Semantic Interoperability in eGovernment initiatives

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Author's version of the manuscript published by Elsevier in Computer Standards & Interfaces 31 (2009) 174 – 180.

doi:10.1016/j.csi.2007.11.011

Abstract. Interoperability has been identified as a major issue to be addressed by every egovernment initiatives. In order to tackle this issue, the egovernment agencies have developed tools to facilitate the interchange of information between departments when providing public services to citizens and businesses through internet. This paper surveys how the egovernment agencies in Europe and the United States have developed tools such as interoperability frameworks and enterprise architectures. It covers specifically how the semantic technologies and standards have been incorporated into the interoperability frameworks. The incorporation is a sign of maturity, because interoperability is to cover not only technical aspects, but also semantic and, in the end, organisational aspects.

Keywords: eGovernment – Interoperability – Interoperability framework – Enterprise architecture – Semantics

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Introduction

During late 90s, most Administrations in OECD countries released their egovernment strategies. Egovernment strategies are supported by several policies, namely security, confidentiality, delivery channels, etc. One of such policies is the interoperability policy [4] [20].

Let us start agreeing on some definitions. Interoperability can be defined as "the ability to exchange information and mutually to use the information which has been exchanged", according to the European Commission [3]. But more technical definitions may be found in the literature, such as the following one: "Interoperability is the ability to exchange functionality and interpretable data between two software entities. It can be defined in terms of four enabling requirements: communications, request generation, data format, and semantics" [19], where the definition goes into detail enumerating the sort of requirements that interoperability must tackle.

An interoperability framework is a tool for guaranteeing interoperability in egovernment service delivery. At least, an interoperability framework contains a technical standard catalogue. Some interoperability frameworks also state policies, guidelines and best practices. Anyway, the recipients of the interoperability frameworks

are those agencies that are engaged in egovernment initiatives. And the final aim of an interoperability framework is to make easy the integrated provision of services to both citizens and businesses by means of the ICT.

Interoperability frameworks cover both technical and non-technical issues. Among those non-technical issues that are relevant to egovernment interoperability, the organisational issues are worth mentioning. The organisational issues relate to collaboration between different levels in the public administration, or to business process modeling. Between the technical and the organisational issues, there is a range of issues that falls in the semantics. The semantic issues are concerned with ensuring that the precise meaning of exchanged information is understandable by the egovernment applications.

In this paper, the use of the interoperability frameworks within the egovernment initiatives is surveyed, and the recent inclusion of semantic technologies is described. First, some of the European egovernment initiatives that have worked deeply in the area of interoperability are presented, and the interoperability frameworks that they have produced are described. Secondly, the relationship between interoperability frameworks and standardisation is explored. After that, the interoperability frameworks are related to the enterprise architecture, as a way to understand the approach of the US to the interoperability in egovernment. The degree of familiarity of the European egovernment agencies with the enterprise architecture is also shown. Finally, the paper

is focused on the progress made by the egoverment initiatives, both in Europe and in the US, in the field of semantic interoperability, and some conclusions are drawn.

The paper is part of a research on the use and utility of the interoperability frameworks for egovernment, which is being conducted by the author, and the first results of which were published in [10] and [11].

Interoperability frameworks in European egovernment initiatives

In this section, four initiatives in egovernment interoperability in European countries which have produced corresponding interoperability frameworks are briefly described. They are three national initiatives, namely the United Kingdom, France and Denmark, and the initiative of the European Commission. These initiatives are relevant as far as the adoption of semantic technologies is concerned, which is the focus of the second part of the paper.

The Cabinet Office[i] of the UK government has based its technical guidance in the e-Government Interoperability Framework (e-GIF), which was first issued in 2000, and updated to its version 6.1 in March 2005. e-GIF mandates sets of specifications and policies for joined-up and web enabled government. It covers four areas: interconnectivity, data integration, e-services access and content management [8]. The e-GIF contains a Technical Standard Catalogue, which is revised and updated every 6 months.

