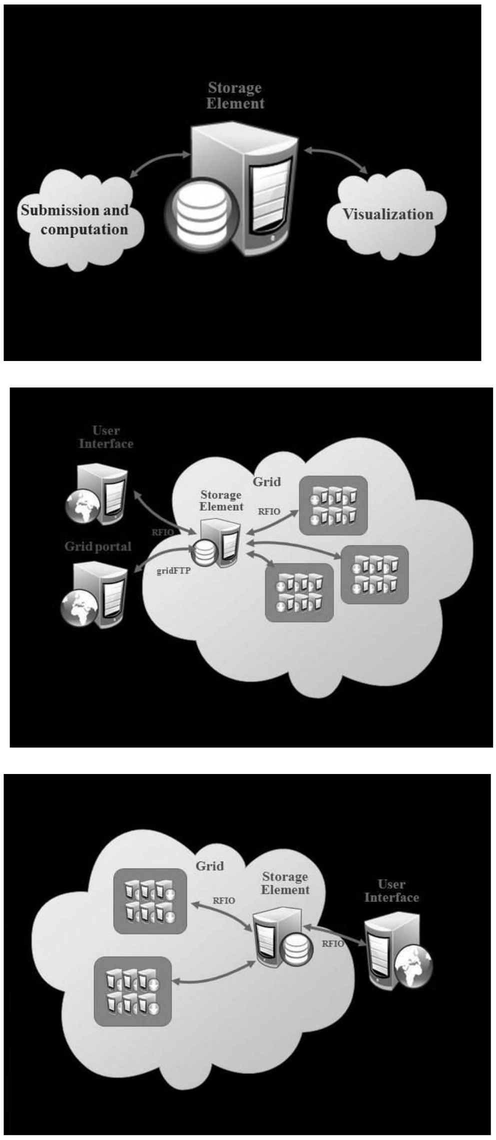


Figure 1. Example On – line visualization – the main position in grid based applications. Example when is visualization using as a control of execution process

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### B. VT as a new discovery for presenting academic research results

In order to demonstrate the practicalities of interchanging multi-dimensional data, we consider the case of cosmological visualization: representation of the three dimensional spatial structure of the Universe, including both observational and simulation datasets. Where such information exists, we extend this definition to include time-evolving datasets (e.g., evolution of structure formation or the hierarchical merging of galaxies), and derived data products such as catalogues and merger trees. A modern, fully-digital cosmological visualization allows the user to rotate, zoom, pan and even interactively select from datasets.

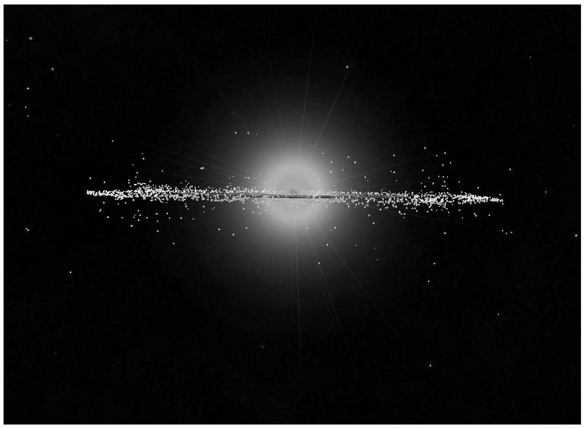
Advance in sciences and engineering results in high demand of tools for high-performance large-scale visual data exploration and analysis. For example, astronomical scientists can now study evolution of all Solar system on numerous astronomical simulations. These simulations can generate large amount of data, possibly with high resolution (in three dimensional space) and long time series. Single-system visualization software running on commodity machines cannot scale up to the large amount of data generated by these simulations. To address this problem, a lot of different developed grid-based visualization frameworks have been developed for time-critical, interactively controlled file-set transfer for visual browsing of spatially and temporally large datasets in a grid environment. To address the problem, many frameworks for grid and cloud based visualization are used.. We can go through evolution of sophisticated grid based visualization frameworks with actualized functionality. For example: Reality Grid, “UniGrid” and “TerraGrid”.

