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A Comparative Analysis of National Interoperability Frameworks

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ABSTRACT

Despite current advancements in online provision of eGovernment services, interoperability issues at national and cross-country level that will facilitate fully integrated, both vertically and horizontally, one-stop, electronic services still remain unsolved. In this context, eGovernment Interoperability Frameworks try to continually extend their scope and to outline the essential prerequisites for joined-up and web-enabled e-government in order to effectively second the seamless exchange of information and the deployment of interoperable systems in the public sector. This paper presents the national interoperability frameworks that have been released by 9 countries (Australia, Belgium, Denmark, Estonia, Germany, Greece, New Zealand, United Kingdom and United States of America) and have reached a certain degree of maturity. A comparative analysis among their contents is conducted in order to indicate the similarities and differences in their philosophy and implementation and to provide a set of recommendations for any interesting party embarking to design or update an Interoperability Framework.

Keywords

e-Government Interoperability Framework; eGIF; NIF Contents; Guidelines on e-Government Interoperability; Comparative eGovernment.

INTRODUCTION

Today, public administrations are striving to leverage modern information and communications technologies to improve the quality of their services to citizens and businesses (Scholl and Klischewski, 2007; Osimo, 2007), to provide multiple communication channels and to make their internal and cross-organization operations more efficient, even if this requires changing their modus operandi (Janssen, 2005; Niehaves, 2007). Since late 90s, most countries have released their eGovernment strategies defining their milestones and action plans and have thereafter made significant progress on eGovernment at all levels of public administration (Capgemini, 2007). However, it soon became apparent that absence of common technological standards and interoperability guidelines yielded considerable leeway to governmental authorities and let them be focused on their own requirements and define inflexible information systems according to their own assumptions and interpretations (Hovy, 2008).

Interoperability has thus become the key issue in the agenda of the public sector (CEC, 2006b) since providing one-stop services calls for collaboration within and across public authorities, while i2010 (CEC, 2006a, 2006b) explicitly addresses interoperability as one of the four main challenges for the creation of a single European information space and essential for

ICT-enabled public services. Achieving interoperability requires resolution at various distinct interoperability levels: political context, legal, organizational, semantic and technical, as argued by (IDABC, 2004, 2008; Gottschalk, 2008; Panetto, 2007; Papazoglou and Ribbers, 2006; MODINIS, 2007; Scholl and Klischewski, 2007).

e-Government Interoperability Frameworks (e-GIFs) pose today as the cornerstone for the resolution of interoperability issues in the public sector and the provision of one-stop, fully electronic services to businesses and citizens. Such interoperability frameworks aim at outlining the essential prerequisites for joined-up and web-enabled Pan-European e-Government Services (PEGS), covering their definition and deployment over thousands of front-office and back-office systems in an ever extending set of public administration organizations (Charalabidis et al., 2007b). They further provide the necessary methodological support to an increasing number of projects related to the interoperability of information systems in order to better manage their complexity and risk and ensure that they deliver the promised added value (Ralyte et al., 2008).

In this direction, the present paper presents the baseline of the National e-Government Interoperability Frameworks (NIFs) that Australia, Belgium, Denmark, Estonia, Germany, Greece, New Zealand, United Kingdom and United States of America have released and conducts a comparative analysis among their findings in compliance with the guidelines of the European Interoperability Framework (EIF). The scope of the analysis is to indicate the similarities and differences in the NIFs philosophy and implementation and to produce a set of recommendations for any interesting party beginning to design or maintain an e-Government Interoperability Framework.

COMPARATIVE ANALYSIS FRAMEWORK

According to the EIF (IDABC, 2008), an Interoperability Framework describes the way in which organizations have agreed, or should agree, to interact with each other, and how standards should be used. In other words, it provides policies and guidelines that form the basis for selection of standards and may be contextualized (i.e. adapted) according to the socio-economic, political, cultural, linguistic, historical and geographical situation of its scope of applicability in a specific circumstance/situation (a constituency, a country, a set of countries, etc). Typically, an e-GIF includes the context, the technical content, the management processes and the tools (UNDP, 2007).

Extending the EIF in terms of providing a comparative analysis framework for NIFs that remains in compliance with its underlying principles, the levels of analysis upon which the national NIFs will be compared in this paper are as following, as also depicted in Fig.1:

1. The "Systems" Level on the basis of deploying the following supporting infrastructures which store and manage the artifacts of the "Standards & Specifications Level":

    1.1 Certification Tools for examining compliance with the Framework and providing specific guidelines for amendments when a certification of a public site or information system fails
    1.2 Services & Processes Directory containing services and processes descriptions
    1.3 XML Schemas & Core Components Repository
    1.4 Web Services Repository and Registry
    1.5 Systems Reference Repository with explicit definitions for systems and their topology
    1.6 Access & Collaboration Tools for seeking and retrieving the eGIF specifications and posting change requests and comments in a bi-directional communication.

