Interoperability of e-Government Information Systems: A Survey

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ABSTRACT

Interoperability has long been recognized as one the major enabler for providing 'one stop' government services to citizen. In order to develop interoperable information systems governments are coming out with technical standards and guidelines so that agencies and their partners can work together. Some governments have accepted Enterprise Architecture as foundation for providing integrated service. This article surveys definition and dimensions of interoperability. Next it attempts to review approaches taken by different government across the world to overcome the problem of heterogeneity.

Keywords: e-government, interoperability, interoperability frameworks

1. Introduction

One of the aims of the e-government program is to use information and communication technology to provide government services to citizen in such a way that the citizen access it without being bothered about the structure of the government. He or she should be able to access the service from a single point of access despite the fact that fulfillment of the service may require inputs from more than one departments of the government. Attaining such a state require interoperability of the government information systems with a strong coordination of all the organisations involved. The fulfillment of the e-Government visions of such an 'One stop' government service would dependent on increased vertical and horizontal integration of government operations and services.

Interoperable e-Government would result in significant benefits, including:

- reduced costs of information collection and management through streamlined collection, processing and storage;
- improved decision making for policy and business processes, resulting in more integrated planning and enhanced government service delivery;
- improved timeliness, consistency and quality of government responses information will be easily accessible, relevant, accurate, and complete;
- improved accountability and transparency for citizens;
- reduced costs and added value for government through reusing existing information, sharing infrastructure and designing integrated, collaborative methods of delivering services;
- improved fraud detection and national security.

Despite such favorable reasons, most of the e-government systems are far away from the cherished goal.

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The main stumbling block is the inherent hierarchical weberian model of government and tradition of independent development of Information Systems by individual departments. As a possible solution government around the globe are coming out with guidelines in the form of Interoperability Frameworks, for the public agencies for develop IT plans and projects. Such guidelines contains descriptions and recommendations of selected standards, technologies and protocols, which might be used and supported in relation with the implementation of e-Government in that country.

2. Interoperability and its Dimensions

There have been numerous definitions of Interoperability put forth by researchers, standard bodies and government over last so many years. Lack of a uniform definition has forced most of the countries which have come out with their interoperability framework to define the term in the first. Ford et al (2007) have identified about thirty four distinct definitions of interoperability. As interoperability is a major deciding factor in modern warfare, most of the definitions are related to armed forces and are mainly concerned about technical interoperability. Another major source of Interoperability definitions is different standard organisatons. Some of the most common definitions from different domains and sources are given in Table 1.

Table 1: Interoperability definitions from various sources

Definition	Source	Interoperability Type and Origin
..the ability of two or more systems or elements to exchange information and to use the information that has been exchanged. • the capability for units of equipment to work together to do useful functions. • the capability, promoted but not guaranteed by joint conformance with a given set of standards, that enables heterogeneous equipment, generally built by various vendors, to work together in a network environment. • the ability of two or more systems or components to exchange information in a heterogeneous network and use that information.	IEEE quoted by Morris (Morris, Levine, Meyers, Plakosh & Place, 2004)	Technical, Semantic, Standard
The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together [*Chairman of the Joint Chiefs of Staff, Instruction 6212.01A: "Compatibility, Interoperability, and Integration of Command, Control, Communications, Computers, and Intelligence Systems." June 1995. Joint Chiefs of Staff. "Department of Defense Dictionary of Military and Associated Terms, as amended through December 7, 1998" (Joint Publication 1-02)]*. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree interoperability should be defined when referring to specific cases [*Joint Chiefs of Staff. "Department of Defense Dictionary of Military and Associated Terms, as amended through December 7, 1998" (Joint Publication 1-02).*].	Kausnic & Anderson p.2 (Kasunic, Anderson, 2004)	Technical, Operational, Defense
interoperability: a state which exists between two application entities when, with regard to a specific task, one application entity can accept data from the other and perform that task in an appropriate and satisfactory manner without the need for extra	CEN/ISSS (CEN/ISSS, 2005)	Technical, Data, Semantic, Health

