Telemedical Applications and Grid Technology

Georgi Graschew[1], Theo A. Roelofs[1], Stefan Rakowsky[1], Peter M. Schlag[1], Sahin Albayrak[2], and Silvan Kaiser[2]

[1] Surgical Research Unit OP 2000,
Max-Delbrueck-Centrum and Robert-Roessle-Klinik,
Charité – University Medicine Berlin,
Lindenberger Weg 80, D-13125 Berlin, Germany
[2] DAI-Labor, Agent Technologies in Business Applications and Telecommunication,
Technical University Berlin, Salzufer 12,
D-10587 Berlin, Germany

Abstract. In recent years different institutions have launched several telemedicine projects which aimed to encourage the Euro-Mediterranean co-operation. The creation of a Virtual Euro-Mediterranean Hospital aiming to facilitate the interconnection of the various services through real integration has been recommended. Therefore Grid becomes inevitable for successful deployment of these services. Existing Grid Engines provide basic computing power needed by today's medical analysis tasks but lack other capabilities needed for communication and knowledge sharing services envisioned. When it comes to heterogeneous systems to be shared by different institutions especially the high level system management areas are still unsupported. Therefore a Metagrid Engine is needed that provides a superset of functionalities across different Grid Engines and manages strong privacy and Quality of Service constraints at this comprehensive level.

1 Introduction

1.1 The EMISPHER Network for Telemedical Applications

The EMISPHER project (Euro-Mediterranean Internet-Satellite Platform for Health, medical Education and Research, see www.emispher.org/) is dedicated to telemedicine, e-Health and medical e-learning [1]. During its implementation over the last two years, EMISPHER has deployed and put in operation a dedicated internet-satellite platform consisting of currently 10 sites in 5 MEDA countries (Casablanca, Algiers, Tunis, Cairo and Istanbul) and 5 EU countries (Palermo, Athens, Nicosia, Clermont-Ferrand and Berlin).

1.2 From EMISPHER Towards the Deployment of a Virtual Euro-Mediterranean Hospital

The EMISPHER network serves as a basis for the development and deployment of a Virtual Hospital for the Euro-Mediterranean region. The Virtual Euro-Mediterranean

P.M.A. Sloot et al. (Eds.): EGC 2005, LNCS 3470, pp. 1 – 5, 2005.

Hospital (VEMH) aims to facilitate and accelerate the interconnection and interoperability of the various services, being developed by different organizations at different sites, through real integration.

1.3 Services of the VEMH

- Euro-Mediterranean Medical University
  improved qualification by exchange and standardization of educational modules
- Real-time Telemedicine
  improved quality of patient care and qualification of staff
- Medical assistance
  improved continuity of care to stimulate tourism
- Implementation of Evidence-based medicine
  improved disease management and individual therapies
- Fellowship programmes for young professionals
  improved qualifications in multi-cultural and inter-disciplinary settings

1.4 Methodologies for the VEMH

- Medical-needs-driven instead of technology-driven!!!
- New management tools for virtual medical communities
  - *trust- and synergy-building measures*
  - *balance between technological and interpersonal skills*
- Management of clinical outcomes
  improved implementation of evidence-based medicine
- Modular architecture
- Integration of different telemedical solutions in one platform to support many different medical services (matrix structure)
  - *individual user needs (as matrix columns)*
  - *technical solutions (as matrix rows)*
- Data security & Patient's privacy

1.5 Communication Infrastructures for a Virtual Hospital

The communication infrastructure of such a Virtual Euro-Mediterranean Hospital should integrate satellite-based networks like EMISPHER with suitable terrestrial channels. Due to the distributed character of the Virtual Euro-Mediterranean Hospital, data, computing resources as well as the need for these are distributed over many sites in the Virtual Hospital. Therefore Grid becomes inevitable for successful deployment of services like acquisition and processing of medical images, data storage, archiving and retrieval, data mining (especially for evidence-based medicine). A more detailed description of the envisioned telemedical services can be found in [2].

Giving access to distributed services in a wide network of connected institutions the system shall integrate domain knowledge, powerful computing resources for analytical tasks and means of communication with partners and consultants in a trusted and secure user tailored support system.

2 Approach

2.1 Metagrid Services

Here we introduce our view of an agent-based Metagrid Service Engine (MGSE), which implements an additional software layer between proprietary Grid engines and the applications and therefore integrates the different approaches. It will make a global Grid across OEM-boundaries become reality.