2. The "Standards & Specifications" Level, which includes the paper-based specifications in alignment with the three levels of interoperability: organizational, semantic and technical.

    2.1 Organizational Interoperability Guidelines for Service Documentation, Business Process Alignment, Business Process Re-engineering and Legal Issues
    2.2 Organizational Interoperability Assets containing: Service Descriptions and Metadata, Service Workflow Diagrams and Web Services Definitions, as well as Transformation and Re-Engineering Patterns
    2.3 Semantic Interoperability Guidelines
    2.4 Semantic Interoperability Assets (IDABC, 2005) including Dictionaries / Codelists; Thesauri and nomenclatures; Taxonomy that includes constant and enumeration definitions; Mapping tables for defining intersections, correspondences, and gaps between constants and enumerations together with guidelines for mapping types onto each other syntactically and semantically; Global or Local Ontologies for describing e-Government knowledge
    2.5 Syntactic Interoperability Assets with XML Schemas Libraries, Core Components Libraries and Metadata Standards
    2.6 Technical Interoperability Guidelines and Standards
    2.7 Guidelines and specifications for Designing and Implementing Integration Mechanisms (Web Services)

2.8 Guidelines for Authentication and Security Mechanisms
2.9 Guidelines for Web Sites Design
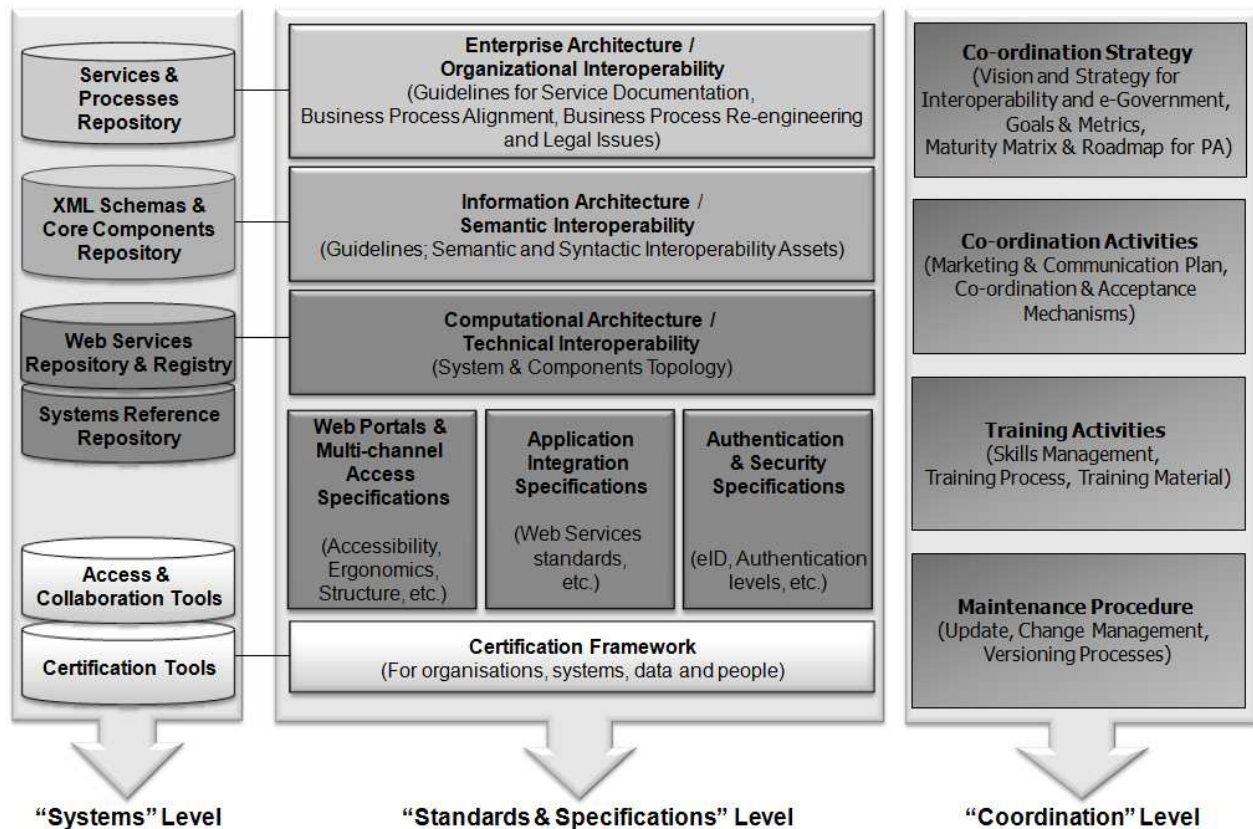2.10 Certification Framework for organizations, systems, data and people