operator intervention.		
"to be interoperable, one should actively be engaged in the ongoing process of ensuring that the systems, procedures and culture of an organisation are managed in such a way as to maximise opportunities for exchange and re-use of information, whether internally or externally. "	Miller, P. (Miller, 2000)	Technical, Organisational, Semantic, Academic
.. interoperability is the way in which reliable data is provided and communicated in a secure, accurate and efficient way. It has to surmount barriers of national policies, culture, language, and systems of medical knowledge representation and use of ICTs.	Telemedicine Alliance (Telemedicine Alliance, 2005)	Technical, Semantic, Human, Health
"The ability of government organisations to share information and integrate information and businesses by use of common standards."	NZ e-GIF (State Services Commission, 2007),	Technical, Semantic, e-government
Interoperability is the ability of a system or process to use information and/or functionality of another system or process by adhering to common standards.	European Public Administration Network (European Public Administration Network, 2004)	Technical, Business Process, e-government
Interoperability describes the ability to work together to deliver services in a seamless, uniform and efficient manner across multiple organisations and information technology systems.	Australian Government Technical Interoperability Framework (Australian Government Information Management Office, 2005)	Technical, Information, Organisational, e-Government
Interoperability means the ability of information and communication technology (ICT) systems and of the business processes they support to exchange data and to enable the sharing of information and knowledge.	IDABC (IDABC, 2004)	Technical, Organisational, Semantic, e-Government

The problem of nomenclature is further complicated by the interchangeable use of the terms Integration, Interoperation and Interoperability. Some researchers and standard organizations attempted to define each term individually. For example Scholl and Klischewski (forthcoming) has attempted to distinguish them by providing distinct definition for these three terms:

- *Integration:* E-Government Integration is the forming of a larger unit of government entities, temporary or permanent, for the purpose of merging processes and/or sharing information. E-government integration refers to the mainly non technical constraints in which technical interoperation occurs.
- *Interoperation:* Interoperation in E-Government occurs whenever independent or heterogeneous information systems or their components controlled by different jurisdictions/administrations or by external partners smoothly and effectively work together in a predefined and agreed upon fashion.
- *Interoperability*–e-Government interoperability is the technical capability for e-Government interoperation.

According to the authors, interoperability is a higher state of interoperation. Interoperability facilitates working together of computers, networks, operating systems and applications dynamically without any prior communication, whereas interoperation requires statically arranged ("hard-wired") agreement among the parties. Similarly CEN/ISSS (2005) [CEN is the European Committee for Standardization. ISSS is the Information Society Standardization System. Together CEN/ISSS provide standardization services and

products] attempts to distinguish the terms Integration, Interoperability. As mentioned already CEN/ISS defines interoperability as "a state which exists between two application entities when, with regard to a specific task, one application entity can accept data from the other and perform that task in an appropriate and satisfactory manner without the need for extra operator intervention". CEN/ISS defines integration as "combination of diverse application entities into a relationship which functions as a whole".

Another separate definitions of these three terms are found in FEA Consolidated Reference Model Document (Executive Office of the President of the USA, 2007). According to that document, integration defines the software services enabling elements of distributed business applications to interoperate. These elements can share function, content, and communications across heterogeneous computing environments. In particular, service integration offers a set of architecture services such as platform and service location transparency, transaction management, basic messaging between two points, and guaranteed message delivery. Interoperability defines the capabilities of discovering and sharing data and services across disparate systems and vendors. Interface defines the capabilities of communicating, transporting and exchanging information through a common dialog or method. Delivery Channels provide the information to reach the intended destination, whereas Interfaces allow the interaction to occur based on a predetermined framework. According to Chen & Vernadat (2003) ability for different system to work together may be characterised at various levels of cooperation (eg. physical systems, application, business and networked organisations). Interoperability has the meaning of co-existence and co-operation while integration relates to the notion of co-ordination and unification. They further define interoperability as capability to communicate with pier systems, while integration is a broader concept embracing communication, co-operation and co-ordination capabilities. There fore interoperability must be achieved to achieve real integration.

