GRIDCC Project

Publishable Final Activity Report

Project acronym: GRIDCC

Project full title: GRID ENABLED REMOTE INSTRUMENTATION WITH DISTRIBUTED CONTROL AND COMPUTATION

Contract no.: 511382

Start of the project: 1st September 2004

Duration of the project: 3 years

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Project coordinator name: Gaetano Maron

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Delivery Slip

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Project information

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Proposal/Contract no.:	FP6/2003/IST/2 nr. 511382
Partner coordinator acronym	INFN
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Section 1. PROJECT EXECUTION

Project Objectives

The goal of GRIDCC is to build a geographically distributed system that is able to remotely control and monitor complex instrumentation ranging from a set of sensors used by geophysical stations monitoring the state of the earth to a network of small power generators supplying the European power grid. These applications need real-time and highly interactive operation of GRID computing resources. To achieve this goal the project has three main objectives:

- To develop generic Grid middleware, based on existing building blocks (Grid Services) which will enable the remote control and monitoring of distributed instrumentation.

- To incorporate this new middleware into a few significant applications to validate the software both in terms of functionality and quality of service aspects. These applications include European Power Grid, Meteorology, Remote Operation of an Accelerator Facility, High Energy Physics Experiment.

- To widely disseminate the new software technology, results of the application evaluations on the testbeds, and to encourage a wide range of enterprises to evaluate and adopt our Grid-oriented approach to real-time control and monitoring of remote instrumentation.

GRIDCC Architecture

While remote control and data collection was part of the initial Grid concept most recent Grid developments have been concentrated on the sharing of distributed computational and storage resources. In this scenario applications that need computational power only have to use these Grid elements in order to access an unlimited amount of computational power and disk storage. From the other side, both scientific and technical facilities provide concrete use cases where a strong interaction between the instrumentation and the computational Grid is required.
The GRIDCC project, launched in September 2004 by the European Union, provides a well proven technology that can be deployed on the top of an existing grid middleware extending the grid e-infrastructure to the control and monitor of the remote instrumentation. EGEE gLite is the natural reference grid middleware for GRIDCC and the EGEE e-infrastructure is the natural framework where deploy and integrate the instrument grid technology.

The core and novel element of the GRIDCC middleware is the Instrument Element (IE) that basically offers a standard Web service interface to integrate scientific and general purpose instruments and sensors within the Grid. Another key component of GRIDCC is the Virtual Control Room (VCR) that has been introduced to provide to the remote users a virtual area from where they can control and monitor the instrumentation and where they can collaborate each other even if located in different physical sites. The third main component of GRIDCC is the Execution Service that basically provides a workflow engine able to handle BPEL workflows interacting both with the new GRIDCC and with the traditional computational and storage grid services. Control and monitor of instrumentation devoted to observe a phenomena or to control a physical process often require deterministic response time. For this reason GRIDCC has implemented a software infrastructure able to guarantee (hard and soft) time constrains.
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The here below reported figure depicts the relationship between the IE, the users and the other Grid components.

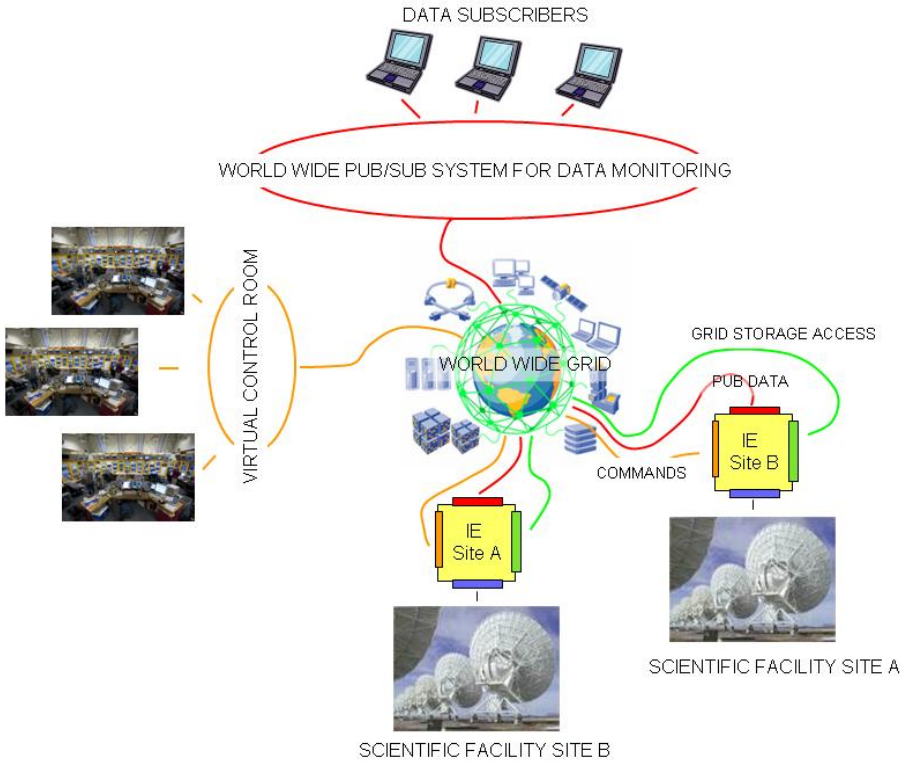

Figure 1 Instruments Integration in the GRID

Users interact with the instruments through a Virtual Control Room (VCR) that provides a prompt and highly interactive environment to control and monitor the instrumentation. Moreover VCR provides to the users a cooperative environment (chat, videoconference, electronic log book) to facilitate the remote interactions between different operators of the instrumentation.