The French ADAE[ii], formerly known as ATICA, published “Le Cadre Commun d’Intéroperabilité” (CCI) in January 2002 and its latest version (2.1) in September 2003. CCI comprises the recommendations for strengthening public electronic systems coherence and for enabling multi-agency electronic service delivery [1].

In Denmark, the National IT & Telecom Agency[iii] published the first version of the Interoperability Framework in 2004 under the name of Danish eGovernment Interoperability Framework (DIF), and its latest version (1.2.14) was released in April 2006[iv]. DIF is intended as a guideline to public agencies as they develop IT plans and projects.

Note that e-GIF shows a higher level of enforcement than CCI and DIF. e-GIF is mandatory, whereas CCI and DIF are recommendations or guidelines.

The European Union has setup different initiatives in the area of egovernment within the limits of its few powers in the domain of Public Administration. Within the European Commission, the DG Enterprise & Industry manages the IDABC Programme[v], which is the initiative that best serves the different National Agencies as far as egovernment is concerned. As regards the interoperability framework, the IDABC Programme issued its Architecture Guidelines (version 4.1) in March 1999, as a supporting tool for the Decision of the European Parliament and the Council 1720/1999/EC “Interoperability and access to Trans-European Networks for the electronic Interchange of Data between Administrations”. Current version is 7.1 and it was issued in September 2004 [14]. These guidelines (hereafter IDABC AG) provide

concepts and reference for optimum interoperability between European Institutions, European Agencies, and Administrations in member States. Furthermore, IDABC published the final version 1.0 of its European Interoperability Framework (IDABC EIF) in November 2004 [15]. IDABC EIF provides a common framework for discussion around interoperability, pinpointing which interoperability issues should be addressed when implementing pan-European e-Government services, but it avoids prescribing any concrete architecture or standard catalogue, which was to be the main objective of successive releases of IDABC AG.

As an example, table 1 contains an excerpt of the e-GIF Technical Standards Catalogue, which shows specifications from the four interoperability areas that are mandated. Note however that the Technical Standards Catalogue is a living document, so that specifications come in and out at the different versions.

Interoperability frameworks and standards

As stated in the first section, each interoperability framework contains a technical standards catalogue. And the previous section described the catalogue content of some interoperability frameworks. The catalogues serve as a basic guidance to the different departments when deploying egovernment systems and services. Working hand by hand with government departments, IT providers are also involved in egovernment deployment. To make possible the involvement of IT providers, public procurement

procedures define how governments should proceed in order to award public contracts that will end in IT systems acquisition and egovernment service implementation.

The use of interoperability frameworks within public procurement delivers benefits to government, because technical requirements are specified in terms of technical specifications that government departments have collectively agreed upon. However, the benefits that an interoperability framework may deliver depend on its mandatory status, i.e. the higher the mandatory status of the framework is, the less degree of freedom the government departments have when preparing contract documentation.

Public procurement is shaped by public laws that regulate different issues. A relevant issue is the use of technical specifications. Technical specifications should exhibit particular characteristics in order to be included in public contract documentation. These characteristics are different in the United States and in the European Union. The differences are caused by the different approaches of the US and the EU in the field of IT standardisation.

In the US, the National Technology Transfer and Agreement Act (NTTAA) of 1995 reduced the need for federal government use of government-unique standards. To achieve this goal, federal agencies were encouraged to utilize voluntary consensus standards where feasible. Voluntary consensus standards are those that meet ANSI's essential requirements of openness, balance, consensus and due process. ANSI is the coordinator of the US standards system. The NTTAA had major implications for the relationship between the government and standardisation. The implications belong not

only to the government regulations, but also to the government participation in standards development and to the government procurement, which is mostly relevant for the content of this paper.