Figure 1. National Interoperability Frameworks Comparison Framework

3. The "Coordination" Level, which mainly deals with long-term envisioning, raising awareness and ensuring maintenance:

   3.1 Co-ordination Strategy that includes: Vision and Strategy for Interoperability and e-Government, Goals & Metrics and Guidelines (Maturity Matrix & Roadmap for PA)

   3.2 Co-ordination Activities with Marketing & Communication Plan and Co-ordination & Acceptance Mechanisms

   3.3 Training Activities which embrace Skills Management & Training Process as well as the Training Material

   3.4 Maintenance Procedure referring to the Change Management - Versioning Processes

In the present work, the methodological approach for the analysis of the e-GIFs bears the following steps:

- The contents of the e-Government Interoperability Frameworks are retrieved and studied.

- A detailed comparison of the e-GIFs is conducted on the basis of the aforementioned levels: Systems, Standards & Specifications, Coordination.

- A discussion around similarities and differences of the various approaches, as well as best practices and lessons learnt, follows on the comparison matrix.

As far as the eGovernment Interoperability Frameworks research is concerned, it must be noted that apart from the information published in the eGIFs official web sites (until September 2008), the findings of relevant work undertaken by Luis Guijarro (2007), Yannis Charalabidis et al. (2007a, 2007b and 2008a), the MODINIS Study on Interoperability (2007) and the UNDP Study (2007) have also been taken into account.

NATIONAL ELECTRONIC GOVERNMENT FRAMEWORKS

This section enumerates major initiatives being carried out by e-government agencies in the interoperability arena, which have produced corresponding interoperability frameworks per country internationally, i.e. Australia, Belgium, Denmark, Estonia, Germany, Greece, New Zealand, UK and US. The specific span of countries has been selected on the basis that their specifications are available in English, are adopted at national level and have reached a certain level of maturity.

In Australia, the Australian Government Interoperability Framework (AGIF) issued and maintained by the Australian Government Information Management Office (AGIMO, 2008) addresses interoperability in three dimensions:

- The business layer comprises legal, commercial, business and political concerns. The *National Service Improvement Framework* and the *Business Process Interoperability Framework* operate in this layer.

- The information layer comprises information and process elements that convey business meaning. The *Information Interoperability Framework* and *GovDex* appear in this layer.

- The technical layer with the *Technical Interoperability Framework* comprises technology standards such as transport protocols, messaging protocols, security standards, registry and discovery standards, XML (Extensible Markup Language) syntax libraries and service and process description languages.

In Belgium, the *Belgian Interoperability Framework* (BELGIF) is built on a wiki collaborative environment and has released recommendations on web accessibility and on the realization of XML Schemas, apart from a list of approved standards. It is a result of the collaboration between several Belgian institutional levels and is compatible with the European Interoperability Framework (EIF).

In Denmark, the *Interoperability Framework* (Version 1.2.14) (KIU, 2006) includes recommendations and status assessments for selected standards, specifications and technologies used in e-government solutions. It is governed by a subcommittee of KIU - The IT Architecture Committee and is compiled in collaboration with KIU (a committee that facilitates coordination of initiatives related to IT in the Danish public sector). Since April 2009, the Danish National IT and Telecom Agency has established Digitalisér.dk as the new, common, web 2.0-enabled entrance to public IT architecture and open standards and provides the potential to debate common public digitization by using intuitive web based interaction rather than traditional standards catalogue. *InfoStructureBase* (ISB) "is a collaboration tool" that supports "exchange and reuse of data related to public and private service delivery, including cooperation, business re-engineering and alignment of related services. The ISB is also intended to be of value to users outside the Danish public sector and is open for use for all, both public and private as well as Danish and non-Danish users."

The *Estonian IT interoperability Framework* (Estonian Ministry of Economic Affairs and Communications, 2007a) led by the Department of State Information Systems of the Ministry of Economic Affairs and Communications is a set of standards and guidelines aimed at ensuring the provision of services for public administration institutions, enterprises and citizens both in the national and the European context. An *Administration system for the state information system* (*RIHA*) has also been deployed with the objective to ensure the interoperability of public sector information systems and the reuse of technical, organizational and semantic resources.

