eGovernment Interoperability Framework for Mozambique

Executive Summary

Harmonizing decentralized development of ICT solutions with centralized strategies, e.g., meant to favor reuse and optimization of resources, is a complex technical and organizational challenge that many governments face. The problem is becoming a priority also for Mozambique, that has started introducing its ICT policy relatively recently and for which it is now evident that - if no particular attention is devoted to the interoperability of the solutions being developed - the result will rapidly become a patchwork of ICT solutions incompatible with each other.

By *interoperability* we mean here the capability of (two or more) systems to exchange seamlessly data, information, and knowledge. Achieving interoperability among the eGovernment initiatives is a central milestone for improving efficiency and effectiveness of government services and it is a key enabler for switching the government to a *citizen centric* approach, a strategic goal of the country.

Several dozens of interoperability frameworks have been defined all over the world. The UNDP (United Nations Development Programme) provided a concise comparative survey of some selected eGIFs and a general guidance on implementing an interoperability framework. Common to nearly all eGIFs is the definition of standards to adopt. Slightly less common is the definition of a reference architecture to achieve interoperability, typically based on service oriented architectures, and addressed only by a part of the eGIFs are organizational, managerial, and technical aspects related to maintenance in the longer term of the frameworks.

By building on top of the achievements from the various eGIFs in the world and as a part of the implementation of the eGovernment strategy of Mozambique, this document proposes a systematic and comprehensive approach to interoperability in Mozambique, called eGIF4M — eGovernment Interoperability Framework for Mozambique. The approach is devised to facilitate its early adoption and to be sustainable in the longer term. This is achieved by addressing specific risks and opportunities of Mozambique, which are also shared by other developing countries.

Besides the criticalities experienced by many countries all over the world in implementing their eGIFs, eGIF4M also takes into account some specific issues and opportunities, typical of countries experiencing a fast development, among which:

- **Governance**: ICT projects are often supported by international donors and the resulting governance process is more complicated than that of other projects, thus reducing the possibility to enforce common architectural solutions and standards.
- **Skills**: the limited availability of specialized technical and managerial skills in the country implies a strong dependence on external support to implement and manage the ICT projects. Without establishing a transition path to provide the necessary competencies to the local context and to gradually increase and enlarge the base of ICT skills, there is a risk of not becoming

able to control the convergence of eGovernment projects on the interoperability framework.

- **Sustainability**: The traditional approach of setting up specific projects to respond to the needs of government agencies is not suited for a long term initiative, like the implementation of an eGIF, where most of the results are envisioned from three to five years. Hence, management of eGIF4M requires the setup of conditions that allow to operate in a multi-year perspective.

At the same time the implementation of an interoperability framework can reduce some of the typical barriers faced by small and medium enterprisers (SMEs) in ICT projects. Thus, eGIF4M can be an opportunity for local companies to join the development of the eGovernment framework and in strengthening international connections and networking.

The analysis of the state of the art of eGovernment ICT projects in Mozambique has revealed a heterogeneous situation in terms of the maturity of eGovernment Strategy implementation. In some areas a few isolated projects started, with mixed results. In some other departments more effort has been put on ICT development, although on projects with independent budgets, technologies, and approaches, resulting in ICT solutions not integrated with one another. Finally there are some good examples of converging resources to a single effort, adopting project management and technical methodologies, and leveraging on a common ICT infrastructure to develop all the required services.

Based on the analyses of the eGovernment implementation status and of the risks and opportunities mentioned above, this document proposes a high-level three-year strategic plan and a detailed one-year plan, describing the concrete steps to be taken to implement eGIF4M. The eGIF4M plan is devised to allow for an incremental introduction, risk minimization, and comprises the following key actions:

- **Technical**, including (i) the implementation of an architectural framework (the eGIF4M service delivery architecture) based on a government service bus, where all the systems shall converge to interoperate, thus reducing the dependencies, the expectations, and the needs of strong coordination with donor funded projects, and (ii) the specification of the standards to be adopted at each level of the architecture, if applicable, and definition of a life cycle for the standards, to accommodate evolving eGovernment projects and innovation in technologies.
- **Organizational**, structured in (i) the definition of an interoperability maturity model, which measures the level of compliance and of adoption of eGIF to quantify and make visible the benefits (or disadvantages) of the framework and to setup incentives for the more virtuous projects, and (ii) the setup of an organizational structure and of the decision processes to manage eGIF4M, monitor its execution, and to maintain and enforce it in the longer term.
- **Systemic support actions**, meant as the set of activities to favour growth of local skills and capabilities, to help create and disseminate a culture of interoperability, to help increase international networking of local companies and universities, and to create a virtuous cycle among public institutions, higher education, and private companies.