In the EU, the directive 2004/18/EC on the coordination of procedures for the award of public service contracts has harmonised the public procurement procedures in the 25 member states. The directive states that technical specification should be set out in the contract documentation without creating unjustified obstacles to competition. When drawing up its technical specifications, a contracting entity may refer to European standards or international standards or, when these do not exist, to national standards. Standards are assumed to be developed by a “recognised standardising body”, industry consortia falling into this category, although European Standards Organisations and National Standards Bodies still play a main role in the standardisation scenario.

There is indeed a relationship between IT standardisation and interoperability frameworks. However, this relationship is not direct. While US federal government is consistent and it accepts voluntary consensus standards in egovernment deployment, the EU institutions and the member states are hesitant: they sometimes show reluctance to accept standards from industry consortia and show preference to European standards and other times demand additional requirements on standards developed by the European standards organisations, which some industry consortia paradoxically fulfil [11].

Interoperability through Enterprise Architecting

The approach to interoperability in egovernment in some countries is different from what has just been presented for the European Agencies in the previous section. In this section, an alternative approach is described, and its implementation by the Federal Government of the United States is described.

The alternative approach is based on enterprise architecture. Enterprise architecture refers to a comprehensive description of all the key elements and relationships that make up an enterprise. In this definition, an enterprise may be a company, an institution or a department within a company or an institution. And the elements to be described may be data, network equipments, software components, business locations, human resources, etc. Enterprise architecting aims at aligning the business processes and goals of an enterprise and the applications and systems that build up its technical infrastructure. There are many different approaches to describing the elements of an enterprise architecture [22]. One approach that has grown in popularity in the last decade is based on a framework developed by John Zachman [23]. The Zachman Enterprise Architecture Framework organises the descriptive representations of an enterprise in a matrix. Each cell in the matrix represents the intersection of a particular focus (data, function, network, people, time, and motivation) and a perspective (contextual, conceptual, logical, physical, and out of context). Each focus relates to one of the Aristotelian questions “what, how, where, who, when and why”, and each perspective relates to one of the following roles: the planner, the owner, the designer,

the builder and the subcontractor. Finally, models (e.g. business models, data models, object-oriented models) are the language of the framework, and are contained within the cells. For example, a business process model may be used for describing the enterprise from the conceptual perspective and the function focus, whereas describing the enterprise with the same focus but from the logical perspective, that is, the perspective of the designer, may be better fulfilled by an application architecture.

Enterprise architecture is a good path to interoperability in egovernment since it contributes to align the models of the organisations that want to interoperate. For instance, there would be no sense in putting the business process model of one organisation and the data model of the other organisation together. The US Federal Government is an example of an approach based on enterprise architecture.

The Federal Enterprise Architecture in the US

In the US, Congress passed the E-Government Act of 2002, which was to expand the use of the Internet and computer resources in order to deliver government services for a citizen-centered, results-oriented, and market-based government. However, the egovernment implementation has been highly influenced by the earlier Clinger-Cohen Act of 1996. In both cases, the Office of Management and Budget of the Executive Office of the President of the US (OMB)[vi] has provided the additional guidance needed for egovernment implementation.

The Clinger-Cohen Act of 1996 shaped federal agencies' approach to IT acquisition and management. The Clinger-Cohen Act required all federal agencies to establish an arquitecture program that integrated a process to select, control, and evaluate their IT investments.

Following the Clinger-Cohen Act, the OMB required in 1997 that an IT architecture should be developed and maintained in agencies that would contain [21]:

- The enterprise architecture, and
- The technical reference model and standards profile, where
  - The technical reference model would identify and describe the information services (such as database, communications, and security services) used throughout the agency.
  - The standards profile would define a set of IT standards that supports the services articulated in the technical reference model; they would be the cornerstone of interoperability.

Note then that what the European agencies have developed under the name of interoperability frameworks can best serve the purpose of the standards profile as stated by the OMB. To some extent, an interoperability framework can be regarded as a building block in the more ambitious endeavour of building an egovernment enterprise architecture.

