GRAPHICAL FRAMEWORK FOR GRID INTERACTIVE AND PARALLEL APPLICATIONS

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Abstract. Considering how complex Grid technology is, it is essential to provide adequate support on users' level in order to simplify interaction and attract users. Intuitive and easy-to-use graphical user interfaces could be critical for the usefulness of the whole infrastructure and may play a significant role within successful stories. We would like to present the int.eu.grid approach to a Migrating Desktop product that brings the grid interactive services to a users desktop. The Migrating Desktop as the framework for grid applications aims at providing a unified and intuitive graphical work environment that allows users to control sophisticated interactive services, access Grid resources, run sequential and parallel jobs – using both batch and interactive paradigms. The Migrating Desktop provides a front-end for embedding some of the application mechanisms and interfaces, and it allows the user to have virtual access to Grid resources. Generic API for applications based on the OSGi specification provides mechanisms for the job submission phase, interaction with an application and remote visualization of the results which assemble the powerful platform for the Grid environment.

Keywords: Grid, user interface, parallel applications, desktop

1 INTRODUCTION

Rapid growth of demands for computational power over the last few years aroused interest in the research in the area of computational Grids. One of the research fields is designing tools and technologies that give easy, secure and consistent access to Grid applications and resources.

Among the commercial or educational products, which can be used for accessing the Grid, one can distinguish general-purpose products and Grid-dedicated tools (containing the most commonly used Web-browser-based Grid interfaces). Contrary to Web-based products, the Migrating Desktop tends to bring the Grid to the users through the system independent application.

The Migrating Desktop is a platform which supports users during work with the Grid environment. It consists of various elements that make Grid infrastructure transparent for users and makes it easily accessible through a user friendly client application.

The Migrating Desktop Platform is a part of The Interactive European Grid project. Thanks to the Migrating Desktop Platform's flexibility it is also utilized within different Grid-based projects (e.g. BalticGrid).

2 MOTIVATION

Grid related environment is usually based either on CLI (Command Line Interface) or Web related solutions. CLI is not considered user friendly by regular users. Working with Grid based applications through the CLI commands requires knowledge which is not that common in today's user interface experience. Because of that, Web based solutions are more suitable for regular users.

There are few factors that make the Web-based user interface the most commonly used way of accessing Grid remote resources. A Web-based interface offers an easy manner of interaction with a user that hides from the user heterogeneity and complexity of the Grid systems. Beside services dedicated for Grid systems (like users profile management, information services, remote job submission, job tracking, file transfer, authentication and authorisation) webbrowser based interfaces usually provide also a large set of additional services, such as e-mail, forums, search engines, etc. The most popular representatives of that group are Grid portals – portals that address a large Grid user community with its various requirements. However, some limitations of portals technology (not so intuitive usage, problems with extending functionality by third party providers, problems with accessing local resources, etc.) make Web-based solutions not efficient in specific areas, e.g. interactivity.

There is a demand for easy access to resources and network file systems independently of the system version and hardware. Additionally there is a need for applications that allow users to run Grid-based applications and tools, manage data files, and store personal settings independently of the locality or the terminal type.

In that context comes a Migrating Desktop Client which hides all low level data processing providing users with well-defined and easy-to-use GUI. Moreover, the MD Client provides features that makes it easier to execute, track and analyse Grid-based applications, provides ways for file management and even makes it possible to visualize interactive jobs while they are running. The Migrating Desktop also offers support for "roaming users". With the Migrating Desktop they can use their

personalized working environment irrespective of their physical location and used operating system.

Grid-based applications can firmly differ one from another. On the other hand, users expect that each application can be executed nearly the same way. The Migrating Desktop Platform handles this issue through a well-defined and established plug-in management system.

3 MIGRATING DESKTOP ARCHITECTURE

The Migrating Desktop Platform consists of two major components: server (Roaming Access Server) and client (Migrating Desktop Client) [1]. Each of them is responsible for different tasks and has different architecture. While the server is based mainly on web services, servlets and JSP, the client is composed of OSGi plug-ins. Thanks to their open structure both are easily extensible.