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Part 1. Introduction and statement of purpose

1.1 Introduction

The Government of Mozambique initiated the development of a national ICT policy by establishing an ICT Policy Commission in 1998. The work of the commission resulted in the release of the national ICT Policy in November 2000 and, subsequently, in the release of the ICT Policy Implementation Strategy, that was approved by the Council of Ministers in June, 2002 and identified six priority thematic areas, illustrated in Figure 1.

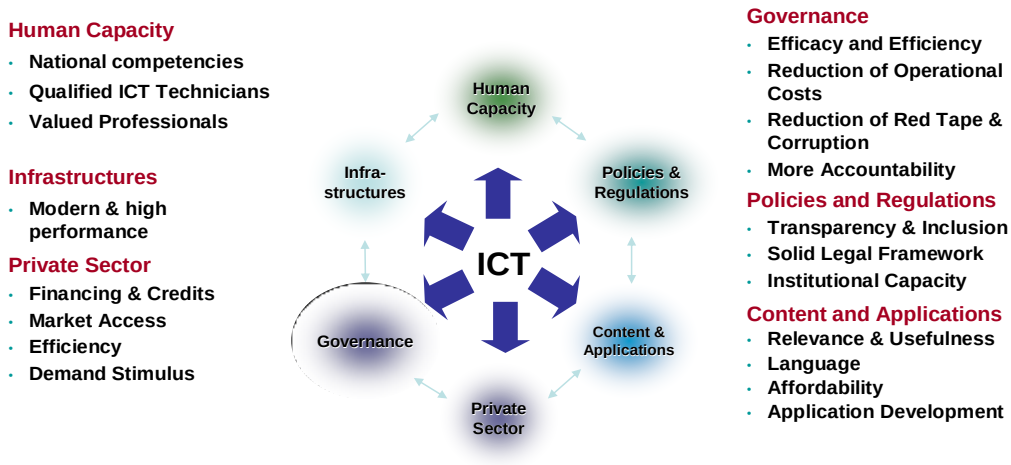

Figure 1: ICT Policy Implementation Strategy - Thematic areas

The ICT Policy Implementation Strategy expressed the need for developing strategic interventions in the area of eGovernment and Universal Access. The eGovernment Strategy, approved in July 2006 by the Council of Ministers, has a time horizon of five years and is tightly aligned with the Public Sector Reform (PSR) activities [2,14,15].

The strategy consists of six flagship projects, supporting the rapid collection and adoption of best practices and the establishment of key instruments and shared infrastructures and services for government-wide ICT-enhanced service delivery. The flagship projects included: (i) establishment of a common communication platform and interoperability framework; (ii) provision of a secure environment for public financial transactions; (iii) integration of land and property registration data to one unified platform; (iv) establishment of a nationwide integrated civil registry; (v) provision of new improved tools and integrated data for business entities registration; and (vi) building of an integrated framework for supporting collaboration of government bodies at the decentralized level.

One of the opportunities (and one of the final goals) of the strategy illustrated above is switching to a *citizen-centric* government, that is, to a state of things in which the Government delivers integrated services focused on the needs of citizens and business and in which citizens and business are able to interact with government in a manner, time and place of their choice[1] [2,16]. The switch to a

[1] Cfr. http://www.egov.dpc.wa.gov.au/Strategies/Pages/ElectronicServiceDelivery.aspx (accessed Jan 2009)

citizen-centric Government requires a profound and all-encompassing restructuring of the Government's services and processes, of its organization, as clearly highlighted by similar experiences[2].

Having adopted a comprehensive approach in the implementation of this vision, many government departments started, from 2000, implementing various ICT initiatives (e.g., Public Servants Information System, State Financial Information System, Enterprise Licensing and Cadastre Information System, Information System of the Administrative Tribunal, eLand Registry and Management Information System) and several projects related to a functional analysis and process re-engineering of government departments. It became clear quite soon that without proper governance and guidance, and without the definition of a proper interoperability framework, eGovernment services in Mozambique would soon be based on a patchwork of incompatible and closed systems, not differently to what happened to other countries, see, e.g., [3,4,5,6].

