Chapter II
E-Government Interoperability: Frameworks for Aligned Development

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ABSTRACT

The mobilization of electronic information across government organizations has the potential of modernizing and transforming information exchanges. The current information exchanges are, however, often inefficient and error-prone, causing interoperability problems for electronic government. Based on a literature review, this chapter presents some of the many frameworks for aligned development to improve e-government interoperability.

INTRODUCTION

Alignment is the adjustment of an object such as a system, a procedure or a process in relation with other objects so that they work better together. For example, strategic alignment refers to business structure and information technology fit in relation to business strategy and external environment. When alignment is attained, then an organization improves its relative performance as compared to other organizations.

The concept of alignment was originally based on the fit in the context of organizational psychology and became an important concept in the management literature. The construct of alignment is difficult to develop, due to the ambiguity and complexity of management and organizational alignment. There have been a number of integrated conceptual frameworks in the recent decades attempting to understand and provide insights into the business-IT alignment complexity. Examples are Chan et al. (1997), Reich and Benbasat (2000), and Sabherwal and Chan (2001).

As illustrated in this chapter, there is no single framework for aligned interoperability development that will solve all interoperability problems. Rather, a combination of frameworks will be appropriate when trying to solve interoperability problems. Solutions to interoperability challenges are dependent on the situation, requiring a contingent approach to aligned development.

The purpose of this chapter is to illustrate the variety of frameworks available for e-government interoperability. Interoperability is referring to a property of diverse systems and organizations enabling them to work together (Cabinet Office, 2005a; Government CIO, 2007). Interoperability is the ability of government organizations to share information and integrate information and business processes by use of common standards (State Services Commission, 2007).

Interoperability is the ability of ICT systems to communicate, interpret and interchange data in a meaningful way (Archmann and Kudlacek, 2008). Interoperability is the ability of government organizations to share and integrate information by using common standards. Successful service innovation and multi-channel service delivery depend on strategies, policies and architectures that allow data, IT systems, business processes and delivery channels to operate, so that services can be properly integrated. If channels and back office processes are integrated, different channels can complement each other, improving the quality of both services and the delivery to government and citizens simultaneously. The ideal is to create an environment in which data, systems and processes are fully integrated and channels become interoperable instead of merely coexisting (UN, 2008).

1. CROSS-ORGANIZATIONAL BACK-OFFICE INTEGRATION

In electronic government, a distinction can be made between the front and back offices of public service delivery organizations. The interaction between citizens and civil servants occurs in the front office, while in the back office, the assessment of inquiries as well as the supporting registration activities take place. Back office activities normally require the exchange of information between the back offices of different agencies. However, back-office co-operation is found to be a serious problem (Bekkers, 2007).

Bekkers (2007) phrased the question: Given the political nature of back-office integration, should cross-organizational back-office integration be seen as a command and control challenge or a process of management challenge? He argues that comparative case study research has primarily shown that integration is the outcome of a process in which offices have been able to create a shared understanding about the necessity of integration and in which conflicting rationalities, with their own core values, internal logic and legitimacy, have to be weighed against each other. Integration is a goal-searching, incremental process, which should anticipate a changing political agenda in order to gain support.

Bekkers (2007) found that understanding is reached through the ongoing recognition of the interdependencies among back-offices, and as a result of a focus on the content of the problem and not on jurisdictions and costs. Trust and political and legal pressure are the lubricants that facilitate this process.

2. CROSS-ORGANIZATIONAL BUSINESS PROCESSES

Increasing interconnection of organizations is a global trend. Independent organizational units or entire organizations build temporary or permanent collaborations, which pool resources, capabilities, and information to achieve a common objective. New business models are emerging and existing procedures are redesigned, forming inter-orga-

nizational processes between several agencies (Greiner et al., 2007).

Inter-organizational processes are labeled cross-organizational business processes (CBP) by Greiner et al. (2007). The successful implementation of CBPs requires a clear understanding of the common processes across all involved stakeholders. It also needs a structured approach to interlink internal processes of en organization into a CBP.

3. ARCHITECTURAL OPTIONS

There are always alternatives when working on information systems generally and interoperability in particular. In a management perspective, it is always important to present alternatives. A nice example is Eckman et al. (2007), who present architectural options for health-care information exchange.