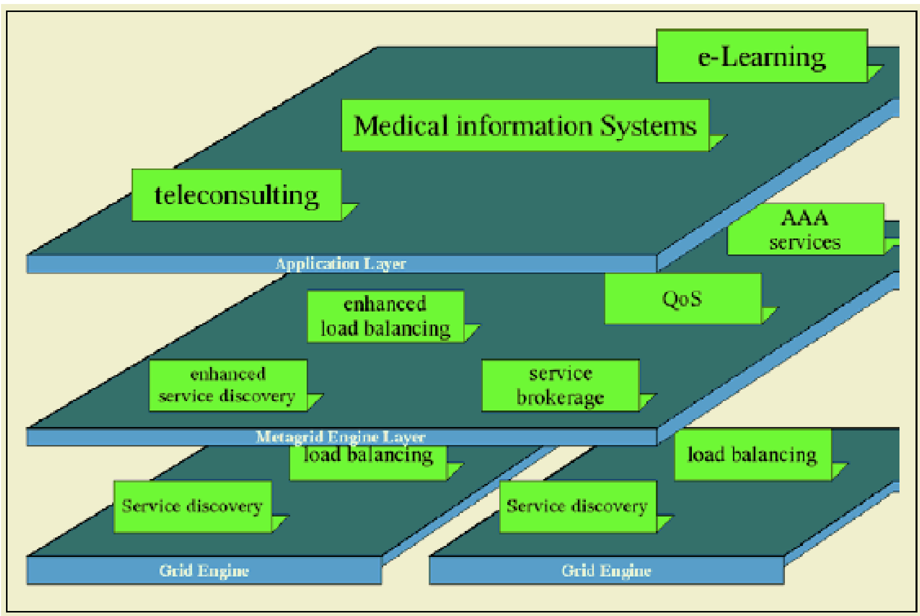

Fig. 1. Agent-based Metagrid Service Engine (MGSE)

The Metagrid Services should address the main issues of today's Grid Computing software. Low level Grids like the SUN Grid Engine provide scalable high performance Grids but have several requirements and shortages that need to be taken care of. First they need homogeneous Grid nodes because scheduled tasks contain only scripts designed to call the programs needed for the tasks.

Furthermore the low level design does not handle AAA aspects too well. When applying the ideas of inter-organizational Grids this becomes a very important issue, as perceived by the Global Alliance. Focusing heavily in this partial area, the Open Grid Service Architecture (OGSA) uses Web Services and sophisticated Authentication and Authorization techniques. Web Services allow a platform independent approach, combined with the included security mechanisms this becomes an important basis for the Global Grid vision [3].

2.2 Mobile Code

We envision the use of mobile code in future Grids which allows service creation and deployment on arbitrary nodes of a Grid giving a flexibility unknown by today's Grid technology. Services can be created and distributed in a Grid through mobile code, severely reducing the need for software installation in the Grids nodes.

The main objective is on the one hand an integration of low level concepts like the SUN Grid Engine in wide scale management like the OGSA and on the other hand bringing more flexibility to systems based on the OGSA framework by integrating features like dynamic service distribution, mobile code, etc. The ultimate goal being the ability to distribute tasks over a secure and organization spanning dynamic Grid.

2.3 Dynamic Grid

By using platform independent software Grids can be extended to large scale networks, allowing the flexible use of computing resources from a vast number of Grid nodes. Here support for dynamic Grid structures becomes an important point. Meta-Grid Services have to be able to tolerate changes in the managed Grid, like the addition or removal of nodes at runtime. Fallback mechanisms have to go to work when tasks cannot be fulfilled because nodes they where assigned to drop out without returning the appropriate task results.

Sub Grids can be put to best use by assigning tasks through intelligent Meta-Grid Services, these can differentiate the individual needs of a task and assign it to an applicable node or sub Grid, e.g. by assigning mathematical computations to high power SUN Grids while directing low priority tasks to other nodes (which possibly demand lower prices).

Integrating meta level accounting is an important Meta-Grid Service, empowering a Meta-Grid to ensure full accounting of scheduled tasks, including the use of sub Grids and other integrated legacy systems. These become immensely important when thinking about the inter-organizational aspects of global Grid structures.

2.4 Experimental Environment

In co-operation between Sun Microsystems and the Technical University Berlin a Grid testbed consisting of seven multiprocessor nodes based on heterogeneous hardware configurations has been set up. All nodes are interconnected by a Gigabit testbed. The systems are configured to run Linux or Solaris operating systems.

3 Conclusions and Perspectives

For successful deployment of the various medical services in the Virtual Euro-Mediterranean Hospital, the development and implementation of Health Grid technology appears crucial.

Subsequently, the implementation of this new technology might trigger a critical evaluation and adaptation / optimization of the medical workflow and corresponding decision-making trees.

References

[1] Graschew, G., Roelofs, T.A., Rakowsky, S., Schlag, P.M., Überbrückung der digitalen Teilung in der Euro-Mediterranen Gesundheitsversorgung – das EMISPHER-Projekt, In: A. Jäckel (Hrsg.) Telemedizinführer Deutschland, Ober-Mörlen, Ausgabe 2005, p. 231-236.

[2] http://whitepaper.healthgrid.org/

[3] Foster, I., Kesselman, C., Nick, J., Tuecke, S., An Open Grid Services Architecture for Distributed Systems Integration, 2002, http://www.globus.org/research/papers/ogsa.pdf.