1.2 What is interoperability

The definition for interoperability we adopt in this document is as follows:

> "***Interoperability is the capability of (two or more) systems to exchange seamlessly data, information and knowledge, thereby enabling efficient and effective services offered by the government organizations (G) to the citizens (G2C), to the business sector (G2B) and to the other government organizations (G2G).***"

In the definition we use the word "system" to indistinctively mean both ICT systems and organizations. This allows to highlight the role interoperability has in building and delivering a citizen-centric government. Notice that it is slightly more general than the frequently used definitions for interoperability, such as those promoted by international standardization bodies. See for details the Appendix of this document.

1.3 eGIF for Mozambique (eGIF4M): objectives and benefits

The objective of eGIF4M is to define a framework that enables interoperability across the Mozambique's Public Administration.

A number of benefits are expected once an eGIF has been implemented (see also [3,4,5,6]):

1. Citizen-centric, one-stop delivery of services through a variety of channels: better public services tailored to the needs of citizens and businesses require the seamless flow of information across government institutions.
2. Better decision-making: in most countries, policy makers are faced not only with overlapping and uncoordinated data sources but also with the absence of common terms of reference and means of representing these data. This results in time consuming and costly procedures to non-homogeneous data. Interoperability will allow data compiled by different agencies to be used together to make better decisions.

[2] See, for instance, http://www.egov.dpc.wa.gov.au/Strategies/Pages/ElectronicServiceDelivery.aspx and http://www.epractice.eu/document/4227.

3. Better coordination of government agency programs and services: if information about government is easier to obtain, policy makers can design better projects and can more easily avoid redundant or similar projects. Furthermore, policy- and decision-makers would have more information by which to evaluate the performance of agencies and the public services they deliver.
4. Better accountability. Although indirectly related, eGIF, by favoring availability and fruition of data, might help improve accountability.
5. Better coordination of ICT initiatives. Although the Mozambique's eGovernment initiative and the related ICT projects (e.g., GovNet, SIP 2000 Public Servants Information System, Civil Identification System, e-SISTAFE State Financial IS, Digital Land Registry, One-Stop Shop, and Electoral Process IS) started recently, - compared, for example, to other eGovernment initiatives in Europe and USA - eGovernment interoperability in Mozambique's is becoming an important issue. In fact, each project is defining its own system architecture, data models, process flows, enabling technologies, software development and project management methodologies. Thus, if no particular attention would be devoted to the interoperability, the result will rapidly become a patchwork of ICT solutions not compatible or integrated each other, and the eGovernment strategy will hardly meet its goals, very much along the lines of what has happened in Europe [6].
6. Cost savings and/or cost avoidance: by making systems 'talk' to one another, there may be no need for new systems that were once deemed necessary. Further, demanding interoperability breaks reliance on single vendors and yields choice for governments in their purchases, upgrades and as they scale, opening at the same time possibilities for local development. By adopting an interoperability framework, the Government promotes the adoption of best practices also in the private sector (e.g., by contractual agreement for the delivery of services), helping improve quality and efficiency of local companies.
7. Promotes international cooperation: interoperability among governments can help create the infrastructures necessary to solve cross-border problems, such as drug trafficking, environmental pollution, money laundering and illegal arms trade. Interoperability among governments can also mean delivery of eGovernment services to citizens and businesses across a region and facilitate trade between a group of countries and their trading partners.

See the Appendix for the list of the key stakeholders and the expected benefits.

Figure 2 describes the overall framework within which eGIF4M develops. The outer circle, in particular describes how a vision, that includes both organizational and technological aspects, has to be used to shape the organizational processes and the technological choices. These, in turn, have to be aligned, so that technological choices and process re-engineering activities proceed in sync, see also [8]. In such scenario, eGIF is a "glue" that provides a common reference for all the different aspects mentioned above.

Figure 2. eGIF: organizational and technological aspects

1.4 Scope and expected outcome

The goal of this document is to provide a framework on how to setup, deploy, and maintain eGIF4M. More in detail, the document:

1. Lists the (open) standards to be applied in eGovernment ICT projects when developing or upgrading technology, including networks and infrastructures, process and data standards. This includes the technical standards for hardware and software interoperability, aspects related to IT security, aspects related to data integration and content management, meta-data, and aspects related to the broad adoption of (web) service technologies.
2. Defines the guidelines, methodologies, project management practices, and reference architectures to promote and support interoperability in the Public Administration. This includes the emerging technical architectures for software interoperability, standards and methodologies for modeling (business) processes, standards and methodologies for managing projects.
3. Proposes an organizational structure and the systemic actions that are necessary to maintain the interoperability framework for Mozambique. This includes actors and responsibilities, a revision processes for standards, metrics and methodologies for measuring the adoption of interoperability, and, above all, incentives and tools to promote eGIF4M. The assumption here is that the *eGIF4M plan and standards need to evolve together with the needs of Mozambique Government and with the development of new technologies and standards.*
4. Analyzes the flagship projects, in order to individuate concrete starting points and proposes a high-level strategic plan, with a time span of three-years, and a detailed plan, with a time span of one year, that describe the concrete steps to be taken to implement eGIF4M.