In Germany the Co-ordinating and Advisory Agency of the Federal Government for Information Technology in the Federal Administration (KBSt) pursues a comprehensive standardization approach for Germany's administrations in order to define technical Standards and Architectures for eGovernment Applications and to standardize processes and data in administrations. It has issued the *Standards and Architectures for e-Government Applications* (*SAGA*) Version 3.0 (October 2006) which identifies the necessary standards, formats and specifications, sets forth conformity rules and updates them in line with technological progress, the "*V-Model*", the "*Migration Guide*" and the "*DOMEA concept*", while the *eGovernment manual* prepared under the leadership of the German Federal Office for Information Security is designed as a reference manual and central information exchange for issues related to eGovernment.

In Greece, the e-Government Interoperability Framework is maintained by the Greek Ministry of Interior (November 2008, Version 3.0) (Greek Ministry of Interior, 2008) and consists of the following building blocks:

- The *Certification Framework for Public Administration Sites and Portals* (including the proposed Government Category List), which specifies the directions and standards to be followed by the public agencies at central or local level, when designing, developing and deploying e-government portals and supporting e-government services.

- The *Interoperability and Electronic Services Provision Framework* which defines the basic principles, guidelines for all interoperability levels and the general strategy to be followed by the public agencies, when developing e-government Information Systems.

- The *Digital Authentication Framework* (DAF) which sets the standards, the procedures and the technologies required for the registration, identification and authentication of the e-government services users.

- The *Documentation Model for Public Administration Processes and Data*, a practical guide which defines the notation, the rules and the specifications for the design, implementation and documentation of the Public Administration processes, documents and electronic data exchange messages, together with a methodology for designing and implementing web services compliant with the e-GIF.

- The *Interoperability Registry Prototype* (Sourouni et al., 2008), a web-based repository of service and document metadata, services process models, standardized XML Schemas for mostly used governmental documents, as well as codelists for the most common information elements within governmental service provision.

In New Zealand, the *E-government Interoperability Framework* (e-GIF) is issued by the State Services Commission and draws from other jurisdictions, most notably the United Kingdom and Australia. New Zealand has also published the *Government Web Standards and Recommendations v1.0* (March 2007) applying to any web site that is intended for the public and financed by the public through the crown or through public agencies. The *NZ Authentication Standards* outline current accepted good practice for the design (or re-design) of the authentication component for online services that require confidence in the identity of parties transacting with government agencies. The *New Zealand Government Locator Service (NZGLS) Metadata Element Set* provides a set of metadata elements designed to improve the discovery, visibility, accessibility and interoperability of online information and services. The NZ e-GIF is accompanied by an *Agency Checklist* that defines two sets of requirements imposed on agencies by e-government – mandatory and discretionary.

In United Kingdom, the e-Government Unit in the Cabinet Office has issued and maintains the following specifications:

- The *e-Government Interoperability Framework (e-GIF)* Version 6.1 (March 2005) setting out the government's technical policies and specifications for achieving interoperability and Information and Communication Technology (ICT) systems coherence across the public sector.

- The *e-Government Metadata Standard* Version 3.1 (August 2006) accompanied by the *Integrated Public Sector Vocabulary* lists the elements and refinements that will be used by the public sector to create metadata for information resources.

- The *Technical Standards Catalogue* Version 6.2 (September 2005) containing the e-GIF technical policies, tables of specifications, a glossary and abbreviations list.

- The *Security - e-Government Strategy Framework Policy and Guidelines* Version 4.0 (November 2002) regarding security requirements for the procurement and acceptance of e-Government services and their implementation.

- The *e-Government Schema Guidelines for XML* Version 3.1 (February 2004) containing guidelines for developing XML Schemas for e-GIF compliant systems.

- The *Schema Library* with adopted, under consultation and draft XML Schemas.

- The *Guidelines for UK government websites*, the *Quality Framework for UK government website design* and *the Guidelines on .gov.uk* and *.EU domain registration* setting out key guidelines that should underpin the design of all current government websites.

At a pan-European level, the *European Interoperability Framework* issued by the Interoperable Delivery of European eGovernment Services to public Administrations, Businesses and Citizens (IDABC) in 2004 (EIF v1.0) defines a set of recommendations and guidelines for e-Government services so that public administrations, enterprises and citizens can interact across borders, in a pan-European context. Today a draft second version of the European Interoperability Framework (EIF draft v2.0) has been released by the IDABC (IDABC, 2008) and attaches a more holistic view to interoperability, incorporates two additional dimensions: Political Context and Legal Interoperability on top of the existing layers of Organizational, Semantic and Technical Interoperability and provides a blueprint for the design of future Public services with interoperability and the pan-European dimension built in from the very beginning.

