E-GOVERNMENT AND GRID COMPUTING
Potentials and Challenges towards Citizen-Centric Services

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Abstract: The demands for integrated and efficient public services have increased worldwide over the recent years, due mainly to the proliferation of the Information and Communication Technologies. In order to develop these new e-Government applications, many challenges are being faced, including higher interoperability claims, scalability and security issues. Grid computing can be considered an interesting middleware solution for supporting e-Government thanks to its high computation and massive storage capabilities added to its recent convergence towards service-orientation. This position paper intends to investigate the state of the art and the challenges concerning the use of Grid technologies as a support platform for Citizen-centric Services and Applications.

1 INTRODUCTION

An increasing demand for the delivery of integrated and efficient public services has been observed worldwide over the recent years and applications in the area of e-Government, e-Democracy and e-Participation are gaining momentum. A recent UN (United Nations) report stated that the "*strategic and meaningful application of Information and Communication Technologies for the purpose of improving the efficiency, transparency, accountability and accessibility of government is possible if the ultimate objective of e-government is to promote social inclusion*" (Ahmed, 2006).

Grid computing intends to provide a vehicle for high computation and massive storage, and no single application domain can be excluded from its potential benefits (Maad et al., 2002), being scalability the most cited one. In addition, the convergence between Grids and Service-oriented Architectures (SOA) is transforming the Grid into a powerful solution for the integration of heterogeneous cross-domain applications.

This position paper intends to investigate the state of the art concerning the use of Grid technologies in e-Government scenarios, the strategies, challenges and what still demands further research. It is organized as follows: Section 2 presents a discussion on e-Government, its applications and requirements; Section 3 introduces Grid computing and shows how it could serve as a supporting platform for e-Government applications; Section 4 critically presents the current challenges and open issues towards a full Grid support for e-Government; and finally Section 5 presents our final remarks.

2 E-GOVERNMENT

The term Electronic Government (*e-Government*), as an expression, was coined after the example of Electronic Commerce. It designates a field of activity that has been with us for several decades and which has attained a high level of penetration in many countries (Lenk and Traunmller, 2002). E-Government can be defined as being all processes which serve decision-making and services in politics, government and administration and which use information and communication technologies (KBSt, 2006). What has been observed over the recent years is a shift on the broadness of the e-Government concept: the demand now is not anymore to deliver traditional services on-line, but to deliver new and dynamic services, which are

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citizen-centric. In addition, the need for citizen participation in governmental processes and decisions is gaining momentum as a way to enforce governments' transparency and legitimacy, a phenomenon called *e-Participation*.

A citizen-centric government can be simply described as one that treats citizens and businesses like customers, so that their needs come first, rather than bureaucracy or other imperatives inside the government machine. It considers the following principles (GOV3, 2006):

1. Treat citizens and businesses as customers of the government as a whole (and not only of a specific agency);
2. Use a government-wide service-oriented architecture to support all interactions;
3. Develop a single place for citizens to get all government information and transactional services;
4. Don't expect to get it right first time, but aim to move quickly and learn from experience.

2.1 Applications

The e-Government applications can be classified into the following categories:

- **e-Services**: On-line delivery of traditional services for citizens (tax declarations, document requests etc) and initiatives like One-Stop Government Portals;
- **e-Democracy / e-Participation**: Applications to improve citizen participation in the government decisions, including e-Voting, pools and discussion forums. Also, tools that increase the public administration transparency, like budget reports, are important in this category.
- **e-Business**: All on-line interactions between the public and the private sector, ranging from e-Procurement initiatives to legal and fiscal transactions;
- **e-Archiving**: Services for storage and retrieval of public documents, reports, and also public libraries.

These application can be also classified according to three interaction levels (KBSt, 2006):

1. *Information*: covers the provision of information to people, businesses and other elements of society. Users on this level merely act as recipients of information;
2. *Communication*: interactive and participation services which enable the exchange of news, messages and information. These services range from simpler solutions, such as e-mail or web-based discussion forums, right through to more complex applications, such as video conference systems;
3. *Transaction*: represent the highest interaction level and include, for instance, the electronic receipt and processing of applications or orders as well as the provision of forms which can be filled in on the computer and directly sent to the correct recipient. Electronic payment or tendering systems also belong to this category.

2.2 Requirements

Considering the technological aspects, the SAGA (*Standards and Architectures for e-Government Applications*) specification cites the following as key requirements for the success of any e-Government effort (KBSt, 2006):

- **Interoperability**: the administration processes must be co-orientated so that the e-Government applications implemented can interact with each other. The interoperability can be further classified into three levels:
  1. *Organizational* interoperability primarily determines when and why certain data are exchanged;
  2. *Technical* interoperability refers to the mere possibility to exchange information, including the definition of transmission routes and protocols;
  3. *Semantic* interoperability exists when two systems exchange data in such a manner that the data is interpreted in the same way by both communication partners and misunderstandings are ruled out. This applies not just to the form but also to the content of the data transmitted.
- **Reusability**: reuse can take place on several different levels of abstraction, e.g. exchange of experience between agencies and the use of joint data and process models, architecture samples and central services.
- **Openness**: applications should feature well-defined and documented interfaces or be encapsulated in such a manner that they can be integrated via portals, and standards should be adopted whenever possible;
- **Scalability**: ensure the usability of applications as requirements change in terms of volume and transaction frequency;
- **Security**: the applications and the supporting middleware should guarantee that information

can only be accessed, modified or published in compliance with a predefined (and possibly fine-tuned) security policy, preserving its confidentiality and integrity. In addition, some e-Government applications demand further security requirements like user anonymity, identity-theft protection and non-repudiation.

2.3 Approaches

Different approaches are found in the literature to implement e-Government applications and platforms. An approach for the semi-automated design of data flows between Web Services that are semantically described using different ontologies and data representations is introduced in (Barnickel et al., 2006). The approach includes a rule-based mechanism for user transparent mediation between ontologies and is intended to be used in e-Government scenarios spanning multiple application domains. In (Medjahed and Bouguettaya, 2005) the authors present a system which automatically generates Web services customized to citizens needs and also to government laws and regulations. The project, called WebSenior, proposes three levels of service customization: the Citizen level, the Service level and the User interface level. A metadata ontology, used to describe e-Government services and operations, is also introduced.

In (Senger et al., 2006) the authors propose the adoption of a grid computing platform as an enabling infrastructure for the development of large, distributed, e-democracy applications, illustrated with an example in the field of policy formulation. A semantically-enriched and service-oriented middleware for the support of e-Government applications is the proposal of (Santos et al., 2005). In this project, called CoGPlat, new services are dynamically composed with the help of semantic descriptions and their execution is mediated through a set of interaction policies.

3 GRID COMPUTING FOR E-GOVERNMENT

We consider a Grid to be a "*sharing environment implemented via the deployment of a persistent, standards-based service infrastructure that supports the creation of, and resource sharing within, distributed communities*" (Foster and Iamnitchi, 2003). These resources (for instance computers, applications, data) are owned by various administrative organizations and shared under locally defined policies (this administrative domain is usually called a Virtual Organization, or VO).

The Open Grid Services Architecture (OGSA) represents an evolution towards a Grid system architecture based on Web services concepts and technologies. The Globus Toolkit (Foster, 2006) is a community-based, open-architecture, open-source set of services and software libraries that support Grids and Grid applications. It addresses issues of security, information discovery, resource management, data management, communication, fault detection, and portability. Its latest release, GT4, is fully based on Web Services and represents a definite step towards the convergence of Grid technologies and Service-oriented architectures.

This convergence to SOA, added to the inherent support for large scale processing and storage, makes the Grid an interesting middleware approach for the support of e-Government applications. In Table 1 we present a relationship between the e-Gov application requirements presented in Section 2.2 and how the Grid infrastructures support (or not) them.

Table 1: e-Government x Grid.

Requirement	Support	No Support
Interoperab.	Technical	Semantic
Reusability	Yes	-
Openness	If standards are used	-
Scalability	Processing and Storage	Reliable Descentralized Control
Security	Authentication, Message Protection	Specific e-Gov Applic. Security Requirements

The *interoperability* requirements are satisfied by the Grid mostly in the technical level, due to the use of approaches like SOA and technologies like Web Services. The lack of semantic support is further discussed in the next Section. The *reusability* requirements are much more related to the application/service model itself than to the middleware infrastructure, but we believe the Grid, due to its cooperative and relative open environment facilitates the reuse of services. Concerning the third requirement, *openness*, the use of standards and well defined interfaces are supported by the latest Grid solutions, like the GT4.

The fourth requirement, *scalability*, is definitely considered the biggest Grid advantage over other middleware approaches, but it is important to note that this scalability is only an advantage in terms of processing power and storage space. The e-Government process security requirements impose a limit to this scalability in terms of process control, i.e., a fully de-

centralized control is not acceptable for most e-Gov scenarios and therefore this represents a bottleneck for the growth of the Grid (what is not true in other application domains). The last requirement, *security*, has very good support in the Grid environments when we consider user authentication and message protection/cyphering. Next section discusses why additional e-Government security requirements are still not fully supported by the Grid.

4 CHALLENGES

In the previous section we discussed the relationships between the Grid infrastructure and the middleware requirements imposed by the applications in the e-Government domain, showing what the Grid supports and what it does not support. In this section we detail our analysis focusing on the main challenges for the requirements interoperability, security and scalability (see Table 2 for a summary of the open issues presented in this Section).

Table 2: Challenges towards a full Grid Support for e-Gov.

Interoperability	- Semantic descriptions + Ontology Support - Workflow (DAG) Support + efficient fault Tolerance mechanisms - Accessibility
Security	- Fine-tuned information access policies - Anonymity and Identity-theft protection mechanisms
Scalability	- Correct VO model choice - Enhanced control mechanisms - Traceability + Auditing support

4.1 Interoperability

The so-called Semantic Web Services have gained momentum over the last years and are being considered as powerful (or even essential) mechanisms to enable fully interoperable services (see Section 2.2). The actual Grid implementations still lack support for semantic descriptions and ontologies and this is certain an issue that is demanding efforts from the research community.

In addition, most Grid platforms offer full support only for ”Bag-Of-Task” applications, i.e., applications composed of independent tasks that do not need to communicate within each other in order to complete. That is for sure a big challenge to be faced, as e-Government processes are usually described as workflows or DAGs (Direct Acyclic Graphs) and many of its tasks are interdependent. There are already some alternatives, like the use of a specific scheduler (e.g. CONDOR over Globus), but they are still poor in handling aspects like fault tolerance and recovery. A scalable and autonomic management of the Grid (including efficient fault handling mechanisms) remains a goal, and experiences are being learned from solutions implemented in approaches like the Peer-to-Peer networks (Foster and Iamnitchi, 2003).

Last, but not least, middleware-level support for mobile devices required by some e-Government applications, added to accessibility mechanisms for disabled and senior citizens is still subject of research.

4.2 Security and Scalability

Due to the nature of the data and processes involved, many e-Government applications have specific security requirements, some of them determined by local specific legislation. Though some Grid implementations like the GT4 have very good security mechanisms, usually focused on authentication and message privacy, the support for demands like anonymity and identity-theft protection still need enhancements. Also, the support for fine-tuned information access policies fully integrated to the service environments needs to be improved.

If we consider Grid environments based on Peer-to-Peer infrastructures and also opportunist Grid approaches, further security issues must be considered. These issues are mainly related to the lack of control over the tasks imposed by the inherent decentralization of these approaches.

Besides that, a critical issue for a successful e-Government support over the Grid seems to be the correct modelling of the Virtual Organizations. This is strongly dependent on the application category (see Section 2.1), on the interaction model and also on the participating entities. For example, if we consider a global e-Procurement application, that can be classified in the category e-Business/Transaction, a VO could be defined having as members all Governmental agencies together with all credited private business partners/suppliers. On the other hand, if the application fits in the category e-Democracy/Transaction, the VO would be formed only by the Government departments involved in decision making processes.

Finally, the ability to follow on-line the status of the different running processes and the possibility of performing late auditing procedures is also required by many e-Government applications as a way to increase the public administration transparency. On one hand, this requires both extra storage and processing power, which might be successfully provided by the

Grid. On the other hand, this represents an extra control issue that should be better solved in the middleware (Grid) level and not left to the applications.

5 FINAL REMARKS

We believe that the proposal of effective solutions to enable fully interoperability among heterogeneous and inter-organizational systems remains a key issue in the development of new citizen-centric e-Government services. Grid computing's promise to provide a vehicle for high computation and massive storage added to its recent convergence towards service-orientation has transformed it into an interesting middleware solution for supporting these new applications.

On one hand many inherent characteristics of the Grid middlewares are of great importance for e-Government applications, namely processing and storage scalability and also the support for technological interoperability. On the other, there are some important issues that still need to be handled: support for complex workflow-based processes, enhanced fault tolerance mechanisms, specific security requirements and support for semantic and ontologies for instance.

Nevertheless, we believe the potentials for the Grid are very high and as long as these challenges are faced, it may become a very solid and powerfull middleware solution for e-Government applications.

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