The plan is devised to allow for an incremental introduction and risk minimization. The assumption is that achieving interoperability is simpler and less risky if started from a few/key projects and areas.

Risk assessment and minimization: the plan presented in this document promotes an approach in which risks are tightly monitored and controlled.

The final goal is ensuring that the eGIF4M initiatives will constitute — and be perceived as — an advantage, not only for the implementation of the PSR and for the realization of a citizen-centric Government, but also for the development and deployment of each one of the eGovernment applications that will be developed when the eGIF4M framework is established.

Notice that this document takes a wider approach than the one described in [3,4,5,6], in which item 1 and part of item 2 are stated as necessary for implementing an interoperability framework[3]. Finally, the scope of eGIF4M does not include the specification of commercial products to be used for developing new eGovernment applications or to integrate existing ones, or to address specific legal, financial and business issues related to the development of eGovernment projects. See the Appendix for the methodology that has been adopted to produce this document.

1.5 Assumptions

The plan, the standards, the architectural guidelines and methodologies here described need strongly coordinated efforts to become effective and widely used and many different aspects need to be verified and ensured in order to establish an effective framework for interoperability in Mozambique, including:

1. Political endorsement – since eGIF4M requires coordination and open communication among ministries and public agencies, commitment to adhere to common principles and prescriptions, it is fundamental to have the endorsement from the government and the support to follow the rules that are shared and agreed on.
2. Clear ownership and coordination – eGIF should be the result of the coordinated effort of many stakeholders, which are involved in the ICT development of Mozambique. To maximize impact, however, there should be also clear ownership and coordination for its implementation, monitoring, and enforcement. This is required to establish and to maintain it in sync with the other national public ICT initiatives.
3. Collaboration from PA agencies – without the support and commitment of all the public agencies involved in ICT projects, eGIF4M will remain a theoretical effort. Therefore, there should be the largest possible involvement of government and public agencies in its definition and implementation and clear mechanisms to support its enforcement to strongly impact ICT development in Mozambique.

[3] "e-Government interoperability can be achieved through the adoption of standards – agreement among independent parties about how to go about doing some task – or through architecture – the fundamental organization of a system embodied by its components and their relationships to each other and to the environment, and the principles guiding its design and activity."

4. Incentives and monitoring – the strategic plan allows defining a path for Mozambique to implement the interoperability framework with a time frame of three years. It includes monitoring and validation aspects to make sure expected impacts and benefits are achieved during that period. Identification of pilot eGIF projects and incentives are also required to test and validate the approach since the beginning and to make sure the actors involved are motivated to support the initiative.
5. Systemic support actions – as any other ICT initiative in developing countries, a number of support actions need to be in place to make sure eGIF4M impacts the society and produces long term sustainable benefits. These actions (including education, continuous ICT training in the country, common infrastructure development and accessibility) can only be guaranteed by an effective supporting ICT Policy.

1.6 Role of business drivers and technology

The implementation of eGIF4M is based on a top-down approach, which we can represent as a pyramid composed of three-layers, shown in Figure 3. Specifically, on the top of the pyramid there are the eGIF4M political and business drivers, which provide strategic decisions and constraints for the desired outcome. These are translated into operational decisions and implementation using the adopted methodologies, standards and reference architectures.

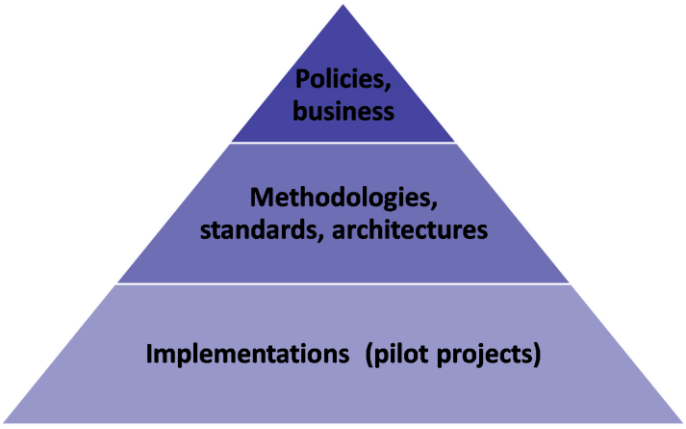

Figure 3. eGIF: Policies, business drivers and technology

1.7 eGIF international experiences

The need for strategic implementation of eGovernment, thereby improving efficiency and transparency of government process has been recognized by many countries, including in Australia, Brazil, Germany, Ghana, South Africa, UK, and various other countries (see the Appendix for details).