3.1 Server Architecture

The Roaming Access Server makes access to Grid-related software fully transparent for the users. Currently the Roaming Access Server supports two different kinds of Grid related middleware: gLite and i2g. Thanks to the web-service-based architecture it can be easily extended with new features and provides system administrators with a posibility to configure the system according to one's demands. Each part of the server can be installed in a different physical system, which provides an easy way to scale and extend the system in the future while a request for a computational power increases.
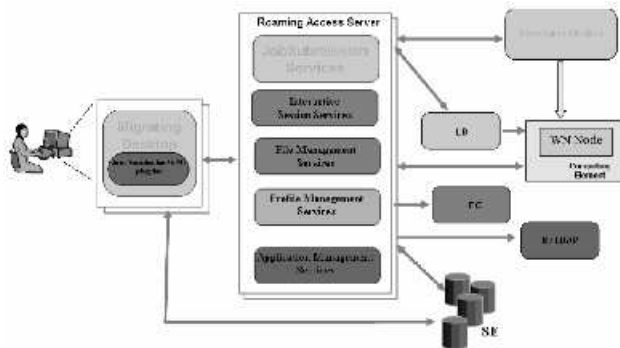

Fig. 1. Migrating Desktop architecture

3.1.1 Server modularity

The Roaming Access Server is composed of different modules responsible for different tasks. Each module is fully separated and has a well-defined API that allows all the modules to communicate with one another. Among others there are main modules that make up the core of the RAS: Job Submission Service (which is done using CrossBroker [4]), Interactive Session Service, File Management Services, Profile Management Services, Application Management Services. Thanks to these modules the client application is able to make gLite and i2g middleware fully transparent. Thanks to easy access to web services, the Migrating Desktop Client can support users with easy-to-use file management, personal settings storage, interactivity and plug-ins management.

3.2 Client Architecture

The Migrating Desktop Client application is a front end of the Migrating Desktop Platform. This is the part that is most extensively used by the users. While RAS focuses on providing the whole platform with access to Grid-related software, the MD Client provides users with an easy, user-friendly way of accessing Grid-related tasks. Application follows desktop-based paradigm that is considered to be much friendlier for the users than CLI.

As the Migrating Desktop Platform must support the extension mechanism for different applications, it uses well-defined and established plug-in standard – OSGi. OSGi is a technology designed to provide a general-purpose, secure, and managed Java framework supporting the deployment of extensible and downloadable modules known as bundles that usually provide services – a collection of interfaces and their implementations. OSGi is a standard with several implementations (Equinox, Knoplerfish, etc). It is used as an engine for open source Eclipse IDE and is heavily supported by commercial companies. More than 35 companies from various areas (Sun, IBM, Ericsson, Nokia, Philips, BMW, etc.) compose the alliance responsible for OSGi development. Thanks to this solution one can easily develop their own applications and extend the Migrating Desktop Platform. To prevent malicious behavior of plug-ins, the Migrating Desktop Platform comes with an administration tool that helps system administrators to manage all the plug-ins that are installed in the infrastructure.

3.2.1 Desktop

The main work area of the Migrating Desktop is represented by the desktop which allows users to store and manage applications that he/she uses most often. On top of that there are many additional features that improve user experience while accessing the grid.

The main application window provides access to most commonly used functionality of the application which simplifies the process of execution of the Grid-based

Fig. 2. File management

applications even more. With a single click users are confronted with tools that help manage files, submit Grid-based jobs and manage jobs later on during computation.

3.2.2 File Management

The file management system provided by the Migrating Desktop Platform simplifies the way users can manage files within the Grid. Apart from a dedicated plug-in for file management the Migrating Desktop Client provides access to different storage systems.
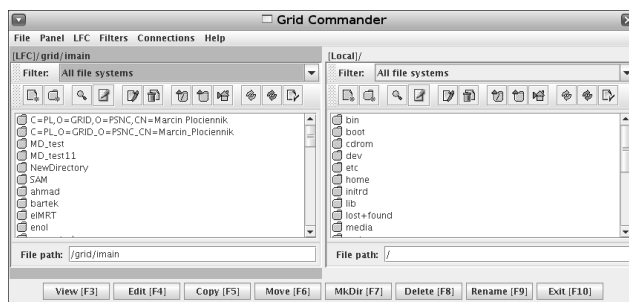

Fig. 3. File management

The Migrating Desktop Client can now fully support: SRMv2.2, LFC(Logical File System), gsiftp, local filesystem. From the user point of view, unified file operations are available through the tools like GridCommander, Grid Explorer. The Grid Commander (3) is a two-panel application similar to the Commander family tools.