The Instrument Element (IE) is a unique concept to GRIDCC and it consists of a coherent collection of services that provide all the functionalities to configure and control the physical instruments, as well as the needed interfaces to interact and integrate itself with the rest of the Grid. The four basic interfaces exposed by the IE are: a) the Virtual Instrument Grid Service (VIGS), a set of Web service compliant methods that allows the remote control and monitor of the instruments; b) a standard SE/SRM interface that makes recently acquired data and information of the IE immediately available to the Grid community; c) a very efficient publish/subscribe and streaming channel based on a multicast implementation of the JMS interfaces (RMM-JMS) that allows the IE to publish both acquired data and information such as errors, status and logs for diagnostic, alarm and monitoring purpose; d) the interface to the real instrument(s), designed according to the instruments specifications.

Current Status of Project

The project has continuously progressed towards the above mentioned aims providing all the foreseen deliverables and reaching the milestones.
The status at the end of the project can be summarized as follows:

- **Progress to develop generic Grid middleware to control and monitor instrumentation:**
  - All the key GRIDCC components have been officially released: Virtual Control Room, Instrument Element, Execution Service (workflow engine).
  - The security have been introduced in all of these components and a Kerberos based security has been adopted for high performance secured connections.
  - Web service and network parameters that have impact on a real time environment have been used to define and implement a software infrastructure able to guarantee (hard and soft) time constrains. An Agreement Service has been developed and fully implemented to use reservation (hard) for all the GRID components that provide such features. This includes the GRIDCC Instrument Element and the gLite Compute Element CREAM that has been extended to include such feature. QoS has been added to guarantee soft time constrains. The workflow engine has been improved for guaranteeing workflow QoS and the Instrument Element has been enriched with a Instrument QoS Service (IQS) that provides parameters defining the execution time of the IE methods and the accessibility of the service.
  - The access to the existing grid computing and storage elements (EGEE) has been improved ensuring a complete integration of all GRIDCC components.
  - The General Purpose Collaborative Environment is available as final release. It includes numerous improvements, a new layout of the GUI and a new resource browser. A graphical workflow editor has been integrated in the Virtual Control Room.

- **Progress to incorporate the new middleware into a few significant applications**
  - GRIDCC has validated its middleware integrating it in three pilot applications.
    - **Power GRID**, that is showing it is possible to control and monitor a very large numbers of “embedded” power generators widely spread on the territory
    - **High-Energy Physics: control and monitor of experiments**, that has installed the GRIDCC middleware in one of the four LHC experiments to provide the run control of the Compact Muon Solenoid (CMS)
    - **Far Remote Operation of Accelerator Facility**, that is showing the remote control of the Elettra (Italy) synchrotron
  - Other significant applications have used the new middleware to control and monitor the own apparatus. The list includes Meteorology, Device Farm control, Geo-hazards monitor and the Intrusion Detection System (IDS).

- **Progress in widely disseminating the new software technology**.
  - The dissemination activities are individually tailored to focus on various target audiences. The effective deployment of the test beds for the project has required a substantial effort, but

now allows us to offer stable and interesting demonstrations. Development work on these is continuing. The focus of the dissemination activity has been initially biased more towards the Scientific Community, rather than directed at EU citizens and industrial stakeholders, since the latter categories must be approached with care, in order to offer a captivating view. Two main media have been used: the publication of printed material and the usage of electronic material delivered via the Web.

- Since the beginning of the project some effort has been devoted to establish connections with other external partners with the aim of finding new collaborations or to disseminate interest in our project. This activity has been enhanced in the last period with the aim to find proper exploitations of the project also beyond the duration of the project itself. Thus contacts with other European projects and with experimental initiatives that could benefit of the GRIDCC middleware have been improved. This has led to two important outcomes in the context of FP7.

Section 2. DISSEMINATION AND USE – PUBLISHABLE RESULTS

Portion[1] of the GridCC Software is freely available as a public donwload at the Project Website. In addition, the software is documented and Technical Support is available via the T.A.R. section of the website. All the released software is protected via a Berkeley Software Distribution (BSD) style Open Source License.

[1] The GRIDCC consortium is composed by Research Centers, Academic Bodies and Industrial Partners. Owing to the peculiarity of the Industrial Components, the PMB (Project Management Board) will evaluate separately each exploitable result. At this moment, there is no need of taking measures to protect the knowledge. Specifically, the knowledge and the pilot software implementations are in early stage, and they are "proof-of-concept" implementations rather than modules to be used in a real deployment. Nevertheless, there is considerable design activity under such software modules, but so far they represent the tweaking of standard approaches, rather than brand new concepts.

The GRIDCC project heavily relies on standard technologies and many of the participants are involved in the field-of-competence standardization bodies. In this perspective, the output in terms of choices and design is a mixture of standard techniques already protected.

As regards the GRIDCC project dissemination performed via journals and conferences, the copyright is protected by the respective publishers.