The work in [3,4,5,6] provides a concise comparative survey of eight selected eGIFs (also mentioned in the Appendix), namely Australia, Brazil, Denmark, EU, Germany, Malaysia, New Zealand, and UK. These are compared on the basis of (i) the context that underpins the whole framework, (ii) technical content, (iii) creation and revision of the eGIF documentation, and (iv) implementation and compliance issues. The most up-to-date eGIF appears to be the one of New Zealand, which went through ten editions from 2002 up to its last release in February 2008.

The eGIF initiatives closest to Mozambique (in the geographical sense, which also implies some closeness in economic development, etc.) have been conducted in Ghana and South Africa. The eGIF document of Ghana, which has been released in February 2006, is still a draft. In turn, the initiative of South Africa, released in its final version in September 2007, focused only on minimal interoperability standards.

Notice that this document follows a holistic approach to eGIF4M and besides its technological part that includes the standards and the reference architecture, it also covers (on top of what is usually delivered in a typical eGIF document, like in those mentioned in the Appendix) the organizational part.

Part 2. eGIF4M: eGIF for Mozambique

As stated in Part 1 of the document, the objective of eGIF4M is the definition of the concrete steps to enable interoperability across the Mozambique's public administration. The eGIF4M plan has been designed to become a central milestone for improving efficiency and effectiveness of government services and a key enabler for switching the government to a citizen centric approach, a strategic goal of the country.

This part of the document describes the main drivers, the approach, the guidelines taken into account and outlines the plan for the implementation and maintenance of an interoperability framework in Mozambique.

Besides the criticalities experienced by many countries all over the world in implementing their eGIFs (see Section *1.7 eGIF international experiences*), eGIF4M also takes into account some specific issues and opportunities, typical of countries experiencing a fast development, among which:

- Governance: ICT projects are mostly supported by international donors and the resulting governance process is more complicated than that of other projects. The possibility to enforce common architectural solutions and standards on these projects, for instance, is limited, requires strong political commitment and clearly defined organizational roles.
- Skills: the limited availability of specialized technical ICT and managerial skills in the country implies a strong dependence on external support to implement and manage the ICT projects. Without establishing a transition path to provide the necessary competencies to the local context and to gradually increase and enlarge the base of ICT skills, there is a risk of not becoming able to control the convergence of eGovernment projects on the interoperability framework.
- Sustainability: The traditional approach of setting up specific projects to respond to the needs of government agencies is not suited for a long term initiative like eGIF, where most of the results are envisioned from three to five years. Hence, management of eGIF4M requires the setup of conditions that allow for operations in a multi-year perspective.

At the same time the implementation of an interoperability framework can reduce some of the typical barriers faced by small and medium enterprisers (SMEs) in ICT projects. For instance, by having governments' solutions based on open standards, SMEs have more possibilities to compete or cooperate with bigger players. Thus, eGIF4M can be an opportunity for local companies to join the development of the eGovernment framework and in strengthening international connections and networking.

2.1 The approach

The risks and opportunities mentioned above require setting up a framework that refines existing approaches to be tailored to the specific needs and constraints of the Mozambique's context.

eGIF4M is therefore based on the following key actions:

Technical implementation, organized in two key areas:

- Implementation of an architectural framework - the *eGIF4M service delivery architecture* - based on a government service bus, where all the systems will converge to interoperate. We envisage the development of the architecture to be guided by a specific government unit. This helps drastically simplify the interoperability implementation process and reduce the dependencies, the expectations, and the needs of strong coordination with donor funded projects.
- Specification of the *standards to be adopted* at each level of the architecture, if applicable, and definition of a *life cycle for the standards*, to accommodate evolving eGovernment projects and innovation in technologies. Notice that the life cycle is an essential aspect to favor maintenance of the framework in the long run. Notice also that the adoption of open source software and standards may provide considerable advantages as also demonstrated by other eGIF initiatives, see [3,4,5,6] and the Appendix for details.