They found four major software architectures, or interoperability approaches, available to implement a health-care information exchange: data federation, data warehousing, information distribution (one-to-many, sometimes referred to as publish-subscriber), and one-to-one transactional messaging (Eckman et al., 2007):

- **Federated (decentralized) architecture.** In data federation, data is distributed among a number of independent repositories. Data may be stored in multiple locations, including, for example, at multiple health-care providers, each with a multiplicity of data repositories. The central infrastructure operated by the exchange accesses this data based on a central index. Information systems within an organization may have their own independent indexes. It is the responsibility of the central index in the operability stack to map to the appropriate data store.
- **Warehouse (centralized) architecture.** A data warehouse, a high-performance storage system including more than one repository for various data types, is maintained in the central infrastructure. For example, the entire history of all patients could be stored in the central repository, which would allow for the widest variety of uses for the data.
- **Information distribution (one-to-many) architecture.** In a one-to-many messaging architecture, each system shares information that is entered into the system and processes all information that it receives. The interoperability stack does not maintain a persistent store of the information, but is merely a clearing-house for information distribution. The transaction hub in the interoperability stack is defined as the component that ensures a reliable transmission infrastructure. Each published piece of data must be maintained in the transaction hub until it is delivered to all subscribers. The interoperability stack in the one-to-many architecture model operates much like an electronic mailing list server. Each enterprise within the exchange that has data entered into its systems publishes the relevant data outward to the interoperability stack. All other agencies participating in the exchange that have subscribed to data feeds receive the data from the transaction hub. The receiver of the data is then responsible for processing the information that it receives.
- **One-to-one transactional messaging architecture.** With the one-to-one architecture, each member of the exchange can communicate with other members. The interoperability stack for this pattern is the most lightweight and requires the least investment in platform components.

These alternatives do all have advantages and disadvantages. According to the contingent approach to management, situational factors for e-government will determine which architecture is better. Typically, there is a broad spectrum of

stakeholders, each of whom plays a different role in deciding future interoperability architecture. When designing a real-world system, one should not consider the four alternatives as mutually exclusive. Rather, to satisfy all of the many stakeholders in a dynamic landscape of requirements, Eckman et al. (2007) argue that one should build into an interoperable infrastructure the ability to adapt to changing real-time requirements.

4. COLLABORATIVE NETWORKS

A framework for aligned development is the concept of a collaborative network suggested by Federowicz et al. (2007). A collaborative network represents the joint organizational entity, infrastructure, business processes, resources, and relationships, which support a shared effort to provide some collective benefit, whether it is a program, service, or a product. An inter-organizational system provides the connecting infrastructure (computing and networking hardware, application software, and databases) to support the exchange of information across organizational boundaries on a continuing basis.

Collaborative networks are created when agencies agree to share information on an ongoing basis. The collaborative network may be governed informally, or it may have formal governance mechanisms and an explicit organizational structure. Whether governed formally or informally, the collaborative network has its own strategy, governance structure, inter-organizational systems, and other systems, processes, and resources apart from the strategies, governance structures, systems, processes, and resources of each of the participating agencies (Fedorowicz et al., 2007).

5. ONE-STOP E-GOVERNMENT SERVICE PROVISION

Citizens and businesses face significant obstacles during their interaction with public administrations and governments, having to cope with bureaucracy, ambiguous procedures, functional disintegration, vague, and/or overlapping authority structures and information fragmentation. One-stop e-government represents an approach and a framework for solving such difficult problems, as described by Gouscos et al. (2007). One-stop e-government has emerged as a trend to offer electronically administrative service packages that meet the needs of citizens' life events and business transactions, with a promise to enhance service accessibility and alleviate service delivery delays and costs.

Gouscos et al. (2007) argue that traditionally, one-stop government developments have been based on approaches concerned with interoperability through standardization. Such frameworks call for some degree of technical "homogenization" of service provision schemes, based on communication and collaboration through common protocols and formats, as prerequisite to interoperability. However, one-stop government initiatives based on adoption of common standards and re-engineering of internal processes may face significant implementation risks due to a number of technical, organizational, regulatory, or political obstacles to standardization, especially in multi-national settings.

6. THE HONG KONG FRAMEWORK

In Hong Kong, the interoperability development framework supports the government's strategy of providing client-centric joined-up services by facilitating the interoperability of technical systems between government departments, as well as between government systems and systems used

by the public, including citizens and businesses (Government CIO, 2007).

The interoperability framework defines a collection of specifications aimed at facilitating the interoperability of government systems and services. By bringing together the relevant specifications under an overall framework, IT management and developers can have a single point of reference when there is a need to identify the required interoperability specifications that should be followed for a specific project. By adopting these interoperability specifications, systems designers can ensure interoperability between systems while at the same time enjoy the flexibility to select different hardware, and systems and application software to implement solutions (Government CIO, 2007).