In 1999, the Federal Chief Information Officers Council (CIOC)[vii] developed the Federal Enterprise Architecture Framework (FEAF) [5]. The FEAF was to provide architecture guidance for federal cross-agency architectures through their compliance with OMB requirements. It was based on the Zachman Framework, and it did not specify any work products. The FEAF focused on introducing enterprise architecture concepts and was planned to undergo revision to provide guidance on architecture work products, technical reference model and standards, etc.

To leverage FEAF guidance in egovernment implementation, the Federal CIOC published its second version of the E-Gov Enterprise Architecture Guidance (CIOC EAG) in July 2002 [6], which contains a IT standards catalogue. An excerpt of the catalogue is shown in Table 1, where the similarity with the eGU e-GIF Technical Standards Catalogue can be seen.

However, the FEAF initiative was never completed as the emphasis shifted towards the development of the Federal Enterprise Architecture (FEA) for the OMB [2]. OMB currently requires alignment of all Departments and cross-agency architectures with the FEA. The FEA consists of five reference models [9]:

- Performance Reference Model, which is a framework for performance measurement providing common output measurements throughout the federal government.

- Business Reference Model, which provides a framework that facilitates a functional (rather than organizational) view of the federal government's lines of business independent of the agencies that perform them.

- Service Component Reference Model, which classifies Service Components according to how they support business and performance objectives.

- Technical Reference Model, which is a component-driven, technical framework that categorizes the standards and technologies to support and enable the delivery of Service Components and capabilities.

- Data Reference Model, which is intended to promote the common identification, use, and appropriate sharing of data/information across the federal government.

Note that the OMB required that FEA Technical Reference Model would unify, as of 2003, when version 1.0 was published, existing technical reference models that were developed on the basis of initial OMB guidance and of the CIOC EAG.

The approach to interoperability of the US Federal Government is effectively based on enterprise architecting. The OMB aims to identify common business processes, common components, common technologies and common data assets across different governmental departments, by means of the Business, Service Component, Technical and Data Reference Models, respectively, and to eliminate redundancy. This is a more

comprehensive objective than thee egovernment interoperability initiatives in Europe are seeking.

Enterprise Architecture adoption in European egovernment initiatives

As far as the author is aware, three egovernment initiatives in Europe have tackled the issue of enterprise architecture. None of them, however, has deeply committed to the use of the enterprise architecture as a tool for interoperability.

Two of the initiatives are national: United Kingdom and Denmark. In the eGU eGIF, the Technical Standards Catalogue was initially regarded as a part of a High Level Architecture, together with other high-level models. Both the catalogue and the models served as a reference in the requirements, design and implementation of egovernment services. The role was played with the help of reusable elements such as patterns, components and resources [7]. The set of high-level models that comprised the High Level Architecture can be regarded as part of an egovernment enterprise architecture.

The eGU changed this approach when released version 6 and no mention to the High Level Architecture was present in the eGIF since then. Recently, however, the eGU officers have shown a renewed commitment with the development of an enterprise architecture.

On June 2003 the Danish Ministry of Science, Technology and Innovation published a white paper on governmentwide enterprise architecture [18]. The white paper

recommended that a common enterprise architecture framework should be developed, and that it would include coordination mechanisms, methodologies for preparing the enterprise architecture, common choices and principles with regard to standards and infrastructure, and common tools such as repositories. At present, progress has been made in the area of common tools and guidance, mainly on the use of XML and standards, but no main achievements have been published in the area of methodologies.

The third initiative is the European Commission IDABC Programme. It used to structure its Architecture Guidelines by means of an interoperability model. The model identified three dimensions: business requirements, security management and implementation, which could have built an enterprise architecture.

Versions later than 6.1 [13] have left the model behind. In 2005, however, there seemed to be a renewed commitment to enterprise architecture, as it is shown by the fact that the CapGemini enterprise architecture framework has been chosen for the technical description of the infrastructure for delivering pan-European egovernment services [16]. The CapGemini enterprise architecture framework, called the Integrated Architecture Framework, identifies 4 Aspect Areas (Business, Information, Information Systems & Technical Infrastructure) and 4 Abstraction Level (contextual, conceptual, logical & physical), in a similar way as the Zachman Framework [17].