In United States of America, the Office of Management and Budget's (OMB) Office of E-Government (E-Gov) and Information Technology (IT), with the support of the General Services Administration (GSA) and the Federal Chief Information Officers (CIO) Council, established the *Federal Enterprise Architecture (FEA)* Program which builds a comprehensive business-driven blueprint of the entire Federal government. The Consolidated Reference Model (Version 2.3) (U.S. Office of Management and Budget, 2007) introduces five FEA reference models: *Performance Reference Model (PRM)*, *Business Reference Model (BRM)*, *Service Component Reference Model (SRM)*, *Technical Reference Model (TRM)* and *Data Reference Model (DRM)*. The *National Information Exchange Model* (NIEM), with its corresponding tools for navigating, building and sharing data models, is also is a Federal, State, Local and Tribal interagency initiative providing a foundation for seamless information exchange (U.S. Department of Justice and the Department of Homeland Security, 2008).

COMPARISON RESULTS

The results emerging from the eGIFs comparison on the basis of the levels: Systems, Standards & Specifications, Coordination are presented in the following Table 1. The indications that accompany each criterion refer to the particular aspects of the analysis levels and the coverage provided by the particular e-GIF, i.e.:

- √ indicates that the e-GIF has adopted an approach for this criterion, without judging whether this approach provides full or partial coverage for the issue.
- X refers to the lack of a tangible approach in any aspect related to this issue.
- ? characterizes a criterion when the information gathered by the publicly available sites and specifications is not sufficient to evaluate it.

	Australia	Belgium	Denmark	Estonia	Germany	Greece	New Zealand	UK
System Level								
eGIF-Supporting Systems Infrastructure	? (1.1) √ (1.2-1.6)	√ (1.6)	√ (1.3, 1.4, 1.6)	? (1.2, 1.4) √ (1.6)	? (1.1, 1.5) √ (1.2-1.4, 1.6)	√ (1.2-1.4, 1.6)	√ (1.6)	√ (1.1, 1.3, 1.6)
Standards and Specifications Level								
Organizational Interoperability	√ (2.1-2.2)	X	√ (2.2)	X (2.1) ? (2.2)	√ (2.1-2.2)	√ (2.1-2.2)	X	X
Semantic Interoperability	√ (2.3-2.5)	X	√ (2.4-2.5)	√ (2.3)	√ (2.3-2.5)	√ (2.3-2.5)	√ (2.4-2.5)	√ (2.4-2.5)
Technical Interoperability	√ (2.6)	√ (2.6)	√ (2.6)	√ (2.6)	√ (2.6)	√ (2.6)	√ (2.6)	√ (2.6)
Integration Mechanisms Guidelines	? (2.7)	X	√ (2.7)	? (2.7)	√ (2.7)	√ (2.7)	? (2.7)	X
Authentication & Security Specifications	√ (2.8)	X	? (2.8)	? (2.8)	√ (2.8)	√ (2.8)	√ (2.8)	√ (2.8)
Web Portals Design Specification	√ (2.9)	√ (2.9)	√ (2.9)	? (2.9)	? (2.9)	√ (2.9)	√ (2.9)	√ (2.9)
Certification Framework	? (2.10)	X	? (2.10)	? (2.10)	? (2.10)	? (2.10)	? (2.10)	√ (2.10)
Coordination Level								
Co-ordination Strategy,	√ (3.1-3.2)	? (3.1)	? (3.1-3.3)	? (3.1-3.4)	√ (3.1,3.4)	√ (3.1-3.4)	√ (3.1,3.4)	√ (3.1, 3.3, 3.4)

	Australia	**Belgium**	**Denmark**	**Estonia**	**Germany**	**Greece**	**New Zealand**	**UK**
Activities and Maintenance	? (3.3-3.4)		√ (3.4)		? (3.2-3.3)		? (3.2-3.3)	? (3.2)

Table 1. eGIFs Comparison Matrix

DISCUSSION

The analysis of multiple National international eGovernment Interoperability Frameworks reveals the existence of different approaches for interoperability with different perspectives, focus points, and level of detail and indicates that national efforts aiming at setting-up an interoperability framework have usually devoted efforts to produce standards and guidelines addressing the three levels of interoperability: organizational, semantic and technical levels. In the European Union, the NIFs are in alignment with the principles and the recommendations of the European Interoperability Framework version 1.0. Common principles, such as scalability, reusability, flexibility, preference for open standards, preference for standards with wide market support and security have been adopted, while the scope of the NIFs mainly extends over G2G, G2B, G2C national transactions. Most NIFs are also accompanied by relevant specifications that elaborate, for example, on web sites, security and authentication issues.