3.2.3 Job Management

Trying to meet all the users' requirements, the Migrating Desktop Platform supports a variety of job types. It allows users to start batch jobs, parallel jobs, and interactive jobs. In addition, it provides support for different kinds of parallel applications. It can fully support OpenMPI, PACX-MPI, and MPICH. One of the most valuable features is that the MD Client is able to visualize parallel jobs while they are running which makes the Migrating Desktop Platform a powerful tool for Grid-based development.

Fig. 4. Job Management dialog

In addition to job submission, Migrating Desktop Client makes it easy to manage jobs that are already running. It simplifies visualization and management of jobs. Users can easily resubmit, cancel or entirely delete a job. There are also options for the users that allow access to full information regarding a particular job.

Different types of jobs may differ in job output visualization. For that the Migrating Desktop Client allows users to develop their own visualization plug-ins that can base on the job output and present it a proper way. Thanks to the OSGi model, it is easy to develop any additional module and to plug it into the Migrating Desktop Client.

3.2.4 Output Processing

Visualization plug-ins are part of the Migrating Desktop Client application, but they may be dynamically added by users. There are both universal and highly specialized plug-ins for visualizations. They also differ when it comes to the way that output is processed.

The Migrating Desktop Client can handle both interactive and non-interactive output. While non-interactive visualization is made for simple outputs, interactive job visualization is a powerful tool that not only allows users to analyse output data but additionally allows users to interact with Grid applications. This feature adds a new value to Grid-based and parallel computation as well. Interactivity is based on two independent solutions: glogin [2] adnd GVid [3]
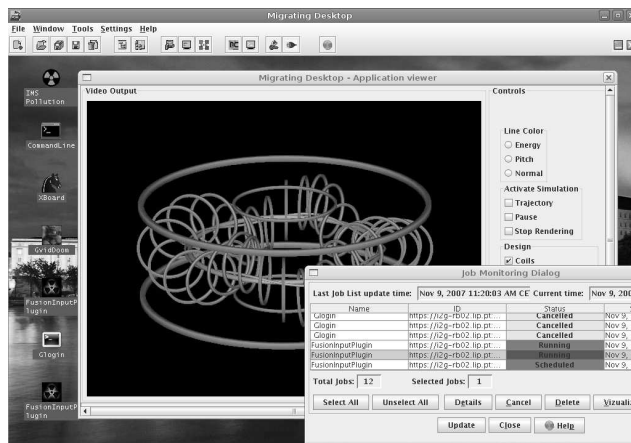
Fig. 5. Migrating Desktop main window

4 INTERACTIVITY

One of the major achievements of the Migrating Desktop developed within the Interactive European Grid project is the ability to execute and maintain an interactive application within the Grid. This powerful tool gives users the whole new perspective to the Grid. Thanks to Gvid [3] and glogin [2] technologies it is possible not only to execute Grid-based application that utilizes graphics but also to interact with it during run time. This provides users with new abilities while running applications that make use of Grid resources. Now users are able to track application's results in real time and take actions which have immediate impact on the running program. Thanks to this solution a Grid application becomes more user-friendly. In addition, users are now able to create solutions that were hard to achieve before interactivity had been introduced.

A good example of interactivity utilization is Visualisation of Plasma in the Fusion Devices application. It provides users with a posibility to use Grid based solutions and at the same time provides users with a user-friendly interface that makes it easier to maintain and steer application while it is running (Figure 5). It seems that a growing tendency to develop interaction-based application will be established and more and more applications will follow the interactivity-based model.

5 USER EXPERIENCE

The Migrating Desktop was validated not only through the validation procedures but by the users as well. There are various applications that have been developed for the Migrating Desktop Platform. The Migrating Desktop is commonly used within the Interactive European Grid project as well as in the BalticGrid project. Various