All of the frameworks have been included in the *visualization*. Frameworks were created during grid based projects and create new features for presentations the academic research academic results in visualization. Visualization resources enabled by a astronomical science gateway the top of researches experiences.

### C. VT and its formal research results

Multiple visualizations generated from a common model will improve the process of creation, reviewing and understanding of requirements. Visual representations, when effective, provide cognitive support by highlighting the most relevant interactions and aspects of a specification for a particular use. The goal of scientific visualization is to help scientists view and better understand their data. This data can come from experiments or from numerical simulations. Often the size and complexity of the data makes them difficult to understand by direct inspection. Also, the data may be generated at several times during an experiment or simulation and understanding how the data varies with time may be difficult. Scientific visualization can help with these difficulties by representing the data so that it may be viewed in its entirety. In the case of data, varying in time animations can be created that show this variation in a natural way. Using virtual reality techniques, the data can be viewed and handled naturally in a true three dimensional environment (e.g. depth is explicitly perceived and not just implied). All these techniques can allow scientists to better understand their data. Viewing the data in this way can quickly draw the scientist's attention to interesting and/or anomalous portions of the data. Because of this, we encourage scientists to use scientific visualization from the beginning of their experiments and simulations and not just when they think they have everything operating correctly. This also allows the scientists to develop a set of visualization tools and techniques that will help them understand their data as their research matures. For example, depending on of our astronomical example in order to understand immediately the evolution of the investigated proto-planetary disc we have developed a Visualization Tool (VT) for astronomers.

VT for the astronomical application provides pictures from simulation of the evolution of proto-planetary disc from 1Myr to 1000 Myr. Specifically, Figure 2. shows the evolution of proto-planetary disc in the time of 1 Myr. We can see that during the 1000 Myr time that the particles were replaced from inside to outside of the spheres. Figure 2 show the result of dynamical evolution of Oort- Cloud as a part of Proto-planetary disk after its evolutionary stage which was the first Gyr (giga year) [7].



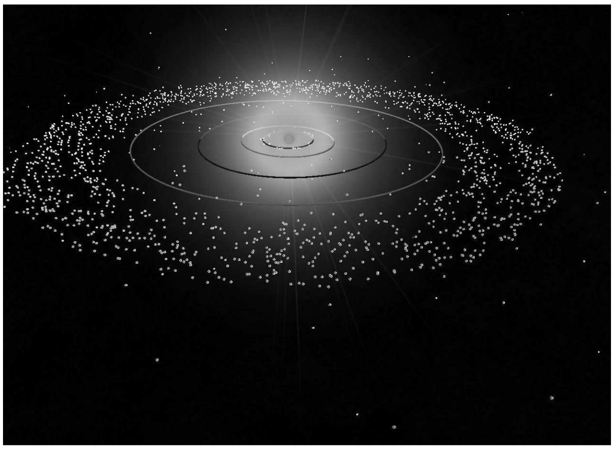


Figure 2. Example On – line visualization – the main position in grid based applications. Example when is visualization using as a control of execution process

### *D. Directly visual education form*

Educational visualization uses a simulation normally created on a computer to develop an image of something so it can be taught about. This is very useful when teaching about a topic which is difficult to see otherwise see, for example, .protoplanetary disk., its evolution or evolution in Solar system. It can also be used to view past events, such as looking at the Solar system during its evolution stage, or look at things that are difficult.For astronomers, the VT has in education roles well.

## III. CONCLUSION

The goal of the paper was to describe the VT architecture and to support the *visualization* as essential component in new portals - gateways technologies and to show some examples. For the future we want to extend the use of the VT for other scientific disciplines in addition to astronomy, but also for Earth Sciences with all *visualization* aspects. For the future, we plan to participate in a project in which the main activity will be to create and operating a pan-European e-Science Support Centre as a global astronomical environment in which portals such as gateways with *visualization* included will be as part of essential requirements. In the future we want instead of grid infrastructure to use the cloud resources.

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