The most mature results appear to relate to technical and syntactic interoperability through:

- Adoption of common open technical standards which are maintained by international standardization organizations
- Definition of shared core components and structured XML schemas to facilitate data exchange among administrations
- Definition of metadata systems for information indexing and retrieval

Despite the similarities observed among many countries, there are no NIFs identical to each other. Different approaches for interoperability that try to look for consensus on some aspects co-exist and the fact that they vary from country to country can be mainly attributed to cultural differences and specific needs of the national public administrations.

Each country has established a governmental agency that maintains and regularly updates the NIF content, while the procedures it follows for its management do not vary significantly from country to country. The methodology and the procedure that has led to the formulation and the release of the NIF are usually explained in detail.

All NIFs define maturity and obsolete levels for the standards and compliance levels for the recommendations, according to specific life cycle transitions. In this way, the standards life-cycle is effectively managed: retirement of standards that are no longer useful and/or have become obsolete and incorporation of new ones.

In certain cases, the adoption of the NIFs by the public authorities is not mandatory and the NIF serves as guidelines that are recommended to be followed. In other cases, however, compliance with the NIF is mandatory for a set of public organizations and penalties for non-compliance with the NIF are imposed.

In this direction, the lessons from the experience of the aforementioned countries reviewed in this paper for others embarking on creating an NIF can be summarized as: e-Government Interoperability cannot be realized by addressing technical issues only. To truly enable interoperability across government, a bottom-up approach starting with technology must be avoided despite the fact that a common standard modelling framework, architecture and general technological paradigm to be followed shall be proposed and best practice guides for public administrations needs to be documented. The starting point is situated on the top with the government's strategic framework, vision and goals of its leaders. In this context, articulating organizational and semantic interoperability issues deserves more priority and effort than the technical interoperability layer that has already mechanisms and standards in place. Organizational interoperability issues should be further supported by a more concrete methodology of how to reengineer and transform traditional services to electronic flows.

The adoption of a service-oriented approach is indeed a crucial factor for implementing one-stop interoperable e-government. The NIFs must focus on the service, not on the standards which must be business needs-driven and not technology opportunity and advancement-driven.

Registries must also play a key role. The paper-based NIF specifications should give way to system-based representations, incorporating service descriptions, data definitions, standard codelists, certification schemes and application metrics in a common repository. Significant effort has to be devoted to the development of such registries as no commercial, ready to apply tools are generally available. Furthermore, integration of enterprise modelling tools and XML authoring tools with the core registry should be performed with caution and supported by high-level technical support from the vendors. The use of

eParticipation and eCollaboration tools, on top of the internet-based registry system has proven to be a worthwhile track in the direction of agreement and adoption of the NIF. Importance and adequate effort should be put in defining standard electronic services for businesses and citizens, thus providing clear examples to administrations and service portal developers.

A clearly defined NIF Governance Model needs to be envisioned and put in place, as well, by:

- Determining observance mechanisms: understanding linkages to processes and policies, such as procurement policies, to ensure that agencies must adhere to these.

- Measuring effectiveness: defining metrics of success (such as 'reuse' of systems and improved service delivery), and using metrics to evaluate progress. Time frames for measurable change though need actually to stretch out into years.

- Stimulating growth of successful projects by breeding initiatives that might become successful and result in best practices while projects targeting similar areas and not likely resulting in success should not be supported and discouraged

No matter how well prepared a government is, it is illusionary to believe that it can achieve interoperability at once in one big step. The starting position of the public sector should be well understood and benchmarked so that the gap between the 'as is' and the 'to be' states are well defined. Securing interoperability is a process that includes many incremental activities over time which are constantly monitored and where the long haul - quick wins will seem to be small wins in the grand scheme of things.

Winning 'hearts and minds' is crucial and mechanisms for increasing awareness must be foreseen. Bringing together officials from across government agencies to discussing the framework, with the participation of businesses and citizens, may go a long way, but it will ensure acceptance in the long term. The supplier community must be in partnership with the government community, with a shared understanding of the means of delivery and the ends sought while coalitions having participants with different backgrounds and from multiple organizations at a national and local level can bring new ideas on the table.

Competencies of the public servants shall be cultivated with the help of appropriate education schemes since knowledge and capabilities are necessary to understand and apply the NIF in its full spectrum. The investment on appropriate certification infrastructure is also crucial for ensuring compliance with the NIF.

