

# GRID ENABLING E-GOVERNMENT THROUGH A UNIVERSAL ACCESSIBILITY GRID LAYER

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## ABSTRACT

The paper establishes a comparison between the grid (concept, standards, programming paradigms and implementation) and e-government as seen from the five viewpoints suggested by the standards and architectures of e-government applications. Based on this comparison, the paper discusses the potential and challenges of the grid for e-government and describes a universal accessibility grid layer that can potentially support grid enabling e-government applications.

## KEYWORDS

e-government, universal access, grid, SAGA, service

## 1. INTRODUCTION

The grid is a massive interconnection of computing resources distributed geographically across different administrative domains. Users of the grid can securely access these computing resources according to their privileges. Various efforts are underway for grid-enabling e-government applications (PGG-web) and (de Alfonso et al, 2006). However, several challenges are acknowledged. Our contention is that this is mainly due to a missing grid infrastructure supporting the accessibility to the grid by various application domains including e-government.

This paper is divided into five sections including this one. The second section introduces the grid and e-government. The third section establishes a comparison between the grid and e-government. The fourth section describes services offered by a grid layer to support universal accessibility and grid enabling e-government applications. The paper concludes with a summary and future research agenda.

## 2. THE GRID AND E-GOVERNMENT

### 2.1 The Grid

The Grid is aiming at bridging the gap between the demand for technology and the supply of technology by providing a vehicle for on-demand computation and massive storage. No single application domain can be excluded from the potential benefit of the grid, but some will benefit more than others. Serving the wider community is highly dependent on establishing an appropriate match between the grid technology and the application's need. The grid can be conceived as a suite of concept, architecture, programming paradigm, and implementation.

Several definitions describe the grid at a conceptual level. A common definition is given by Foster (2001) who identifies the real and specific objective that underlies the Grid concept as: "coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations. The sharing that we are concerned with is not primarily file exchange but rather direct access to computers, software, data, and other resources, as is required by a range of collaborative problem-solving and resource-brokering strategies emerging in industry, science, and engineering". The rules for sharing resources between the providers and the consumers of these resources are defined within the scope of a virtual organization (VO). The latter could be a set of individuals and/or institutions with varied purpose, scope, size, duration, structure, community, and sociology (Foster et al, 2002) and (Tuecke et al, 2003). The users trust the VO, the VO trusts its users, the resource providers trust the VO and the VO trusts the resource providers. The VO is central.

The *Open Grid Service Architecture* (OGSA) (Foster et al, 2005) is emerging as a standard for a service oriented architecture that can meet the objectives of the high level conceptual definition of the grid. OGSA adopts web services as an infrastructure and framework where service interfaces are defined by the *Web Services Description Language* (WSDL). However, web services cannot meet all the requirements for grid systems and applications and in particular security requirements and statefulness. Hence the Web Service Resource Framework (WSRF) (Czajkowski et al, 2004) was developed to overcome the limitations of web services.

The grid architecture suggests new programming paradigms that can harness the massively interconnected physical resources of the grid, yielding higher speed, increased power, and larger storage. Parallel programming is a key in this respect. Existing paradigms for parallel programming include *Message Passing Interface* (MPI) (Speight et al, 1998), *Distributed Shared Memory* (DSM) (Keleher et al, 1994), or a hybrid of the latter two (Ryan et al, 2004).

The grid middleware is the underlying grid software. Several grid middlewares are being developed within the framework of various grid projects. They differ in architecture, target application domain, and basic constituents. Depending on the architecture, these middlewares can interoperate to a certain extent. Once deployed on a grid site, a middleware will allow grid users to authenticate and use the various grid services. A typical component is the Globus toolkit (GlobusToolkit-web) that is part of most of the existing middleware. Basic services offered by the latest release of the Globus toolkit include: security, data management, execution management, information, and common runtime services.

### 2.2 e-Government

Vassilios (2003) classified e-government applications in five broad categories: 1) *e-Archive* including *e-Libraries*, *Job-Room*, land and properties information, and digitized historical archives *e-Archive*; 2) *e-*

**Democracy** including complaint management, a virtual forums for the democratic and political processes, people's participation in public decision- making process, and Internet voting; 3) **e-Business** including *Business Services Centres* and Business Registers; 4) **e-Citizens** including population records, social security administration, VAT declaration, reporting of a crimes, change of address notification, on-line skills evaluation system for farmers, and eHealth services; and 5) **e-Accessibility** including talking webpages for disabled, public web for computer illiterates, and a web-bus to help people start with computer. Heeks (2001) gives a high level description of the structure of e-government applications, see Figure 1.