Organizational implementation, structured in:

- Definition of an *interoperability maturity model*, which measures the level of compliance and of adoption of eGIF. This information is essential to quantify and make visible the benefits (or disadvantages) of eGIF and can be used as an important tool for the setup of incentives for the more virtuous projects.
- Setup of an *organizational structure* and of the *decision processes* to manage eGIF4M, monitor its execution, and to maintain and enforce it in the longer term.

Systemic support actions, meant as the set of activities to favour growth of local skills and capabilities, to help create and disseminate a culture of interoperability, to help increase international networking of local companies and universities, and to create a virtuous cycle among public institutions, higher education, and private companies.

Operationally, in order to implement the above mentioned actions this document proposes a high-level three-year **strategic plan** and a detailed one-year plan, describing the concrete steps to be taken. Below, we discuss each of these in detail.

2.2 Technical implementation

In this section we discuss the eGIF4M technical implementation details, including (i) the service delivery architecture, (ii) the data formats, (iii) mapping the standards/data formats onto architecture, (iv)documentation and development standards, and(v) the standardization lifecycle.

2.2.1 eGIF4M service delivery architecture

Figure 4 describes eGIF4M service delivery architecture, which will serve as the basis for interoperation of data, systems, and processes. The architecture is based on a

Government Service Bus (GSB) and follows the standard SOA (service-oriented architecture) and EDA (event-driven architecture) approaches, see the Appendix for details.

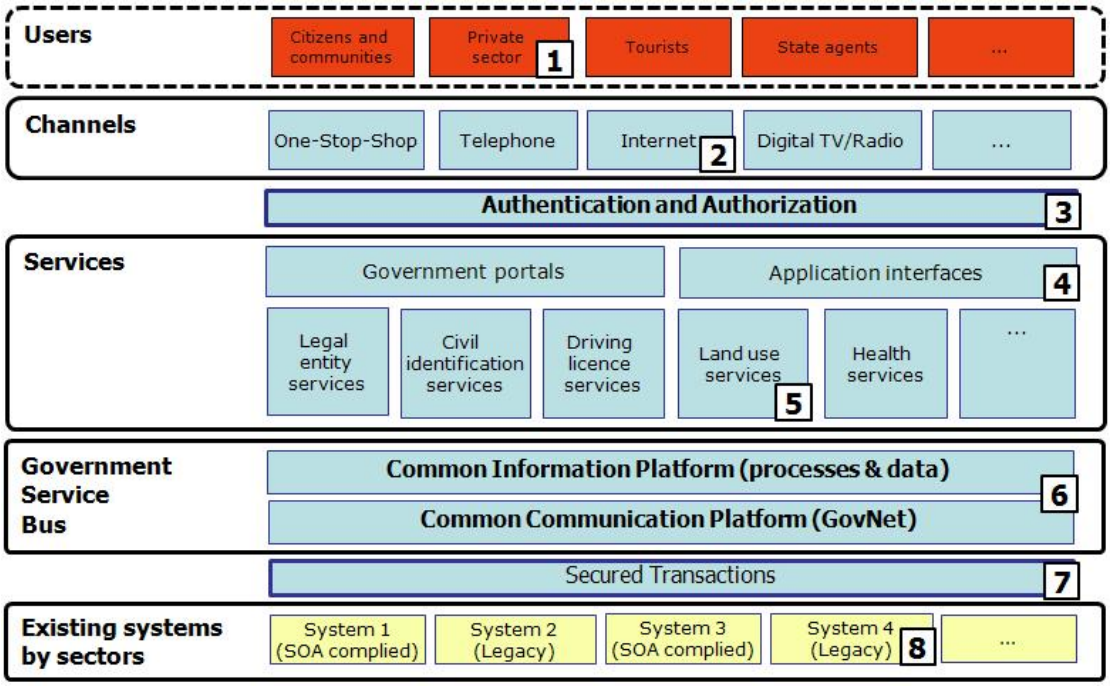

Figure 4. eGIF4M service delivery architecture.