Semantics in European eGIFs

In the rest of the paper, some insight is provided with reference to the semantic interoperability, both in the Europe and in the US. In this section, evidences are provided on how the semantic aspects are increasingly tackled on in the interoperability frameworks of European egovernment agencies that have been presented above.

First, I would like to make clear where semantic interoperability lies with reference to other dimensions of egovernment interoperability. The IDABC European Interoperability Framework, briefly presented in the second section, is agreed to be the reference in this respect. The European Interoperability Framework, which may be named more properly as the European Interoperability "MetaFramework", states the general principles for pan-European cooperation, and it identifies three dimensions of interoperability [15]:

- Organisational interoperability, concerned with defining business goals, modelling business processes and bringing about the collaboration of administrations that wish to exchange information and may have different internal structures and processes.

- Semantic interoperability, concerned with ensuring that the precise meaning of exchanged information is understandable by any other application that was not initially developed for this purpose.

- Technical interoperability, which covers aspects such as open interfaces, interconnection services, data integration and middleware, data presentation and exchange, accessibility and security services.

UK eGU – eGIF

Within the framework of the eGU e-GIF, two initiatives are relevant for content management metadata:

- e-GMS (eGov Metadata Standards[viii]), which lays down the elements, refinements and encoding schemes to be used by government officers when creating metadata for their information resources or when designing search systems for information systems.

- IPSV (Integrated Public Sector Vocabulary[ix]), which is a structured thesaurus of administrative activities both at central and local governments. IPSV was setup initially for use within the e-GMS and it enhances the Government Category List (GCL).

IPSV is a truly semantic initiative, whereas e-GMS deals mainly with syntactic issues.

France ADAE – CCI

Since 2004, ADAE has been very active in the development of reusable information resources, which are commonly called “référentiels”. This term designates any reference schema, core component, category, or semantic asset.

ADAE has set up the Antalia project, which aims to provide services to central and local governments as well as businesses and citizens in order to search for and find reusable reference resources. The user would be able to find on Antalia nomenclatures, guides, data models, and XML schemas. Antalia was due for deployment around summer 2005.

Denmark ITST – DIF

The Danish initiative, through the InfostructureBase webite[x], has setup a repository of XML schemas, named OIOXML schemas.

It comprises the joint use of XML in the Danish Public Sector, and it contains business process descriptions, datamodel descriptions, interface descriptions, and XML schemas from public and private organizations.

It is open for use of all, and a common coordinated method has been chosen for the development. Still, the standards should be finally approved by the Danish XML Committee.

European Commission IDABC – EIF

IDABC launched a Horizontal Measure called “Content Interoperability Strategy” in 2004[xi]. The measure would provide more specific concepts and implementation plans in semantic interoperability within the European Interoperability Framework.

The measure is closely related to the new concept of PanEuropean eGovernment Services (PEGS), which has been put at the centre of the activities of IDABC. PEGS will enable citizens and businesses from all Member States to access egovernment services in all Member States.

The recommendations issued by the Content Interoperability Strategy refer to the concept of semantic interoperability assets, which include dictionaries, thesauri, ontologies, and registries. The Content Interoperability Strategy aims to encourage the production of these assets, and their validation and publication for open use.

One tangible result of this IDABC measure is the setting up of a European Interoperability Clearinghouse, which will organise the publication of semantic interoperability assets at European level, adding value to any national service of this sort. The Clearinghouse is due Q2/2007, according to IDABC Work Programme 2005-2009.

The approach described above may be designated as bottom-up, since the objective is to create a critical mass of semantic assets which will eventually solve semantic interoperability problems. However, the concrete role that the assets will play is still to be defined. One would say that the aim at this stage is to diffuse the use of semantic technologies, rather than to develop a coherent plan for solving semantic interoperability problems.