Despite such attempts in most of the cases Integration and Interoperability are used interchangeably. So, in order to keep clarity, it would be better to define upfront the scope and definition of the term, in any work on Interoperability.

3. Elements of Interoperability

As there is no consensus on the definition, so is the lack of unanimity on what constitutes Interoperability. Flowing list shows some of the important examples.

These examples show that Interoperability is not merely technical, it has many other dimensions. In fact, the technology side may prove the least difficult to address, while the organizational, legal, political, and social aspects may prove much more of a challenge (Scholl 2005). Over and above such propositions about dimensions of Interoperability, there are further attempts to organize interoperability into evolutionary models (Peristeras, Tarabanis 2006). Such maturity models are generally used to measure degree of interoperability among systems. Where each stage is expected to be an advancement of the previous stage. Most of such attempts are related to armed forces. Levels of Information System Interoperability (LISI) by C4ISR Architecture Group (Kasunic M, Anderson W 2004)

LISI defines five levels interoperability of increasing sophistication.

- Isolated Systems: No physical connection exists (manual).
- Connected Systems: Electronically connected; separate data applications; homogeneous data exchange is possible (peer-to-peer).
- Distributed Systems: Minimal common functions; separate data & application; heterogeneous data exchange is possible (functional).
- Domain Systems: Shared data but separate applications; sophisticated collaboration (integrated)

- Enterprise Systems: Enterprise wide shared systems; advanced collaboration; interactive manipulation of shared data & applications (universal).

Table 2: Dimensions of Interoperability

Source	Interoperability aspects
Australian Interoperability Framework (Australian Government Information Management Office 2005),	Technical - comprises technology standards such as transport protocols, messaging protocols, security standards,process description languages etc. Information - comprises information and process elements that convey business meaning Business- comprises legal, commercial, business and political concerns
NZ e-GIF (State Services Commission 2007),	Acess & Presentation- Covers how users access and present business systems. Business Services - concerned about data exchange in particular business applications and information contexts. Data Integration- concerned about data exchange and processing. Network - Covers details of data transport, such as network protocols.
EU (European Public Administration Network 2004)	Organisational - This aspect of interoperability is concerned with defining business goals, modeling business processes and bringing about the collaboration of administrations that wish to exchange information and may have different internal structures and processes. Semantic- This aspect of interoperability is 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- This aspect of interoperability covers the technical issues of linking computer systems and services.
Danish e-Government Interoperability Framework (Government of Denmark 2006)	Process- concerned with how and where information is sent and processed – and how it is handled. Technical-comprises of technical aspects like data integration, interconnectivity, user interfaces etc. Data- concern about unambiguous definition of the terms exchanged between IT systems and their components.
Miller (2000)	Technical Interoperability Semantic Interoperability Political/ Human Interoperability- concerned about the organisational aspects, worker and end users. Inter-community Interoperability -concerned about interoperability among different domains, subject area. Legal Interoperability - concerned about legal constraint in integration and exchange of information. International Interoperability
Seth (1999)	Semantic Interoperability Structural Interoperability - representational, schematic Syntactic Interoperability - format System Interoperability - information system – DBMS, data model etc., platform, operating system- file system, naming, file types, - hardware / system – instruction set, data representation etc.

Clark and Jones (1999) in proposed an Organisational Interoperability Maturity Model. The model defines the levels of organisational maturity that describe the Five levels were identified, closely aligned with the descriptions of the LISI model.

- Independent (Level 0): This level describes the interaction between independent organisations. Only interaction is that of personal contact.
- Ad hoc (Level 1): At this level of interoperability only very limited organisational frameworks are in place, which could support ad hoc arrangements. There will be some

- guidelines to describe how interoperability will occur but essentially the specific arrangements are still unplanned.
- Collaborative (Level 2): The collaborative organisational interoperability level is where recognised frameworks are in place to support interoperability. Shared goals are recognised and, roles and responsibilities are allocated as part of on-going responsibilities, however the organisations are still distinct.
- Integrated (Level 3): The integrated level of organisational interoperability is one where there are shared value systems and shared goals, a common understanding and a preparedness to interoperate. For example, detailed doctrine is in place and there is significant experience in using it.
- Unified (Level 4): a unified organisation is one in which the organisational goals, value systems, command structure/style and knowledge bases are shared across the system.

Tolk and Muguira(2003) has developed the Levels of Conceptual Interoperability (LCIM) Model that addresses levels of conceptual interoperability that go beyond technical models like LISI. Authors observe that the model has been developed for the simulation domain but the basic premises apply to many complex sets of interoperating systems. The focus lies in the data to be interchanged and the interface documentation that is available. The layers of the LCIM model include -

Level 0: System specific data: black box components with no interoperability or shared data.

Level 1: Documented data: shared protocols between systems with data accessible via interfaces.

Level 2: Aligned static data: common reference model with the meaning of data unambiguously described. Systems are black boxes with standard interfaces. However, even with a common reference model, the same data can be interpreted differently in different systems.

Level 3: Aligned dynamic data: Use of data is defined using software engineering methods like Unified Modeling Language. This allows visibility into how data is managed in the system. But even systems with the same interfaces and data can have different assumptions and expectations about the data.

Level 4: Harmonized data: Non-obvious semantic connections are made apparent via a documented conceptual model underlying components. This goes beyond Level 3 because the assumptions concerning the data are made apparent.

Tolk (2003) has put forward another model to facilitate discussion on technical and organizational (political and military) support required for interoperable solutions.

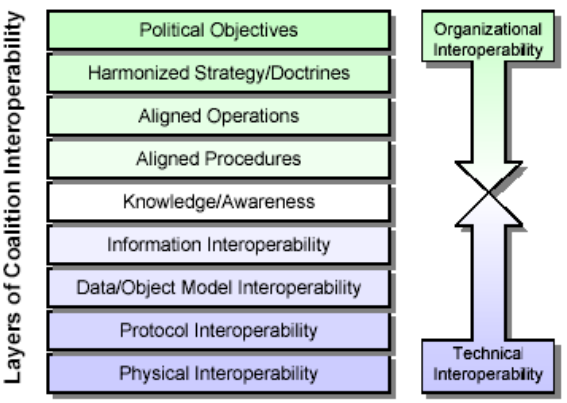

Figure 1: Layers of Coalition Interoperability (Tolk 2003)

The four lower levels of the model deal with technical interoperability. The knowledge/awareness level provides a transition between technical interoperability and organizational interoperability, which is represented by the top four levels.

4. Approaches of attaining Interoperability

Klischewski (2004) suggest two approaches to achieve interoperability viz. Information Integration and Process Integration. information integration aims at facilitating information flow, i.e. providing access to structured informational resources across technical and organisational borders in order to enable new services based on a virtually shared information environment. Process integration, on the other hand, centres around interrelating steps and stages of process performance across technical and organisational borders in order to enable new services based on an overarching monitoring and control of process flow. Author further suggest that process integration compared to information integration needs more planning operations, therefore it requires a higher intensity of cooperation and financial investment and finally provides guideline for their selection in a given situation.

While the former format requires the interoperation of government Information Systems for information sharing purposes, the latter extends to the interoperation of functional components contributing to a single "overarching process" that is, a much tighter integration than in the former format. Jhingran, Mattos & Pirahesh (2002) describes four distinct approaches to integration. They are-

- Portals integration is the shallowest form, bringing potentially disparate applications together in a single entry point.
- Business-process integration orchestrates processes across application and possibly enterprise boundaries, such as those involved in a supply chain relationship. Web services and their derivatives are potential candidate for this.
- Application integration, in which applications that do similar or complementary things communicate with each other, is typically focused on data transformation and message queuing, increasingly in the XML domain.
- Information integration, wherein complementary data are either physically or logically brought together, makes it possible for applications to be written to and make use of all the relevant data in the enterprise, even if the data are not directly under their control.

Stelzer, Fischer& Nirsberger (2006) defines two types of Integration viz. Interconnection and Unification. Former is a state where integration items are distinct, whereas in the later case, as the name suggest, integrating items are merged into a single entity. They further subdivided the Interconnection into 'Partially Automated Interconnection and Fully Automated Interconnection. The authors suggest that Unification leads to higher intensity integration compared to Interconnection.

5. Interoperability frameworks

The most common approach undertaken by governments to address the problem of interoperability is by encouraging all agencies to use of standards when developing new or upgrading existing IT systems. Government generally publishes such technical standards, policy principles and guidelines in the form of a Interoperability Framework. Interoperability framework of some of the countries are listed below

Australia (Australian Government Technical Interoperability Framework, version 2) (Australian Government Information Management Office 2005) The Framework divides the technical domain into a series of layers Interconnection, Data Exchange, Discovery, Presentation, Metadata for Process and Data Description, Naming and Security. The *Security* category covers standards and technologies whose primary role is for supporting secure interoperation. Included in this category are standards and technologies for the encryption of data, public key infrastructure standards supporting the use of public and private encryption

and decryption keys, digital signatures, and secure transmission protocols such as IPSEC. The *Interconnection* category covers standards and technologies for connecting systems. Included within this category are basic connection protocols such as HTTP, FTP, SOAP, WSDL. The *Data Exchange* category contains standards and technologies for the description of the structure and encoding of data for exchange, such as the email protocols SMTP and X.400, resource syndication protocols like RSS, data markup languages such as XML and SGML. The *Discovery* category covers standards and technologies for supporting the discovery and location of resources. These include metadata standards and thesaurus standards for supporting consistent description of resources. Also included are directory standards such as LDAP and X.500. The *Presentation* category covers standards related to the presentation of information. These standards allow data to be interpreted and presented in consistent ways when shared between systems. Such presentation standards include HTML (and XHTML) as well as selections from the wide range of image and streaming media formats. *Metadata for Process and Data* Description standards are concerned with the sequencing of operations and their execution dependencies. Common amongst these standards are a range of workflow definition and description languages and the emerging Web Services coordination and choreography languages such as BPEL4WS. The standards under this heading also support the description of the meaning of data elements, data structures and the interrelationships between data elements. The *Naming* category covers the basic primitives for defining consistent names for resources.

Canada (Treasury Board of Canada Secretariat,2007). Main objective of Government Information and Technology Standards Program is to increase effectiveness and economy in acquiring and administering information technology resources throughout government by promoting compatibility and interchangeability of equipment, programs, data and the characteristics of data. Standards in the following are available under this program. Data Interchange and Media (DIAM) Series, Databases and Documents (DBD) Series, Information Management (IM) Series, Operating Systems Services and Utilities (OSSU) Series, Programming Languages and Software Engineering (PLSE) Series, Quality Assurance (QA) Series, User Environment (UE) Series, Network Services, Application and Management (NSAM)

Denmark **(**The Interoperability Framework, version 1.2.14)(Government of Denmark, 2006). The Danish e-Government Interoperability Framework offers three overall categories of standards: technical standards, data standards and process. The Danish e-Government Interoperability Framework is based on following general approaches -

- Use open standards.
- Incorporate exsisting standards in a broader context.
- Stimulate reuse of established standards.
    - Redesign administrative processes to make the best use of available technology.
    - Coordinate and manage the e government initiative. Centrally agreed XML schemas would be shared to reduces cost while the need to develop separate mechanisms for interchanging data is greatly reduced.

The Technical standards covers the following area –

- User Interfaces - standards related to the presentation of data to the user.
- Document and Data Interchange - standards related to formatting of documents.
- Web-based Services - standards related to the World Wide Web and Web services
- Content Management and Metadata Definition - standards and requirements for metadata.
- Data Integration - standards related to processing of data.
- Identity Management - standards related to storing, using, and safekeeping identity information for users, citizens, employees, and resources.
- Interconnectivity - standards related to networks and system development

- Operations - standards related to system operations and monitoring
- Business area specific standards - standards related to specific business areas, e.g., e-learning.

The process standards describe common approaches to processes and are particularly concerned with how and where information is sent and processed – and how it is handled. Hence, it is a category of standards more focussed on humans and work processes than the technical aspects of IT. The Data Standards ensure that the terms exchanged between IT systems and their components are unambiguously defined.

European Union (European Interoperability Framework for pan-European eGovernment Services, version 1.0) (IDABC,2004) The European Interoperability Framework (EIF) is developed to support the pan-European delivery of electronic government services. The EIF makes recommendations, defines generic standardisation requirements with regard to organisational, semantic und technical aspects of such interoperability and offers a comprehensive set of principles for European cooperation in eGovernment. The EIF recommends the following principles, of a general nature, for setting up of any e-Government services at a pan-European level. They are -Accessibility, Multilingualism, Security, Privacy, Subsidiarity, Use of Open Standards, Assess the benefits of Open Source Software and Use of Multilateral Solutions.

An accompanying document titled 'Architecture Guidelines, version 7.1', describes the architectural models and the services and standards for developing pan-European government services. The Architecture Guidelines is be used as reference material whenever procuring or implementing services that access the trans-European Services, or as a technical framework for the achievement of generic services. The guideline, also contains technical specifications for candidate technology, as well as a number of 'Best Practice'. Specification and recommendations are provided for areas like Data Presentation and Exchange, Interconnection, Network service, Security Services, Web Service, Workflow Management etc.

Germany (Standards and Architectures for e-Government Applications (SAGA Version 3.0) October 2006) (Federal Ministry of the Interior,2006). The Standards and Architectures for e-Government Applications (SAGA) guideline pursues the following aims: (a) Interoperability, (b) Reusability, (c) Openeness, (d) Reduction of costs, (e) Scalability. At the first place SAGA describes a architecture model for e-Government applications. The model consists of the of following:

a. The enterprise viewpoint specifies the aims, scope, processes and policies of an application.
b. The information viewpoint describes the structure and semantics of the data to be processed, i.e. the data model.
c. The computational viewpoint represents the breaking down of an application into functional modules and their interaction interfaces.
d. The engineering viewpoint represents the distribution of the individual elements of the system to physical resources and their connections.
e. The technology viewpoint describes the technologies used to implement the system.

SAGA under technology view point define the SAGA standards for the IT architecture and for ensuring data security and integrity.

Hong Kong **(**The HKSARG Interoperability Framework, version 5.1) (Office of the Government Chief Information Officer,2007). The HKSARG Interoperability Framework is a collection of technical and data specifications that help inter-Bureau and Departments to define the interface between interacting applications. Extensible Markup Language (XML) is a key component of the Interoperability Framework. Data specifications for interface between systems are defined in XML. This Interoperability Framework lists the technical specifications for the following interoperability domains. Application integration – technical specifications to enable application-to-application integration;

- Information access and interchange – technical specifications for file exchange, character sets and encoding, etc.
- Security – technical specifications to enable the secure exchange of information;
- Interconnection – technical specifications to enable communication between systems.

Each domain is further subdivided into several sub domains.

India (IFEG – Interoperability Framework for E-Governance – Technical Standards, version 2.0, 2004) (National Informatics Centre, 2004). National Informatics Centre (NIC) has initiated the development of an Interoperability Framework for E-Governance (IFEG) which comprises of policies and technical standards to facilitate interaction between isolated e-governance applications. The IFEG has the following components – Technical Standards and Policies – defines technical policies and specifications governing electronic information flows across the government. Government Data Standard – XML schemas used for interchange of data would be based upon data standards. The data standards would also be used for data storage and other interchange process. Data standard would consists of Naming Convention, Standard Designators, Acronyms, context, scope etc. IFEG Meta Data Standard – Metadata would be used for easier management and discovery of information resources possessed by government agencies. IFEG Metada standard would define the elements, refinements and encoding schemas for the resources. XML Schema – IFEG envisages that a library of XML schemas would be developed for inter-organizational interchange of data. The technical standard for IFEG is arranged under the following domains–(a) Information Access, (b) Presentation, (c) Process, (d) Data Integration, (e) Data Schema, (f) Metadata, (g) Network, (h) Security and (i) Communication

New Zealand (New Zealand E-government Interoperability Framework (NZ e-GIF))(State Services Commission, 2007) New Zealand Interoperability Framework categorised standards using a "layer model". Constituent of the layers are – (a) Network, (b) Data Integration, (c) Business Services and (d) Access and Presentation. The framework also contains standards related to security, web services, best practice, e-Government services, which according to the framework is applicable to all elements of the layer model.

UK (e-Government Interoperability Framework Version 6.1,March 2005)(Cabinet Office, Government of UK 2005). e-Government Interoperability Framework (e-GIF) is at the heart of UK governments strategy for IT supported business transformation of government towards delivering better, more efficient public services.

The e-GIF architecture contains:

- the Framework, which covers high-level policy statements, technical policies and management, implementation and compliance regimes
- the e-GIF registry, which covers the e-Government Metadata Standard (e-GMS) and Government Category List (GCL), the Government Data Standards Catalogue (GDSC), XML schemas and the Technical Standards Catalogue (TSC)

The e-GIF defines the minimum set of technical policies and specifications governing information flows across government and the public sector. These cover interconnectivity, data integration, content management metadata and eservices access.

USA (Consolidated Reference Model Document Version 2.2 July 2007)(Executive Office of the President of the USA, 2007). The Federal Enterprise Architecture consists of a set of interrelated "reference models" designed to facilitate cross-agency analysis and the identification of duplicative investments, gaps and opportunities for collaboration within and across agencies. Collectively, the reference models comprise a

framework for describing important elements of the FEA in a common and consistent way. Through the use of this common framework and vocabulary, IT portfolios can be better managed and leveraged across the federal government. The Consolidated Reference Model (version 2.2) along with Data Reference Model (version 2.0) can be considered to be comparable with the Interoperability Framework of other countries. The Consolidated Reference Model, under the chapter 'Technical Reference Model (TRM)' provides the standards and technologies to support and enable the delivery of Service Components and capabilities. Whereas the Data Reference Model enables information sharing and reuse across the federal government via the standard description and discovery of common data and the promotion of uniform data management practices. The TRM categorizes standards into following categories-

- Service Access and Delivery
- Service Platform and Infrastructure
- Component Framework
- Service Interface and Integration

Each category is further subdivided in to number of sub categories.

6. Enterprise Architecture in providing seamless government services

Creating interoperability in government requires more than just having a common technical standard or using XML to create technical integration between two applications (Klischewski 2003). Linking different administrative services to provide quality and reliable e-government services also require that we understand the complex linkages of cooperation – and conflicts – between government organizations. Therefore, interoperability must be defined at a broader level as the ability of information systems and the business processes they support, to exchange data and enable sharing of information. Enterprise architecture (EA) captures an organization's core business processes and IT capabilities using a set of policies and technical choices, to achieve business standardization and integration requirements of the organization's operating model. Typically, Government is the largest and the most complex organization in almost every country. On a holistic basis, EA allows Government organizations to uncover common business services and allow underlying systems and applications to interoperate. This facilitates seamless delivery of e-services to its citizen and business. Additional benefits include common technology platforms, data exchange standards and application development standards.

USA is in the forefront of adopting Enterprise Architecture in the domain of government. In 2002, Office of the Management and Budget (OMB) of the Executive Office of the President of the United States, established Federal Enterprise Architecture (FEA) as 'a business based framework for cross agency, government-wide improvement'.

The FEA is a collection of reference models that develop a common taxonomy and ontology for describing IT resources. These include the Performance Reference Model, the Business Reference Model, the Service Component Reference Model, the Data Reference Model and the Technical Reference Model.

Performance Reference Model (PRM) -The PRM is a framework for performance measurement providing common output measurements throughout the federal government. It allows agencies to better manage the business of government at a strategic level, by providing a means for using an agency's EA to measure the success of IT investments and their impact on strategic outcomes.

Business Reference Model (BRM) - The BRM provides a framework facilitating a functional (rather than organizational) view of the federal government's lines of business, including its internal operations and its services for citizens, independent of the agencies, bureaus and offices performing them. The BRM describes the federal government around common business areas instead of through a stovepiped, agency-

by-agency view. It thus promotes agency collaboration and serves as the underlying foundation for the FEA and E-Gov strategies.

Service Component Reference Model (SRM) - The SRM is a business-driven, functional framework classifying Service Components according to how they support business and performance objectives. It serves to identify and classify horizontal and vertical Service Components supporting federal agencies and their IT investments and assets.

Technical Reference Model (TRM) - The TRM is a component-driven, technical framework categorizing the standards and technologies to support and enable the delivery of Service Components and capabilities. It also unifies existing agency TRMs and E-Gov guidance by providing a foundation to advance the reuse and standardization of technology and Service Components from a government-wide perspective.

Data Reference Model (DRM) - The DRM is a flexible and standards-based framework to enable information sharing and reuse across the federal government via the standard description and discovery of common data and the promotion of uniform data management practices.

Guijarro (2007) have done a comparative study of the EA and Interoperability Frameworks of the major countries of the world. Guijarro's considered opinion is, UK government's set of specification, viz. The Government Common Information Model, The Government Data Standards Catalogue, The Government Message Reference Model, The e-GIF and Technical Standards Catalogue should be considered as elements of a architecture and hence the whole suit can be considered as an EA.

Few other countries like Denmark, Netherlands, Australia have also in principle agreed about adopting EA or in the process of implementing EA, to improve their services and efficiencies. Janssen and Hjort-Madsen (2007) have found both Denmark and Netherlands are using their National Enterprise Architecture(NEA) programs as instruments to govern the public sector organisational network from an integrated strategy, business and technology perspective. At the end of the study Guijarro(2007) suggests that FEA shows the highest degree of maturity among the interoperability efforts and their chances of success in removing the organizational barrier for interoperability are high. Guijarro further suggests that government should approach interoperability issue in two phases. In the first phase government should provide technical standards and policies, in the form of Interoperability framework to enable seamless flow of information between government departments in the delivery of e-services. In the next phase government should attempt to acquire organizational interoperability by, aligning administrative procedures with technical systems by means of Enterprise Architecture.

7. Concluding Remarks

Due to time and resource constraints, it is very difficult to cover all the attempts and all the approaches made by various countries to attain interoperability in providing government services. In this article an attempt has been made to cover important initiatives, for which English version of the document is readily available. This study instead of going into details of the standards covered in each framework and comparing, them, attempt has been made to cover different approaches and their key elements. Wherever possible pointer to the reference, which deals with more detail survey of each element is provided for the interested reader. It is expected that this survey, would provide a ready reference to the available approaches and would help us to understand the state of the art.

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