In Figure 4 we distinguish:

- *Users,* who are the actual service recipients that can be individuals, representatives of a private sector, such as SMEs, state agents, and so on.
- *Channels* that deliver the services, e.g., one-stop-shop, telephone, Internet.
- *Services* that are offered by eGovernment, such as legal entity services and civil identification services. Notice that access to the services offered either via a government portal or application interfaces might require authentication and authorization procedures.
- *Government service bus* is the core of the interoperability. It is constituted by two main components, the common information platform (providing interoperability of data, services, and processes), and the common communication platform (that provides network and infrastructure). Of these two components, the latter has already been implemented. As a matter of fact, within the GovNet project, in its fifth year of operation, more than 140 government institutions from central (ministries), provincial, and district levels are now interconnected [6, 15].
- *Existing systems by sectors* represent existing information systems (which can be SOA-complied or legacy) by sectors. Some examples include Enterprise Licensing and Cadastre Information System, State Financial Information System, eLand Registry and Land Management Information System. Access to these systems is through secured transactions. Notice that this layer is included to emphasize the situation of the last decade in Mozambique, that is of a sectorial approach to definition and

implementation of government information systems with its consequences, e.g., of duplication of resources, which is to be improved within eGIF4M.

The implementation of the architecture described in Figure 1 relies upon the identification and allocation of standards to the various architectural components, see next.

2.2.2 Standards: data formats

Below we provide a concise overview of the standards promoted by international bodies that are currently adopted, or under consideration in various eGIFs, see Figure 5. The complete list with details can be found in the Appendix.

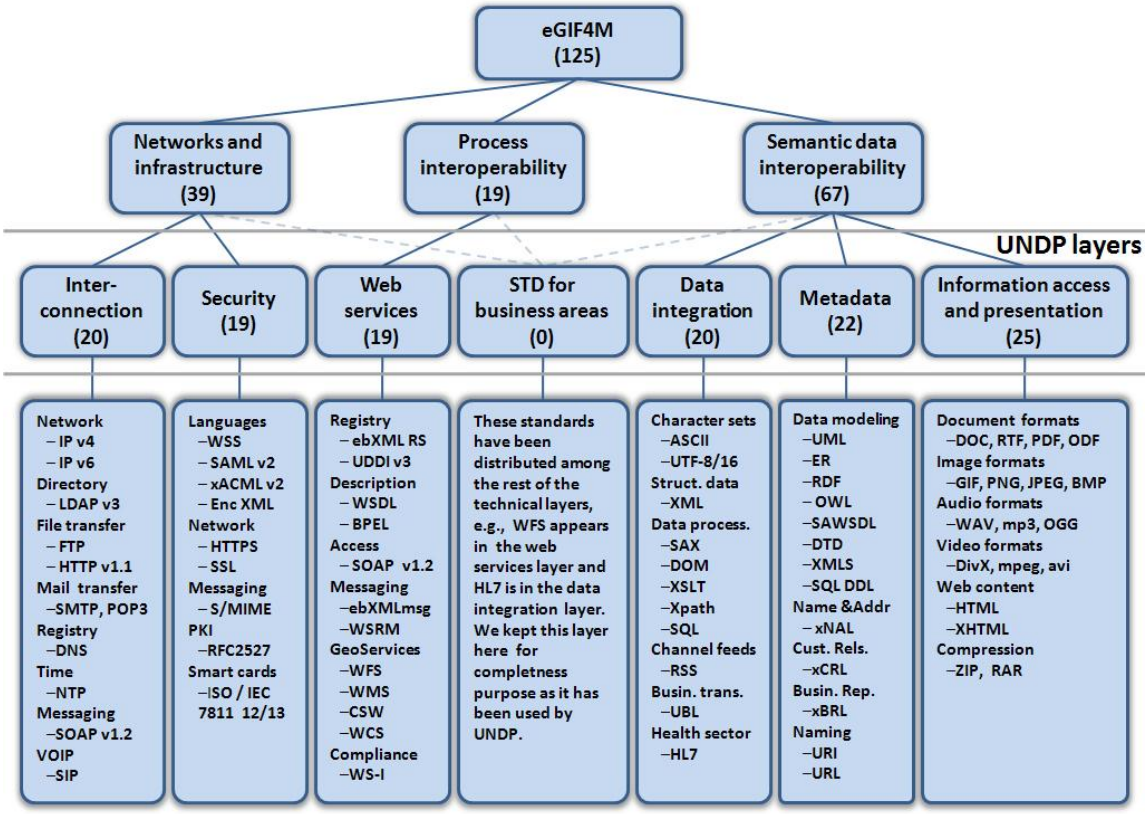

Figure 5: Overview of the eGIF4M standards.