For existing systems, the framework says that conformance to certain specifications may not be readily achieved, given the diversity of current platforms and systems. Existing systems are required to consider conformance to the interoperability framework only when there is a new requirement for government to public integration, and only in respect of the modifications that specifically relate to external interfaces. Migration to the interoperability framework must be considered when a major functional change is being performed. In either case, connection or changes to existing systems are required to conform to the framework only when it is financially and functionally prudent to introduce compliance with the interoperability framework (Government CIO, 2007).

7. A THREE-LEVEL FRAMEWORK

In electronic government, the cooperation between agencies is specified in a changing environment. The aligned development includes a specification that is tailored towards information sharing and cross-organizational process enactment. Process enactment, however, relies on intra-organizational process specifications that have to comply with the infrastructure available in an organization for process and data management.

Therefore, Grefen et al. (2003) developed a three-level process and data specification framework:

- **Internal level.** The internal level is geared towards enactment of processes in the context of a specific organization, e.g. by means of workflow management systems. The internal level is a mapping of the conceptual level, where mapping is a combination of translation (specialization for a specific platform) and refinement. The internal process specification is used to have local parts of cross-organizational processes enacted by process support systems. Workflow management systems are a general infrastructure for the automated support of business process enactment. Often, these systems are separate entities in an information system infrastructure, and sometimes they are embedded in other systems.
- **Conceptual level.** The conceptual level is the centerpiece of process specification. It is independent from external use and internal implementation. It is used for conceptual reasoning about the process, e.g. for design and analysis purposes. The conceptual level is a combination of abstraction and aggregation of the internal level. The process exhibited by an organization to the outside world is usually less detailed than the implementation of the same process actually enacted by the organization. Consequently, several process aggregation levels exist. The mapping between these aggregation levels is dealt with by a process refinement hierarchy.
- **External level.** The external level is geared towards communicating process specification between different organizations. It can

be considered a projection of the conceptual level, where projections uses hiding and translation operations. Interoperability of processes is the main focus of the external level. A process specification at the external level can be a high-level abstraction of a complex process that on the conceptual level is considerably refined into separate sub-processes. Still the process specifications at the external level should not be too general as they may turn the process of information exchange into a black box process, thereby not allowing the fine-grained cooperation that is required in dynamic relationships.

Grefen et al. (2003) argue that the three-level approach to business process specification provides a clear separation of concerns in business process design, thereby increasing quality, flexibility and reusability of process specifications in cross-organizational settings. This separation of concerns is becoming increasingly important, as the complexity of automated cross-organizational processes grows through the advent of digital government.

8. WEB-BASED INTER-ORGANIZATIONAL INITIATIVES

One of the most comprehensive institutional frameworks to study information technologies in government settings is the technology enactment theory, which explains the effects of organizational forms and institutional arrangements on the information technology used by government agencies. The technology enactment framework pays attention to the relationships among information technology, organizations, embeddedness, and institutions. Luna-Reyes et al. (2007) argue that institutional arrangements and organizational structures shape not only the enacted technology, but also other processes and results of government IT projects. They studied collaborative digital government in Mexico in terms of federal web-based inter-organizational information integration initiatives.

The national e-Mexico system is an "umbrella" initiative to develop government services and applications for the Mexican society. The mission of e-Mexico is to "be an agent for change in the country, integrating efforts from diverse public and private actors in the elimination of the digital divide and other socioeconomic differences among Mexicans, through a system with technical and social components to offer basic services on education, health, commercial interchange, and government services, being at the same time leader in Mexican technological development" (Luna-Reyes et al., 2007).

9. ELECTRONIC MARKETS

Markets have purely been the prerogative of business, not of government, which have relied upon bureaucracy as the way to administer society. The advent of e-government has created new opportunities to apply market mechanisms in government. Collaboration between agencies to solve complex issues, the citizen in focus, and public private partnerships are three examples to achieve better government using electronic markets.

The practice of markets has a long history. On a market, there is supply and demand. Electronic markets have supply and demand for information. Governments adopting electronic markets to inform citizens better as customers with a choice embark upon a line of development where information economics becomes relevant to the design of government triggered costs. Informed customers trade better than lesser informed which is why consumer policy and competition policy both support measures to ensure information quality and availability.