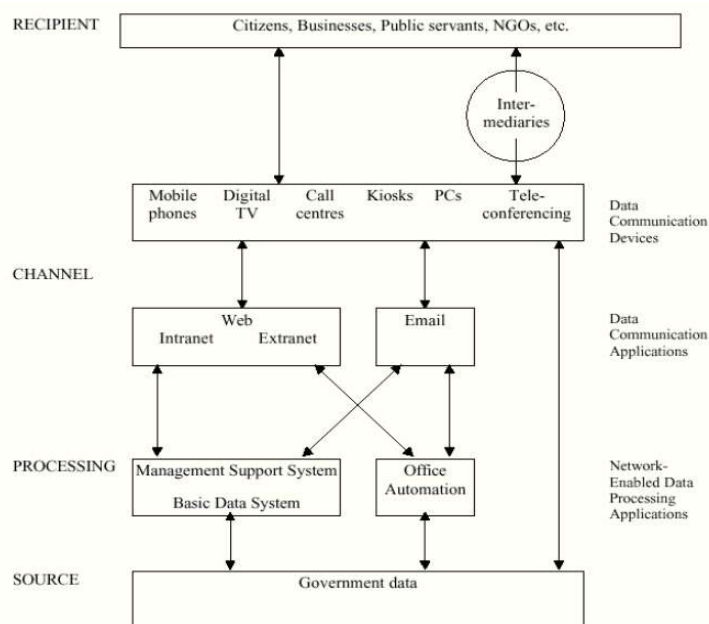


Figure 1. Structure of e-government applications (Heeks, 2001)

Heek's description refers to a four tier architecture proposed by the Standards and Architectures for e-Government Applications SAGA (SAGA, 2003) describing a specialist e-government application (see Figure 2):

**The client tier** represents different access channels reflecting different users, terminal devices, transmission routes, as well as different applications in order to interact with the specialist applications. Terminal devices involve: a) Web access via web browsers or special browser plug-ins; b) Mobile phones and personal digital assistants (PDAs); and c) External systems (such as ERP systems for industrial companies)

**The presentation tier** describes the processing of information in the client and the user's interaction with the specialist application. The presentation component includes all the standards for communication with the relevant terminal devices of the client tier.

**The middle tier** constitutes the core of e-government-specific applications. The specific business logics of the specialist applications are linked together in the middle tier. The middle tier processes the data from the backend or from the persistence tier.

**The persistence tier** is responsible for data storage, usually in databases



Figure 2. Structural view of e-government applications - a four tier architecture (SAGA, 2003)

The technology requirements for e-government applications can be translated into various needs for *interoperability* (which relies on well defined standards for data exchange and metadata), *accessibility* (through various media delivery channels such as (TV, mobiles, PC, etc.), *real time execution* and *collaboration*. This necessitates the development of new paradigms for human machine interaction to deliver e-government for the wider audience including the disabled (Vasilios, 2003) and (Heeks, 2001).

The Standards and Architectures for e-Government Applications SAGA (SAGA, 2003) aims at defining standards featuring modern and service-orientated administration. The SAGA architecture kit shows the basic structure of e-government applications from the different viewpoints and provides models, standards and technologies for modeling and implementing the applications. According to (SAGA, 2003), e-government applications can be seen from five viewpoints:

**The Enterprise Viewpoint** specifies purposes, scope, processes and policies for an application.

**The Information Viewpoint** describes the characteristics and semantics of the data processed, as well as the detailed processes for data processing.

**The Computational Viewpoint** represents the breaking down of an application into functional modules and their interaction interfaces.

**The Engineering Viewpoint** represents the distribution of the individual elements of the system to physical resources and their connections.

**The Technology Viewpoint** describes the technologies used to implement the system.

The five viewpoints can be used to describe existing systems and to model new systems and applications.

### 3. THE GRID FOR E-GOVERNMENT: POTENTIAL AND CHALLENGES

This section attempts to establish a comparison between the grid concept, standards, programming paradigms, and implementation, with the five viewpoints from which e-government can be seen (enterprise, information, engineering, technology, and computational) (Maad et al, 2005).

From an *enterprise viewpoint*, the key issue to be addressed is the suitability of the VO concept to accommodate various forms of e-government interaction. SAGA (2003) divided E-government interaction into three categories :

*government-to-government (G2G)* interaction involving public agencies interacting with each other in order to implement processes.

*government-to-citizen (G2C)* interaction involving interaction between citizens and public agencies.

*Government-to-business (G2B)* interaction which is the interface between companies and public agencies.

Another critical success factor for the VO concept for e-government is the capability of identifying an appropriate economic model that governs the grid VO concept (Pierantoni, 2007).

From an **information viewpoint**, the key issue to be addressed is the suitability of the grid data management solution in meeting the aims of the e-government information viewpoint. These aims can be translated as:

- The determination of the structure and semantics of the system's information
- The definition of information sources and sinks, as well as processing and transformation of information by the system.
- The definition of integrity rules for data.
- The provision of tools to define the data models.
- The provision of a common database.

At the data level, the grid can potentially provide:

- the federation of scratch data, resources, and content
- the parallel processing of terabytes scale of data
- the provision of a human readable logical view of data and digital representation of data over heterogeneous domains (Maad et al - Journal1, Maad et al - Journal 2).

While the grid could be invaluable for e-government with reference to integration of data (Maad et al – Journal 2) and the parallel and compute intensive processing of data, the determination of the structure and semantic of the data is not yet deployed as a grid service. However, the grid can provide the needed computational resources to semantically analyze huge data content.