CONCLUSIONS AND FUTURE STEPS

Interoperability reaches all governmental organizations at national and international level and constitutes a thriving research domain from all aspects – scientific, entrepreneurial, societal and political. Today, most countries internationally have created an interoperability framework, a strategic document containing specifications and standards to be followed in order to ensure interoperability among public administrations and their beneficiaries (citizens, businesses, other public administrations). It provides guidance to practitioners what to consider and to do in order to enable seamless interaction within their public administration as well as with other public authorities. However, in most cases the scope of the NIFs needs to be extended applying best practices drawn from other NIFs in order to provide a thorough set of specifications covering the Comparative Analysis Framework proposed in this paper.

As far as the completeness of the frameworks examined is concerned, Australia together with Greece appear to have a more complete set of specifications together with appropriate system infrastructures on eGovernment interoperability. Germany has a clear vision and methodology on how to achieve interoperability through specifications and systems which are under way and tangible results come to validate its approach. UK, although a pioneer some years ago, today seems to have lost pace with the advancements on interoperability and attention is now paid on the "process" and the "people" dimensions, ensuring that everything from governance to technical standards selection and mandate is business needs driven. Denmark has critical achievements around systems, like its UDDI registry, and technical standards, as well as on co-ordination efforts on top of Web 2.0 tools, but should look more to organizational aspects. Estonia and New Zealand need to emphasize more on their missing parts of organizational and semantic interoperability, as well as the systems infrastructures. Belgium is very technical standards-oriented and should obtain a more holistic view of interoperability. The collaboration among these NIFs should be pursued, since on the one hand it ensures that lessons from the pioneers' experience are learnt and that the same mistakes will not be repeated, while on the other hand it eventually leads to facilitating cross-country interoperability.

Following on the findings of this study and the directions provided by relevant literature (Charalabidis et al., 2008a, 2008b; Dawes, 2008), future perspectives on e-Government Interoperability Frameworks cover two areas:

- Practical Research that focuses on issues for which scientific research has proposed a solution but the results have not been yet applied effectively in the e-GIFs, such as Interoperability Registries that support service transformation and re-

engineering (apart from modelling) and on-the-fly service execution with the help of content federation mechanisms with central governmental portals; Interoperability impact analysis and monitoring mechanisms.

- Scientific Research concerning areas at all aspects of interoperability, for example: Creating methodologies and solutions that provide end-to-end interoperability (like a service utility) and incorporate capabilities for semantically enriched service composition, brokering, negotiation, mediation and evolution on-the-fly; Semantic and cultural interoperability of cross-country public services; Empowerment and initial deployment of Web 2.0 technologies in the public domain.

REFERENCES

1. Australian Government Information Management Office (AGIMO) (2008) Australian Government Interoperability Framework, http://www.finance.gov.au/agimo/

2. BELgian Governement Interoperability Framework (2008) http://www.belgif.be/index.php/Main_Page

3. Cabinet Office (2007) UK e-Government Interoperability Framework, http://www.govtalk.gov.uk

4. Capgemini (2007) The User Challenge Benchmarking: The Supply Of Online Public Services, 7th Edition, http://www.epractice.eu/files/media/media1673.pdf

5. Charalabidis, Y., Tschichholz, M. and Hopkirk, A. (2007a) Advancing the eGovernment Interoperability Framework in European Countries: Architectures, Challenges and Perspectives from the new Greek eGIF, *Proceedings of the eChallenges 2007 Conference*, October 24 – 26, The Hague, The Netherlands.

6. Charalabidis, Y., Lampathaki, F., Askounis, D. and Stassis A. (2007b), Shifting to Second Generation E-Government Interoperability Frameworks, *Proceedings of the 6th International EGOV 2007 Conference*, September 3-7, Regensburg, Germany.

7. Charalabidis, Y., Lampathaki, F. and Askounis, D. (2008a) Unified Data Modeling and Document Standardization Using Core Components Technical Specification for Electronic Government Applications, *Journal of Theoretical and Applied Electronic Commerce Research*, 3, 3, 38-51.

8. Charalabidis, Y., Gionis, G., Moritz Hermann, K. and Martinez, C. (2008b) Enterprise Interoperability Research Roadmap, Draft Version 5.0, ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/enet/ei-roadmap-5-0-draft_en.pdf

9. Commission of the European Communities (CEC) (2006) i2010 e-Government Action Plan: Accelerating e-Government in Europe for the Benefit of All, COM (2006) 173 final, http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/com/2006/com2006_0173en01.pdf

10. Commission of the European Communities (CEC) (2006) Interoperability for Pan-European eGovernment Services, COM (2006) 45 final, http://europa.eu.int/idabc/servlets/Doc?id=24117

11. Dawes, S. (2008) An Exploratory Framework for Future E-government Research Investments, Proceedings of the 41st Hawaii International Conference on System Sciences, January 7-10, Hawaii.