virtual organizations are prepared for using the Migrating Desktop as a front end for the following users: imain, imon, itut, itest, ifusion, iplanc, ibrain, ienvmod, iusct, and gamess. The Fusion application, run within the ifusion Virtual Organization, is a good example of software ability. It provides users with features that make the software simple to use, while on the other hand to extensively use the Grid power. Thanks to the Migrating Desktop's open architecture it can follow various trends within science and fulfil different requirements. There are several pilot applications currently running within the Migrating Desktop Environment; just to mention few of them: Ultra Sound Computer Tomography (support for ultrasound computer tomography, including real-time data storage, assisted diagnosis on brain images and support for clinical VO), Visualisation of Plasma in Fusion Devices (visualization of the behaviour of plasma inside a Fusion Reactor), Simulation of the Dispersion of Pollutant Agents in the Atmosphere (modeling dispersion of the pollutant in the atmosphere as the movement of individual independent particles), SYNTSPEC (The Stellar Spectra Modeling – calculation of normalized to the continuum stellar spectra that serve for determinations of e.g. chemical composition, effective temperatures and surface gravities of stars), GAMESS (used for ab initio molecular quantum chemistry), SemtiKamols (development of semantic resources and methodologies for automatic meaning extraction from Latvian texts).

The Migrating Desktop Platform can be considered as well perceived by the Grid users. The EGEE User Forum has appreciated the product (together with other int.eu.grid middleware) with a special award that was presented to the best demo. The demo "interactive and parallel applications on the Grid – Visualization of Plasma Particles in Fusion Devices application example" have presented the abilities of running interactive, parallel applications across several sites supporting real-time computation on the Grid, including interactive access and powerful visualization features within user-friendly Migrating Desktop framework.

6 USER SUPPORT

Because of a variety of configurations the Migrating Desktop can be run at, there is a demand for users' support. For that the Migrating Desktop development team provide different ways of support which can be divided into three major categories – based on their target groups: administrators, users, and developers. Each group has different expectations and each group must be supported in a different way. While administrators are responsible for setting up the whole infrastructure they usually require support for all the elements that compose the whole Migrating Desktop Platform. Users, on the other hand, are focused on the MD Client only and require support regarding basic usage of the application. As the Migrating Desktop Platform is open for other developers (it allows to build extensions that can be plugged into MD later on) there is a demand for developers support as well.

The Migrating Desktop Platform team fulfils these expectations with a variety of support products – documentation, API definitions, support during development,

different kinds of tutorials and demos. In addition, users are free to report bugs and request new features through the open bug tracking system. The source code is freely available for the people who are interested in developing the Migrating Desktop Platform extensions.

7 RELATED WORK

Access to grid resources is frequently realized through portals or command line interfaces, including Java CoG Kit Desktop [5], GridSphere [8], g-Eclipse [6], and P-GRADE [7]. All these products are based mainly on middleware designed and developed within projects they belong to. The core grid functionality is quite similar in all cases: basic operation on files, job submission and monitoring. The main difference from the user's point of view is the general outlook of described products interface. GridSphere and P-GRADE are portals with a standard browser-like user interface. In contrast to these products, the Migrating Desktop offers a "Windows-style" desktop, so working with that product can be much more comfortable and intuitive for a user acustomed to working with any "windows" systems (MS Windows, KDE, Gnome, etc.) used by a significant majority of computer users. Java CoG Kit Desktop and g-Eclipse are also a windows-based solution, but they differ from the Migrating Desktop. g-Eclipse seems to be more a developer-oriented solution – not that easy to use for regular users. While Java CoG Kit Desktop seems to be more user-friendly it lacks some of the Migrating Desktop's features, like multi-file selection for job input/output, flexible job definition, easy file management. The Migrating Desktop has one more very important advantage – it supports interactivity within the Grid environment. It seems to be very hard to achieve this feature in Web-based applications. It also seems that other solutions based on the Desktop paradigm lack this feature.

8 CONCLUSIONS

The success of information technologies, such as grid computing, heavily depends on how easy it is for that are non-experts in the technology and systems being used to access and use them. It is also crucial for better deployment of the project results within new scientific user communities to enable user-friendly and intuitive access to the Grid environment. To achieve this goal we proposed the Migrating Desktop advanced graphical user interface and a set of tools combined with a user-friendly outlook, similar to window-based operating systems.

The Migrating Desktop, currently developed in the int.eu.grid project and deployed also within the BalticGrid infrastructure, proved useful in everyday work as a tool that makes Grid application usage much easier and more intuitive, which is essential for the encouraging potential beneficiaries to reap profits from the Grid infrastructure for computation- and data-intensive applications.

The future works include enhancement of the Migrating Desktop Platform components to follow rapid development of grid standards and services for ensuring compatibility with the gLite middleware in terms of jobs submission, running and monitoring processes state. Important future tasks include supporting scientific workflows, integration with accounting system, and work on interoperablility with other infrastructures.

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