From a **computational viewpoint**, there are fledgling extant grid services to support, to some extent, the *Middle*, *Persistent*, and *Backend* tiers illustrated in Figure 2. This paper proposes a universal access grid layer that will potentially support the *Client* and *Presentation* tiers.

From an **engineering viewpoint**, there is a need to develop an “e-government middleware”, a unique integrated system that can support the entire functionality of e-government applications, thus ensuring interoperability, consistency, reliability, and standardization. The “grid middleware” could be a good candidate for an “e-government middleware” provided it can prove successful in developing services to support the *Client* and *Presentation* tiers described in Figure 2 above.

The **technology viewpoint** of e-government dictates rules for the implementation of the computing architecture of e-government applications as described in the four tier structure illustrated in Figure 2. It also dictates the data security standards to be adopted at each tier.

For the *Client tier*, first generation Grid portals are currently available that allow secure access to grid services (Falzone et al, 2006) and (Gergely, 2006) and (Genius-web), Mobile access to grid services is still in the research phase (Jameel et. Al, 2005).

For the *Presentation tier*, the e-government implementation standards dictates rules for the layout and format of the information to be processed with emphasis on considering presentation formats for the disabled.

For the *Middle tier*, the e-government implementation standards address issues of communication protocols and referred to them as "middleware protocols". E-government standards dictate the use of web services and the Web Service Description Language (WSDL) (WSDL-web). The grid introduced the Web Service Resource Framework (WSRF) (Czajkowski et al, 2004) that addresses the major limitations of web services.

These limitations are mainly regarding security and the dynamic update of the state of resources. This makes WSRF proposals better positioned to support the middle tier implementation of e-government. For the *backend tier*, the e-government implementation standards addressed the issues of data security and integration. Currently, the grid technology is the leading candidate technology in addressing issues related to data federation, access of data on heterogeneous administrative domains, plug-and-play of data storage resources, and human readable logical view of data and digital representation of data.

#### 4. UNIVERSAL ACCESS GRID LAYER

The universal access grid layer (under development at Trinity College Dublin) attempts to port the concept of universal accessibility to the Grid. Universal accessibility is rooted in the concept of Design for All in Human Computer Interaction (Stephanidis et al, 1998) and (Stephanidis, 2000). It aims at efficiently and effectively addressing the numerous and diverse accessibility problems in human interaction with software applications and telematic services. So far, the key concept of universal accessibility has been supported by various development methodologies and platforms (Akoumianakis et al, 2003) and (Stephanidis et al, 1997). Various application domains benefited from research and development in this area, including among others interactive television and media (Maad et al, 2003) and (Maad et al – Journal 3). Porting the concept of universal accessibility to the Grid (Maad et al, 2006) is faced by major obstacles attributed to the following: (a) the lack of an underlying functionality similar to that of a desktop operating system allowing the plug and play of resources and the direct user interaction with these resources; (b) the dilemma between hiding the grid versus making it more transparent; and (c) the software engineering practice adopted in grid middleware development, where the bottom up approach that is predominant (Maad et al, 2005-2) conflicts with the ethos of universal accessibility that considers accessibility at design time.

The universal access grid layer which is a metagrid infrastructure, will potentially host solutions to all issues related to universal accessibility to the Grid. It extends the notion of interoperability to embrace grid application interoperability (interactivity and universal accessibility). While heavily based on existing grid middleware services and architecture such as EGEE (EGEE-web), Globus (Globus-web), CrossGrid (Crossgrid-web), GridPP (GridPP-web) and GGF (GGF-web), the universal access grid layer hosts one or more target grid technologies (e.g. it has been demonstrated simultaneously hosting WebCom (Morrison et al, 2005), LCG2 (LCG-web) and GT4 (GlobusToolkit-web)) while also supporting its own services that provide things like universal accessibility that the target grid technologies do not. By doing so it firmly places the user within the metagrid environment rather than in any one target grid environment. The user obtains universal accessibility via the metagrid services, and the target grid technologies are relieved of the need to support direct user and device interactions.

Three types of services are offered by the universal access grid layer. These includes: transparent services, metagrid (interoperability) services, and value added services.

*Transparent services* include a transparent grid filesystem (Maad et al – Journal1) that supplies a vital missing component beneath existing middleware. The grid filesystem can support universal accessibility by supporting all modes of data access (read / write / execute) in the course of collaborative interaction, by providing a logical user view of grid data (to support integration of the data centre), and by helping locate (discover) data in the course of interaction. In so doing it can improve the utility of existing grid middleware. *Metagrid services* include services to support secure interoperability (in its broader sense).

*Value-added services* meet specific domain needs such as data semantics in government applications.

The universal access grid layer can potentially support grid-enabling e-Government applications by providing necessary infrastructure for the *Client* and *Presentation* tiers described in Figure 2.

## 5. CONCLUSION

This paper established a comparison between a e-government standard architecture and the Grid and proposed a universal accessibility grid layer to support grid enabling e-government applications. Future research aims at developing the various services offered by the universal accessibility grid layer.

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