12. Estonian Ministry of Economic Affairs and Communications (2007) Estonian IT Interoperability Framework, http://www.riso.ee/en/information-policy/interoperability

13. Gottschalk, P. (2008) Maturity levels for interoperability in digital government, Government Information Quarterly, Article in Press, doi:10.1016/j.giq.2008.03.003

14. Greek Ministry of Interior (2008) Greek eGovernment Interoperability Framework, http://www.e-gif.gov.gr/

15. Guijarro, L. (2007) Interoperability frameworks and enterprise architectures in e-government initiatives in Europe and the United States, *Government Information Quarterly*, 24, 1, 89-101

16. Hovy E. (2008) Data and Knowledge Integration for e-Government, in Chen H. et Al. (Eds.), *Digital Government: e-Government Research, Case Studies and Implementation*, Springer, 219-232.

17. IDABC (2004) European Interoperability Framework for pan-European e-Government Services, Version 1.0, http://europa.eu.int/idabc/en/document/3761

18. IDABC (2005) Content Interoperability Strategy, Working Paper, http://ec.europa.eu/idabc/servlets/Doc?id=24405

19. IDABC (2008) European Interoperability Framework draft version 2.0, http://ec.europa.eu/idabc/servlets/Doc?id=31508

20. Janssen, M. and Cresswell, A. (2005) Enterprise Architecture Integration in E-government, *Proceedings of the 38th Hawaii International Conference on System Sciences (HICCS)*, January 3-6, Hawaii

21. KBSt unit at the Federal Ministry of the Interior (2006) SAGA Standards and Architectures for e-Government Applications, http://www.cio.bund.de/cln_102/DE/Standards/SAGA/saga_node.html

22. KIU (2006) Danish Interoperability Framework, http://standarder.oio.dk/English/Guidelines

23. MODINIS (2007) Study on Interoperability at Local and Regional Level, Version 2.0, http://www.epractice.eu/files/media/media1309.pdf

24. Niehaves, B. (2007) Innovation Processes in the Public Sector – New Vistas for an Interdisciplinary Perspective on E-Government Research?, in Wimmer, M.A., Scholl, H.J. and Grönlund, A. (Eds.), *Proceedings of 6th EGOV Conference 2007*, LNCS 4656, 23–34

25. Osimo, D. (2008) Web 2.0 in Government: Why and How?, European Commission Joint Research Centre Scientific and Technical Reports

26. Panetto H. (2007) Towards a Classification framework for interoperability of enterprise applications, *International Journal of CIM*, 20, 8, 727-740, Taylor & Francis

27. Papazoglou, M. P. and Ribbers, P. M. A. (2006) E-business: Organizational and technical foundations, UK, West Sussex: John Wiley & Sons

28. Ralyte, J., Jeusfeld, M., Backlund, P., Kuhn, H. and Arni-Bloch, N. (2008) A knowledge-based approach to manage information systems interoperability, *Information Systems*, 33, 754–784.

29. Scholl, H. J. and Klischewski, R. (2007) E-Government Integration and Interoperability: Framing the Research Agenda, *International Journal of Public Administration*, 30, 8, 889–920.

30. Sourouni, A.-M., Lampathaki, F., Mouzakitis, S., Charalabidis, Y. and Askounis, D. (2008) Paving the way to e-Government Transformation Interoperability Registry Infrastructure Development, in Wimmer, M.A., Scholl, H.J. and Ferro, E. (Eds.), *Proceedings of 7th EGOV Conference 2008*, LNCS 5184, 340-351.

31. State Services Commission (2007) NZ E – Government Interoperability Framework, http://www.e.govt.nz/standards/e-gif

32. United Nations Development Programme (UNDP) (2007) e-Government Interoperability: A Review of Government Interoperability Frameworks in Selected Countries, http://www.apdip.net/projects/gif/serieslaunch

33. U.S. Department of Justice and Department of Homeland Security (2008) National Information Exchange Model (NIEM), http://www.niem.gov/

34. U.S. Office of Management and Budget (2007) FEA Consolidated Reference Model Document Version 2.3, http://www.whitehouse.gov/omb/assets/fea_docs/FEA_CRM_v23_Final_Oct_2007_Revised.pdf