Embarking on digital government is more than applying information systems to government

administration. It is to embark upon a trajectory of electronic markets according to the thesis of information value integration. Pedersen et al. (2006) claim that electronic markets represent a viable and fruitful conceptualization of the change from bureaucratic government to digital government, meaning government as a decision-making and allocating mechanism, wedded to periodic public elections of politicians constrained in the short run by constitutional institutions, yet having the potential power to change constitutional rules in the long run, legitimately authorized to govern and to appoint civil servants to enforce obligations and to service the needs of the public.

Electronic marketplace adoption by government is affected by several factors (Wang et al., 2006):

- **Performance expectancy.** An agency will be positive to electronic markets because of the economic and other benefits that electronic markets offer.
- **Effort expectancy.** An agency may adopt electronic markets if they are easy to use and implement.
- **Institutional influence.** Examples of such influences are trend followers, public request, and other influences.
- **Facilitating conditions.** Examples of such conditions include system compatibility, familiarity with business practices, and special funding for interoperability projects.

10. CONNECTED GOVERNANCE

Connected governance is a framework for alignment that ensures integrated information flows, new transactional capacities, as well as new mechanisms for feedback, consultation and more participative forms of democracy. Underlying the concept of connected governance is a systematic approach to collection, reuse and sharing of data and information. To achieve connected governance, the following steps are required (UN, 2008):

- Intra-government process re-engineering: efficient, responsive and tailored government to reflect citizen needs
- Inter-government process re-engineering: efficient, joined-up and borderless government:
  - vertical cooperation/integration between levels
  - horizontal cooperation/integration between agencies at same level
  - multi-stakeholder cooperation (with private and third sectors)
- Re-engineer legacy technology, processes, skills and mindsets.

Underlying the concept of connected governance is a systematic approach to collection, reuse and sharing of data and information. The key platform on which connected government is built upon is the concept of interoperability, which, according to UN (2008), is the ability of government organizations to share and integrate information by using common standards. Strengthening connected governance concepts within e-government is an important step towards improving the coordination processes and systems within and across government agencies and organizations and changing the way that government operates. Improving the government agencies' capability to transfer and exchange information is critical and will require the improved interoperability between agencies' information systems. In the longer term it will require agencies to adopt and implement common information policies, standards and protocols.

Governments transform themselves into a connected entity that responds to the needs of its citizens by developing an integrated back office infrastructure. This is the most sophisticated level of online e-government initiatives and is characterized by (UN, 2008):

- Horizontal connections (among government agencies)
- Vertical connections (central and local government agencies)
- Infrastructure connections (interoperability issues)
- Connections between governments and citizens
- Connections among stakeholders (government, private sector, academic institutions, non-government organizations and civil society).

From the perspective of more horizontal but in reality networked governance solutions that are the essence of service transformation and effective security strategies, the two fundamental questions that remain stubbornly unanswered according to the UN (2008) are:

- How to motivate public managers to share data and, more generally, to work jointly for the public good
- How to understand and influence the range of barriers, from psychological and social to structural, political and technical, that mitigate across cross-agency initiatives

In order to better illustrate such tensions, the Swedish experience of public management and their recent quest for interoperability provides a useful case study as described by the UN (2008). Although one of the most prosperous and technologically sophisticated countries in the world, the Swedish government has faced critics both internally and externally pointing out that the traditional culture of decentralized agency autonomy does not lend itself easily to achieving government-wide capacities.

Swedish government, having studied several other European country experiences, concluded that many such models being developed elsewhere would not be workable in their context. The main reason is what they term as the contractual model of public sector management underpinned by a networked administration. According to the contractual model, an administrative unit decides for itself whether external services and functions are sufficiently attractive for the unit to use them or pay for this use. According to the networked administration, government is composed of independently managed units that rely on functions and resources provided by other such units or private companies, and form part of permanent and temporary cooperative structures.

11. MODELING METHODS FOR INTEROPERABILITY

A number of modeling methods and approaches exist for the purpose of aligned development. An example is the unified enterprise modeling language (UEML), which is an ongoing effort to develop an intermediate language for modeling enterprises and related domains, such as information systems. The aim is to support integrated use of enterprise and information systems models expressed using different languages (Opdahl & Berio, 2007).