We organize the standards into three key areas, namely: (i) networks and infrastructure, (ii) process interoperability, and (iii) semantic data interoperability. In parenthesis we indicate the number of standards considered in each area (only a subset of which is shown in Figure 2). Thus, for example, in overall we have considered 125 standards, among which 39 in the area of networks and infrastructure, 19 in the area of process interoperability, and 67 in the area of semantics data integration. These three areas are further articulated following the seven technical layers covered by the UNDP eGIF reviews [3,4,5,6], for which we provide some examples. For instance, the interconnection layer contains 20 standards, grouped into the following themes: network protocols (e.g., IP v4), directory protocols (e.g., LDAP), file transfer protocols (e.g., FTP),

mail transfer protocols (e.g., SMTP), registry services (e.g., DNS), time protocols (e.g., NTP), messaging protocols (e.g., SOAP), voice over internet protocol (e.g., SIP). Similarly for the other layers.

2.2.3 Mapping Standards onto Architecture

In Figure 6 we provide a high-level mapping of the eGIF4M standards onto the architecture layers. In particular, the interconnection standards are matched to both the channels layer and the common communication platform of GSB, thereby resulting in *1-n* mapping. The web services, data integration, metadata and information access and presentation layers are matched to both the portals/application interfaces part of the services layer and the common information platform part of GSB, thereby resulting in *n-n* mapping. And, similarly for the security standards.

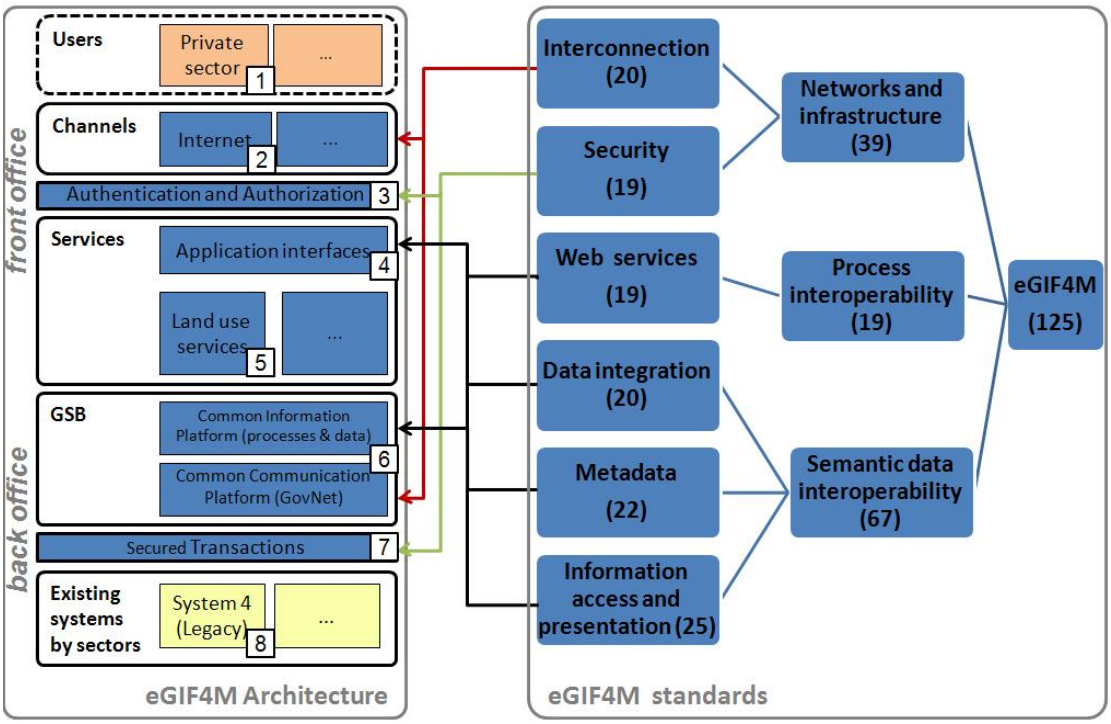

Figure 6: Mapping eGIF4M standards onto architecture.

Notice that in Figure 6, the "users", the "services", and the "existing systems by sectors" layer are left unmatched. The users are out of scope here. Particular services, such as the land use services, are (composite) logical government functions, which are at a higher level than the technical standards. Once these functions have been formalized as processes the standards can be applied. Finally, heterogeneity of the existing systems is usually handled through the service bus. This is also the reason why the web services, data integration, metadata and information access and presentation standard layers are matched via *n-n* mappings to the corresponding back- and front-office parts of the architecture.

In order to provide further details on the mappings between the eGIF4M standards and the architecture, we consider a scenario from the land

management application following the path of eight items marked by numbers in rectangles in Figure 6 (and in Figure 4). Notice that items 1-5 are grouped under the front-office heading, while items 6-8 represent back-office. