

# Towards Standardising Interoperability Levels for Information Systems of Public Administrations

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**Abstract.** Targeting systematic and formal description methods for interoperability levels of public sector organisations and systems is emerging as an important research challenge in interoperability for governments and administrations. The Government Interoperability Maturity Matrix (GIMM) that is proposed in this paper aims to provide administrations with a simple, self-evaluation method that can be used to assess the current status of the administrations concerning eGovernment interoperability and the steps that need to be taken to improve their positioning in respect to system implementation and services provision to citizens and businesses. The paper expands the three types of interoperability considered in the European Interoperability Framework (EIF) identifying several Interoperability Attributes that need to be taken into consideration in order to evaluate each organisation positioning in eGovernment interoperability and presents the rationale of the Methodology that has been formulated and introduced. Within this modeling context, levels of existing interoperability status of organisations are clearly defined, while certain practices or directions lead to interoperability state changes within the maturity matrix.

**Keywords.** Interoperability, eGovernment, Maturity Matrix

## 1. Introduction

Interoperability has shown up as a principle in the conception and deployment of the eGovernment initiatives, and the interoperability frameworks have been the tool for implementing the principle [1]. Before an organisation start restructuring processes and changing its procedures initially need to comprehend its ‘as is’ or current situation in relation to government process interoperability before it can sensibly begin to move towards its ‘to be’ or future situation. This paper is aimed at addressing exactly this need: it provides a method for administrations that will help them better understand their positioning, identify the gap they need to fill, determine the weaknesses and deficiencies they need to improve and define their exact target position prior to formulating and implementing a full scale Interoperability Transition Plan for further adopting and implementing eGovernment initiatives.

While it may not be the result of a structured or strategic approach, most agencies possess some level of government process interoperability [2] capability by default. This reflects various factors including the use of management improvement practices, the level of ‘process-awareness’ of IT and Information Systems, governance arrangements, skills and strategic alignment. An organisation that has identified, mapped and documented its governmental processes as part of an application development project will have already developed some process interoperability capability that could be built upon.

With the aid of a maturity model, an organisation can identify its current capability status (its ‘as-is’ interoperability position) and its desired capability maturity level (its ‘to be’ interoperability position). Knowing where an organisation currently stands in its business process interoperability capability development is critical to the design of a strategy to move the organisation to its desired level of capability.

Within this modeling context, levels of interoperability of Governmental organisations are clearly defined, while a large number of certain parameterised-attributes lead to state changes, within the

maturity matrix. GIMM helps the administrations position their current status on a table in respect to interoperability readiness and performance, identify the position they wish to move to and plan the actions and steps that need to be taken in order to improve their standing. The GIMM is based on the essential states that organisations have devised for achieving the interoperability at the public administrations. A remarkable number of Interoperability Attributes (IA) are classified, in three interoperability main dimensions as they defined in European Interoperability Framework for Pan-European eGovernment Services [3] from the Interoperable Delivery of European eGovernment Services to public Administrations, Business and Citizens (IDABC), in a parametric score matrix. The Interoperability State is clearly defined by a vector consisting of the values of GIMM Interoperability Attributes (IA). GIMM addresses the existing status of governmental organisations and systems concerning interoperability. This could be used as bedrock to the next eGovernment movement of the public administration.

The objective of the paper is to address the use of some patterns for developing better interoperable organisations. The paper will discuss certain patterns which appear in various levels of the modelling representations, both in the problem and in the solution space, formulating an initial, structured set of concepts: interoperability levels, organisation types, models for representing given solutions, as well as patterns and principles for achieving interoperability. After having given the basic concepts in section 2, section 3 will present the mathematical formulation and patterns to use in the context of organisation's interoperability state transition. In section 4 the application of GIMM in a public organisation is presented and section 5 concludes the paper outlining strengths of the proposed approach, open issues and future work.

## **2. Concepts and definitions**

### **2.1 Government Interoperability Levels**

The paper contributes to critical discussion on the contribution of methodologies as a means of addressing the interoperability gap in implementing eGovernment projects. The Government Interoperability Maturity Matrix (GIMM) presented in the next pages has been formulated on the basis of the bibliography and literature written on the issue of eGovernment and relative Maturity Matrixes [4]. This work is partly carried out within the frame of the Greek eGovernment Interoperability Framework implementation project.

The Government Interoperability Maturity Matrix (GIMM) is based on the Capability Maturity Matrix Integration [5] (CMMI) Theory but has been introduced in order to better address the needs of the administrations that are going to use it. Capability Maturity Model Integration (CMMI) is a process improvement approach that provides organizations with the essential elements of effective processes. It can be used to guide process improvement across a project, a division, or an entire organization. CMMI helps integrate traditionally separate organizational functions, set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes.

CMMI is at the forefront of process improvement because it provides the latest best practices for product and service development and maintenance. The CMMI models improve the best practices of previous models in many important ways. CMMI best practices enable organizations to do the following:

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- More explicitly link management and engineering activities to their business objectives
- Expand the scope of and visibility into the product lifecycle and engineering activities to ensure that the product or service meets customer expectations
- Incorporate lessons learned from additional areas of best practice (e.g., measurement, risk management, and supplier management)
- Implement more robust high-maturity practices
- Address additional organizational functions critical to their products and services
- More fully comply with relevant ISO standards

CMMI consists of 22 process areas with capability or maturity levels. CMMI can be adapted to each individual organization according to its business objectives. Organizations cannot be CMMI "certified." Instead, an organization is appraised (e.g., using an appraisal method like SCAMPI) and is awarded a 1-5 level rating. The rating results of such an appraisal can be published if released by the appraised organization. CMMI comes with two different representations: staged and continuous. The staged representation, which groups process areas into five maturity levels, was also used in Capability Maturity Model [6] (CMM), the ancestor methodology of CMMI. The continuous representation, which is used, defines capability levels. The differences in the representations are solely organizational; the content is equivalent. Both can be used to achieve level ratings because of Equivalent Staging. CMMI models use a common structure to describe process areas (PAs). A process area has 1 to 4 goals, and each goal is comprised of practices. These goals and practices are called specific goals and practices, as they describe activities that are specific to a single process area. An additional set of goals and practices applies across all of the process areas; this set is called generic goals and practices.

In a relevant way, GIMM provides an easy, apprehensive and complete way for local [7], regional or national [8] administrations to evaluate their current status on eGovernment issues, assess their ability to adopt or enhance eGovernment applications and identify the areas that need further elaboration and improvement on eGovernment issues.

In order to provide a proper framework for analyzing and categorizing organisations according to their eGovernment interoperability level, in extending recent research on the representation of organisational interoperability issues, the following definitions are made:

The Government Interoperability Maturity Matrix (GIMM) is a set of levels (Figure 1)  $L = (L1, L2, L3, L4, L5)$ , where each level corresponds to a different interoperability level [9] for a set of Interoperability Attributes (IA). The model defines the levels of an organisation's maturity that describe the ability of the organisation to interoperate. Five levels were identified, closely aligned with the descriptions of the LISI model [10], as following:

- Level 1: Independent, this level describes the interaction between independent organisations
- Level 2: Ad hoc, at this level of interoperability only very limited organisational frameworks are in place, which could support ad hoc arrangements
- Level 3: Collaborative, 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
- Level 4: Integrated, 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 with other organisations. For example, detailed doctrine is in place and there is significant experience in using it.

- Level 5: Unified, a unified organisation is one in which the organisational goals, value systems, command structure/style and knowledge bases are shared among organisations.

It has to be noted that the absolute number of Levels may be extended, in order to increase the granularity of the matrix.

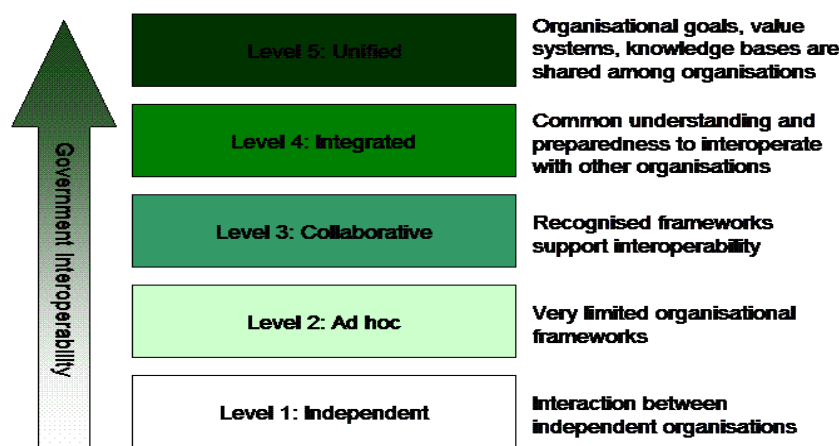


Fig. 1: Set of Government Interoperability Levels

## 2.2 Interoperability Attributes

The categorization of a specific organisation in a specific GIMM Level follows scoring in a vector of Interoperability Attributes (IA) (Table 1) each one belonging in one of the following 3 main dimensions:

### Organisational Interoperability

This dimension of interoperability is concerned with defining business goals, modelling business processes and bringing about the collaboration of administrations that wish to exchange information and may have different internal structures and processes. Moreover, organisational interoperability aims at addressing the requirements of the user community by making services available, easily identifiable, accessible and user-oriented

### Semantic Interoperability

This dimension 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. Semantic interoperability enables systems to combine received information with other information resources and to process it in a meaningful manner. Semantic interoperability is therefore a

prerequisite for the front-end multilingual delivery of services to the user.

### **Technical Interoperability**

This dimension of interoperability covers the technical issues of linking computer systems and services. It includes key aspects such as open interfaces, interconnection services, data integration and middleware, data presentation and exchange, accessibility and security services.

## **2.2.1 Analysis of the Interoperability Attributes (IA) of GIMM**

### **Organisational Interoperability**

#### **Government Process Alignment**

Many eGovernment services exist, such as taxation functions and social services that require government agreement on their own processes. Likewise there are frequently additional public sector requirements in general business processes such as procurement, e.g., specific competitive bidding requirements and/or specific approval approaches. For eGovernment, process alignment in many cases requires an alignment of information architectures with organisational goals and helping government processes to co-operate.

#### **Compatibility with eGovernment legislation issues**

Each country's legislation brings some constraints regarding the use of government eServices. In most of the cases national legislative adjustments [11] should take place in order to provide government eServices.

#### **Interoperability at local level**

This is the need for local government agencies to interact with many other government agencies to deliver their services. More specifically, local administrations require interoperability mechanisms that will allow them to offer online access to their services and to participate in orchestrated procedures involving services provided by multiple agencies. Starting from business episodes or citizen events [12], eGovernment services will rely on technologies for modelling business processes and managing workflows orchestrating access to services across administrations [13].

#### **Interoperability at national level**

The goal of the organisation is to collaborate within the organizational and geographic boundaries of the country to improve service delivery – providing citizens with transparent, convenient and secure access to government services.

#### **Interoperability at international level**

The goal of the organisation is to collaborate across organizational and geographic boundaries to improve service delivery – providing citizens with transparent, convenient and secure access to government services of other countries than their home country.

### **Semantic Interoperability**

#### **Existence of common XML-based data schemas**

The organisation uses XML-based schemas to describe its documents. The schemas comply with the national government interoperability standards, to W3C [14] recommendations and are exchangeable with other organisations.

#### **Existence of XML-based common code lists**

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The organisation uses XML-based common code lists defined from international organisations (e.g. ISO) or from acknowledged national bodies in order to implement predefined lists in its documents.

#### **Common Service Categorisation**

Common Service Categorisation makes it easier to find information. The organisation classifies its provided services in relation to users' informational needs [15] and according to the existing common Government Category List (GCL).

#### **Existence of Service Metadata**

The organisation provides structured information about the provided services. The service metadata provides the essential information concerning the classification [16], discovery and usage of the provided services (e.g. service provider, service type, service name, service version etc).

#### **Existence of Documents Metadata**

The organisation provides structured information about the provided documents. The document metadata provides the essential information concerning the discovery and usage of the provided documents (e.g. document issuer, document type, document title, document version etc).

#### **Technical Interoperability**

##### **Interoperable front and back-office systems**

The organisation's front-office systems [17] (where the service is handed over to the citizen or enterprise) are directly and easily accessible and usable from the user (citizen/enterprise). Front-office interoperability refers to the ability of operations that involve interactions with the citizen/enterprise such as application form submission.

The organisation's back-office systems (where the service is produced) refer to the internal operations of an organization that are not accessible or visible to the general public. Organisations back-office systems can communicate and interchange data with other systems, usually electronic services delivery.

##### **Existence of Web-service interfaces**

Organisations make some general decisions about the provided services, including how to expose the Web services, how the services perform their processing, and their granularity.

##### **Existence of Web-service discovery mechanisms**

The organisation provides the process of finding its Web services. It provides access to its Web services over the Internet using standard protocols.

##### **Interoperability with payment systems and services**

The organisation provides interoperability with existing payment systems and services in order to facilitate the electronic payments of a wide variety of provided services through the web [18].

##### **Single sign-on facilities for user authentication**

Organisation's portal provides a single-sign-on facility to avoid the necessity for users to authenticate themselves multiple times undertaking the responsibility to transfer user's credentials between distributed systems [19]. The administration of users, roles, etc. and their permissions on security objects are supported in an integrated way.

### Connectivity with central government gateways

Organisation's portal (web site) provides connectivity with the central Government Gateway which is the central government portal someone uses to register for online government services. Central Government Gateway enables people to communicate and make transactions with government from a single point of entry [20].

### Interoperability with external enterprise systems

Organisation provides easy access to public information and better cooperation with external business systems through open interfaces between citizens, companies and authorities [21]. It integrates functionality across its ownership boundaries. This resource is developed by the organisation to facilitate business process collaboration with its back-office systems. It promotes effective and efficient information sharing, which is core to achieving collaboration.

	eGovernment Interoperability Maturity Matrix	Independent	Ad hoc	Collaborative	Integrated	Unified
S <sub>i</sub>	<b>Interoperability Attributes (IA)</b>	Level 1 (0-3)	Level 2 (4-6)	Level 3 (7-10)	Level 4 (11-14)	Level 5 (15+)
<b>1</b>	<b>Organisational Interoperability</b>					
	Government Process Alignment				*	*
	Compatibility with eGovernment legislation issues			*	*	*
	Interoperability at local level				*	*
	Interoperability at National Level				*	*
	Interoperability at International Level					*
<b>2</b>	<b>Semantic Interoperability</b>					
	Existence of common XML-based data schemas		*	*	*	*
	Existence of XML-based common code lists					*
	Common Service Categorisation	*	*	*	*	*
	Existence of Service Metadata	*	*	*	*	*
	Existence of Documents Metadata		*	*	*	*
<b>3</b>	<b>Technical Interoperability</b>					
	Interoperable front and back-office systems			*	*	*
	Existence of Web-service interfaces		*	*	*	*
	Existence of Web-Service discovery mechanisms			*	*	*
	Interoperability with payment systems and services				*	*
	Single sign-on facilities for user authentication				*	*
	Connectivity with central government gateways					*
	Interoperability with external enterprise systems					*

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	<b>Type of organisation / System</b>	Informational Web Site	Electronic ad hoc exchange of information with other organisations	Interoperability goals are recognised and, roles and responsibilities are allocated. Distinct organisation	The organisation has shared value systems and shared goals, common understanding with other organisations and is prepared to interoperate with other organisations	The organisation is fully interoperable with front office and back office systems of other organisations
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**Table 2:** GIMM Levels and Interoperability Attributes with examples

### 3. Mathematical formulation and eGovernment Interoperability Design Patterns

Extending the definitions concerning the interoperability status of an organisation, the following structures are defined:

A State (or situation) of an organisation, concerning its interoperability level, is a specific vector  $S = (S_1, S_2, \dots, S_n)$ , that is denoting the exact interoperability attributes (IA) that are present or not within the analysed organisation.

The categorization of an organisation according to the GIMM is based on the number of the interoperability attributes that are valid or not, thus allowing for different configurations belonging to the same level. As shown in Table 1, scoring in the various attributes with yes/no creates a set of attributes that corresponds to a specific Level, also indicating a possible instantiation of example configurations for each level.

Once the GIMM is complete, an Organisation Interoperability Metric can be obtained. The metric quantitatively describes the level of interoperability for an organisation. The specific metric describes the highest common level of interoperability between two interoperability states ( $S_1, S_2$ ) across all (or part) of the Interoperability Attributes. GIMM takes the Interoperability Metrics for multiple organisation's states and arrays them on a grid in which states are labelled on the rows and columns and the intersections contain the interoperability score for the specific Interoperability Attribute, Organisational Level pair. The score (0, 5) of the intersections (Interoperability Attribute value) indicates how well the specific Interoperability Attribute (IA) is met. Thus, the matrix can be used to visualize the interoperability of a group of states. Comparison Tables can be used to provide a comparison of interoperability implementation information between states, and are flexible in that they can be used for a specific attribute, or more generically for a group of attributes. Finally, various organizations can use GIMM to compare their interoperability states.

The results of interoperability modeling are presented in the six-level scale starting from 0 representing none interoperability, to 5 representing full interoperability for the particular Interoperability Attribute. The mathematics of our methodology comes next as Amanowicz and Gajewski [22] describe a set of systems as "points in multi-dimensional space" and the features of these systems as "coordinates of these points." We define "**distance**" between two states as

$$d(S1, S2) = \sum_{i=1}^n |S1_i - S2_i| \quad (1)$$

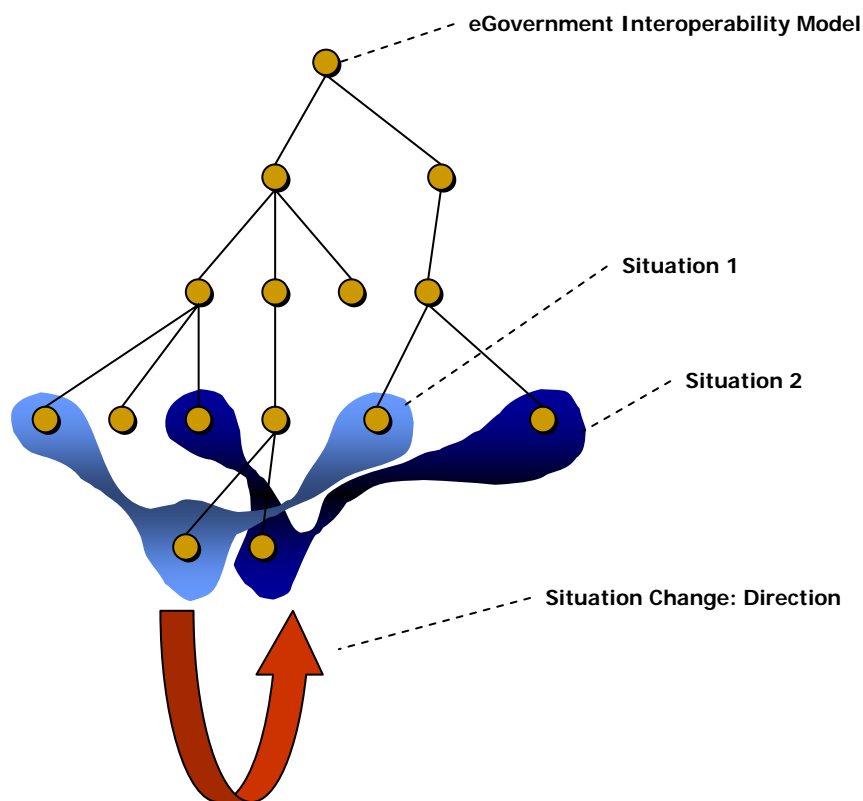
and the “**normalized distance**” between two states as

$$nd(S1, S2) = \frac{\sum_{i=1}^n |S1_i - S2_i|}{n} \quad (2),$$

where  $S1_i, S2_i$  are organisation’s Interoperability Attributes for the states  $S1$  and  $S2$  respectively.

When  $d(S1, S2)$  and  $nd(S1, S2)$  increase, it means that the organisation needs to make greater steps in order to achieve the expected interoperability state transition and the opposite.

A Direction (or State Transition) is the change needed so that an organisation moves from a Situation to another: D12 depicts the change from Situation  $S1$  to Situation  $S2$ .



**Fig. 2:** Situations and Directions of interoperable organisations

The change from a State to another can usually be achieved by one or more Paths, that is specific directives or principles aiming at changing certain attributes of the organisations. This notation allows the proper definition of patterns and principles for both the interoperability problem solving approaches

presented in Chapter 2:

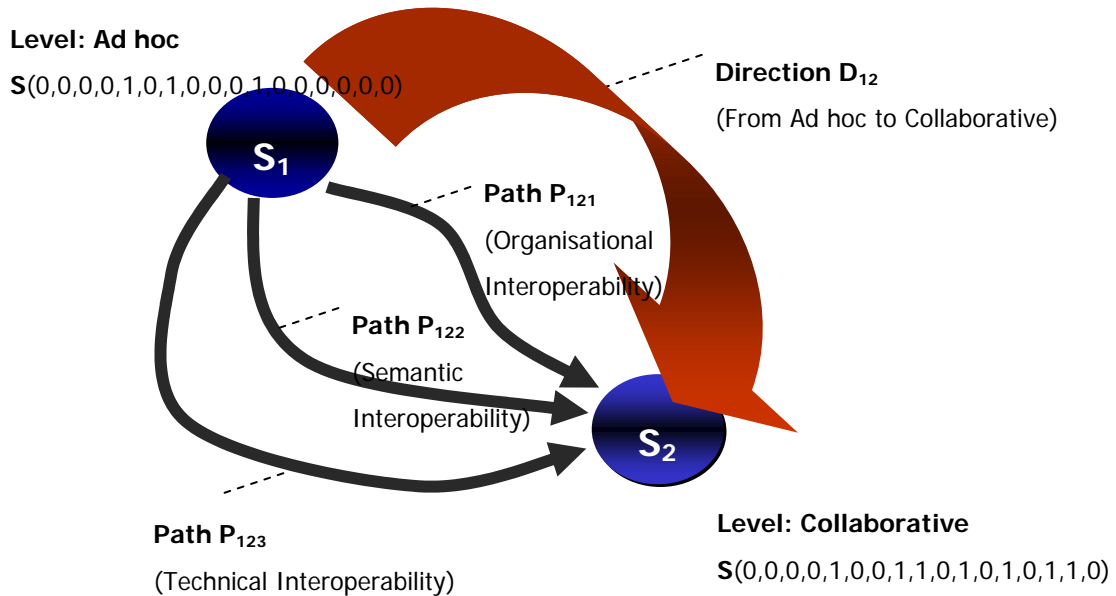
- The various “retrofit” solutions, patterns and principles, aiming at increasing the existing interoperability level of organisations are represented as Directions or Paths between certain, defined Situations
- Patterns and principles for organisations aiming at improving interoperability situations are represented as Directions or Paths leading directly to a specific Interoperability Level or Situation

Figure 3 that is based on the Levels and specific States of Figure 2 illustrates the following case:

- Two specific situations have been identified, pertaining to Levels 2 and 3 (Ad hoc and Collaborative), both with specific vectors S1 and S2, respectively. S1 corresponds to an organisation that has a limited interoperability capability. S2 corresponds to an organisation which even though is still distinct has recognised concrete frameworks to support interoperability
- The change from S1 to S2 (Direction D12) can be achieved by following more than one specific methodological patterns, that is Paths P121, P122, P123. In the example these Paths correlate to Organisational-driven, Semantic-driven or Technical-driven interoperability approaches for enhancing interoperability of the organisation towards Situation S2

The methodological patterns that are proposed are aligned with the to the European Interoperability Framework (EIF) document which has been developed under the “Interchange of Data between Administrations” (IDA) programme which is managed by the Enterprise DG of the European Commission, an interoperability framework defines “a set of standards and guidelines which describe the way in which organisations have agreed, or should agree, to interact with each other.” The three types of interoperability considered in the EIF include:

- Technical – linking up computer systems by agreeing on standards for presenting, collecting, exchanging, processing and transporting data
- Semantic – ensuring that transported data shares the same meaning for link-up systems
- Organisational – organising governmental processes and internal organisation structures for better exchange of data



**Fig. 3:** Situations, Directions and Paths in enterprise application interoperability

#### 4. Applying GIMM in a Public Organisation

Filling and submission of electronic tax forms is a key issue for Greek Ministry of Finance, since most electronic services offered in this context used only to include some variant of electronic forms. Although the state-of-the-art provided sufficient tools for tackling the various phases of electronic service lifecycle, these phases were still handled in isolation, rather than as an integrated process. Besides requiring numerous implementation teams with diverse skills, this approach introduces an impedance mismatch situation, where the same information is represented using different concepts, terminology and structures in various phases, leading to increased development times, difficulty in communication between teams and reduced maintainability [23].

Considering that citizens approximately need two (2) hours to move from and being serviced from a Local Tax Office (LTO) five millions (5,000,000) working hours were wasted by them. Furthermore, considering that an employee needs five (5) minutes per transaction, two hundred thousand (200.000) work hours are needed. This corresponds to at least a hundred (100) person-years. Greek Ministry of Finance decided to improve its interoperability status regarding the tax-related transaction systems (Table 2). The main goals of Ministry's eGovernment Interoperability strategy were:

- Introduction of eServices. Certain government services, such as Income tax and VAT characterized as of "critical interest" for citizens and businesses.
- Free distribution of in-house developed, freeware programs in order to support newly introduced web-based services. These programs provide easier and faster way for filling and

submitting tax statements through the Web to promote the use of its services.

In order to achieve its goals The Ministry of Finance decided to move from Level 2 (Ad-hoc) to Level 4 (Integrated). GIMM can be applied in the specific case (Table 2) to quantify the organisations eGovernment interoperability transformation.

	<b>eGovernment Interoperability Maturity Matrix</b>	<b>Independent</b>	<b>Ad hoc</b>	<b>Collaborative</b>	<b>Integrated</b>	<b>Unified</b>
$S_i$	<b>Interoperability Attributes (IA)</b>	Level 1 (0-2)	Level 2 (3-5)	Level 3 (6-8)	Level 4 (9-13)	Level 5 (14+)
<b>1</b>	<b>Organisational Interoperability</b>					
	Government Process Alignment		2		4	
	Compatibility with eGovernment legislation issues		5		5	
	Interoperability at local level					
	Interoperability at National Level		0		3	
	Interoperability at International Level					
<b>2</b>	<b>Semantic Interoperability</b>					
	Existence of common XML-based data schemas		0		4	
	Existence of XML-based common code lists		0		3	
	Common Service Categorisation		2		3	
	Existence of Service Metadata					
	Existence of Documents Metadata					
<b>3</b>	<b>Technical Interoperability</b>					
	Interoperable front and back-office systems		1		3	
	Existence of Web-service interfaces					
	Existence of Web-Service discovery mechanisms					
	Interoperability with payment systems and services		0		3	
	Single sign-on facilities for user authentication		0		4	
	Connectivity with central government gateways					
	Interoperability with external enterprise systems					

**Table 2:** Ministry of Finance existing and targeted interoperability situation

Initially the GIMM is completed in order to represent qualitatively the existing interoperability state (S1) and the targeted interoperability state (S2). In this way the eGovernment Interoperability Transition Strategy for the Ministry of Finance is formulated. Subsequently the distance and the

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normalised distance between the existing State (S1) and the targeted State (S2) are calculated in order to assess quantitatively the amplitude of the change. In the specific case the “distance”  $d(S1,S2)$  between the two states (S1, S2) is calculated with the use of formula (1)  $d(S1,S2)=17$  and the “normalized distance” between the two states (S1, S2) is calculated with the use of the formula (2)  $nd(S1,S2)=1,89$ .

The result was the implementation of TAXISnet system [24] which is the Greek e-government portal enabling tax-related transactions, issuing electronic certificates, and document handling through the Web. TAXISnet offers a considerable number of additional, fully transactional e-services.

- The number of registered users of tax related e-services exceeds one million five hundred (1,500,000) (August 2006) with an increase of sixty-seven percent (67%) comparing with the number of subscribers in 2003.
- Only in 2005 two millions five hundred (2,500,000) digital transactions were carried out through TAXISnet.
- First mobile service of the Public Administration, offering information to the citizens on their tax return clearance. Currently, more than one hundred thirty thousand (130.000) subscribers are using this 1st m-Government service in Greece.

## 5. Conclusions & Discussion

The proposed maturity matrix depicts efficiency and responsiveness (effectiveness) impacts for a range of interoperability strategies and capabilities within a whole of government approach to public policy and administration. The chart, in association with the accompanying matrix, provides a relatively quick way to determine an organisation’s maturity with respect to government process interoperability and whole of government readiness.

Using GIMM as a guide, public agencies can undertake a basic assessment of where they currently stand from a maturity perspective for each of the levers of change. It is likely that an agency will discover that its current state is not vertically aligned across the levers of change. This will provide agencies with a guide to understanding the relative maturity of different levers for change and will point towards areas which need to be addressed, first to achieve alignment and a consistent basis for advancing to a new state. It will also provide a guide to identifying which areas of an organisation are most likely to provide the greatest challenges in moving towards governmental interoperability or undertaking an eGovernment transformation initiative.

Moving to higher levels of eGovernment interoperability maturity requires agencies to move to a functional view of what it is that the agency does in a whole of government context. In many ways, this is the greatest challenge to government process interoperability and requires agencies to break down well established structural perspectives and arrangements. It also requires the development of strategy and agency goals which are clearly aligned to whole of government objectives.

Moving to higher levels of maturity also requires the establishment of effective cross agency governance arrangements, controls and performance measures and viewing people, processes and technology as whole of government resources.

GIMM provides a critical tool to support agencies to understand a whole of governmental interoperability context and help public agencies to take a functional view of their interoperability. The approach supported by GIMM is an initial approach to establishing an agency’s current whole of

government interoperability capability and is able to provide only indicative results. It will, however, provide a basis for agencies to commence interoperability activities with an understanding of the relative maturity of their agency in relation to others.

Agencies may wish to engage more sophisticated and rigorous approaches to determining their current status, particularly in relation to business process management that will assist in developing a strategy to move to a desired future position.

The present work has introduced a maturity matrix framework for connecting the interoperability levels of an organisation with the performed or needed actions that increase the interoperability between organisations. This extendible framework is capable of capturing the internal characteristics of each interoperability situation that a governmental organisation may adhere to at a certain time point, together with the directions that may be followed in order to achieve a better level. Also, design directives for achieving of new interoperability situations are mapped, so that decisions can be made for their adoption.

The initial population of the above modeling structure showed the difficulty in collecting, analyzing and finally extracting the needed core descriptions from various existing approaches, due to the complexity of the provided solutions and the convolution of various patterns in each real-life scenario. Future relevant research topics include:

While it may not be the result of a structured or strategic approach, most agencies possess some level of government process interoperability capability by default. This reflects various factors including the use of management improvement practices, the level of 'process-awareness' of IT and Information Systems, governance arrangements, skills and strategic alignment. An organisation that has identified, mapped and documented its governmental processes as part of an application development project will have already developed some process interoperability capability that could be built upon.

- The mostly accurate definition of Interoperability Attributes of governmental organisations that will lead to the more analytical structure of the Government Interoperability Maturity Matrix (GIMM)
- The application of a novel approach for analyzing interoperability solutions and patterns, so that directives and principles are more easily de-convoluted, categorized and presented

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