The UEML construct template provides a standard, integrative format for representing modeling constructs. Entries of the construct template are derived from a UEML meta model. Template entries are filled in by gradually using concepts to build a UEML ontology that is rooted in central ontological concepts. This ontology grows incrementally as more modeling constructs are added, whether centrally by some UEML management organ or locally within an enterprise that uses UEML. As a consequence, when two modeling constructs, from the same or from different languages, have both been described using the UEML-template, the exact correspondences between them can be identified in terms of the common ontology. This paves the way for comparison, consistency checking, update reflection, view synchronization and model-to-

model translation. Therefore, Opdahl and Berio (2007) define UEML as a web (or family) of languages that co-exist while at the same time relate precisely to each other.

In addition to UEML, there are a number of other modeling methods. Examples are activity diagrams, XML, and OWL. The idea is to improve interoperability through model-based generation of systems. For example, Touzi et al. (2007) demonstrated how a collaborative information system might be interoperable through model-based generation. In their approach, a collaborative process model focuses on process interaction, data interaction, and application interaction in a collaborative information system.

12. SERVICE-ORIENTED ARCHITECTURE

Another approach to alignment is service-oriented architecture (SOA), where the technology side is aligned to the business side by making the technology optional for systems. SOA is an architectural style that attempts to support business processes by being an independent infrastructure. It is an approach defining and provisioning the IT infrastructure that is supposed to allow different applications to exchange data and participate in business processes loosely coupled from the operating systems and programming languages underlying those applications (www.wikipedia.org).

Still in 2008, many government organizations seemed to have unrealistic expectations concerning benefits of SOA. While the idea and the concept of loosely coopled infrastructure and applications has great potential, experience so far in implementing this idea has for the most part been less successful.

With the increasing use of software applications for the conduct of business, the need to link software applications of co-operating organizations with minimal effort and in short timeframes is becoming ever more evident. This need for interoperability has stimulated not only SOA but also a similar approach labeled service-oriented computing (SOC). SOC is emerging as a promising paradigm for enabling the flexible interconnection of autonomously developed and operated applications within and across organizational boundaries (Dijkman & Dumas, 2004).

SOC is a distributed application integration paradigm in which the functionality of existing applications (the services that they provide) is described in a way that facilitates its use in the development of applications, which integrate this functionality. The resulting integrated applications can themselves be exposes as services, leading to networks of interacting services known as service compositions or composite services (Dijkman & Dumas, 2004).

SOC brings along a number of specific requirements over previous paradigms (such as object-oriented or component-oriented) that should be taken into account by service-oriented design (Dijkman & Dumas, 2004, p. 338):

- **Autonomy:** As services are expected to be developed by autonomous teams, service-oriented design is an inherently collaborative process involving multiple stakeholders from different organizational units. This raises the issue that certain organizational units may opt not to reveal the internal business logic of their services to others, making it difficult (yet indispensable) to ensure global consistency.
- **Coarse granularity:** Services are highly coarse-grained, at least more so than objects and components. Often, a service maps directly to a business object or activity (e.g. a purchase order or a flight booking service). It follows that the design of services (and in particular composite ones) is a complex activity. It involves reconciling disparate aspects such as the involved providers and consumers, their interfaces, interactions,

and collaboration agreements, their internal business processes, data, and legacy applications.

- **Process awareness:** As services often correspond to business functionality exported by an organizational unit, they are likely to be part of long-running interactions driven by explicit process models. Hence, service-oriented design should take into account the business processes as part of which services operate and interact, and in particular, the integration (or retrofitting) of services into business processes. This effectively places service-oriented design at the crossroads between software and enterprise design.

At IBM, a top-down approach to service-oriented architecture was implemented. The IBM enterprise architecture is designed to ensure effective linkages between enterprise business and IT deliverables. It is a means to integrate business strategy, process, data, applications, and infrastructure. Enterprise architecture governance attempts to unify design approaches with a set of published principles, architecture criteria, standards, and guidelines (Walker, 2007).

CONCLUSION

A variety of frameworks and approaches exist to achieve interoperability in electronic government through aligned development. As governments evolve into more online and interoperable governmental processes and services, the traditional civil servant must develop as the organizer and manager of processes and services that increasingly propagate towards business, education, health and other domains critical to citizens. As a consequence, there is a need to train civil servants into their new roles.

Wilson et al., (2007) recommend training sessions on methodology to be organized as action learning and problem based learning. In addition, a range of support tools for service design exercises might be used as well. Case studies are also useful.

As shared services organizations become more popular as a service management and delivery option in government, properly defining and setting up the governance structure for aligned development continues to be a key success factor. A shared services organization is essentially a business unit or organizational entity within the public service that delivers specialized, value-added services across the entire domain.

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