Semantics in the US egovernment initiative

The US have also tackled the semantic issue in relation with egovernment and interoperability.

Both the private and public sector have shown their concern about semantics. The Industry Advisory Council[xii], through its Enterprise Architecture Shared Interest Group, stated that "Semantics, semantics and semantics are the top three challenges for interoperability." [12]. Within the public sector in the US, the promotion of the use of the semantic technologies is also gaining momentum. An example of this dynamism is the creation of the Semantic Interoperability Community of Practice[xiii] (SICoP). The purpose of this CoP is to support two Federal CIOC Committees and the egovernment initiatives in their use of Semantic Web Services to demonstrate increased accessibility and interoperability. The scope of the activities of this CoP is broader than the semantic interoperability, since it also encompasses semantic web services and intelligent search.

The OMB and the Federal CIOC have chosen this broad-scope approach when leveraging the semantic technologies in the building of the Federal Enterprise Architecture. In November 2005, the second version of the Data Reference Model was released. As a reference model, the Data Reference Model is presented as an abstract framework from which concrete implementations may be derived. The Data Reference Model provides standard means or foundation principles by which data may be described, categorized, and shared. These means are reflected within the following standardisation areas: data description, data context and data sharing. Some insight in the first two areas is delivered in the following paragraphs.

As far as the Data Description standardization area is concerned, its purpose is to provide a means for an agency to agree to the structure (syntax) and meaning (semantics) of the data that it uses. The recommended artifacts for data description are logical or conceptual data models that provide metadata to be associated with the various data databases, documents and files. This area is to enable data discovery, data reuse, data sharing, data harmonisation and semantic interoperability.

As regards the Data Context, it is defined as any information that provides additional meaning to data to relate it to the purposes for which it was created and used. In this area, agencies are called upon to categorise their data using taxonomies. Implementation of taxonomies could take the form of XML topic maps, Web Ontology Language hierarchies or ISO11179 classification schemes.

The publication of the Data Reference Model shows that there is a clear commitment of the OMB and the Federal CIOC with the adoption of semantic technologies. On the other hand, the scope of its application is not only to enable the semantic interoperability, but also to contribute to the ultimate purpose of the FEA, which is to facilitate cross-agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration within and across federal agencies. The Data Reference Model is definitely a framework for enabling information sharing and reuse across the federal government.

The approach of the United States has a more solid rationale and a clearer objective than that of the European initiatives.

Conclusions

The egovernment agencies policies in interoperability have been scrutinized in order to identify common treats in the creation and maintenance of their interoperability frameworks. The study has been based on the analysis of the publicly available documents.

In Europe, interoperability frameworks have shown up as a key tool for interoperability in the deployment of egovernment services, both at national and at European level. They initially focused on technical interoperability, but recently inclusion of semantic in the interoperability frameworks started. The inclusion is still at

early stages: the interoperability frameworks are mainly dealing with syntax issues, but increasingly tackling specific issues in semantics, namely ontologies.

At a supranational level, the European Commission is dealing with semantics in egovernment through the IDABC Programme, in collaboration with Public Administrations in Member States.

On the other hand, the approach in the United States is more comprehensive, because the focus of the adoption of semantic technologies in egovernment is to easy not only the interoperability when providing services, but also the effective reuse of data and information within the scope of cross-agency initiatives.

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Table 1. Technical Standards Catalogues. eGU e-GIF and CIOC EAG

UK – e-GIF 6.0		**USA – CIOC EAG 2.0**	
Interoperability areas	**Specifications**	**Services**	**Voluntary industry standards**
Interconnection	IPv4, HTTP, S/MIME	Human computer interface services	HTML, Symbian
Data integration	XML, XSL, UML, RDF	Data interchange services	WAP, J2EE, .NET, Web Services
Content management metadata	XML, e-GMS	Network services	MIME, T.120, H.323
Access	DTV, mobile phone, PDA, smart card	Data management services	JDBC, WebDAV
		Security services	S/MIME, SAML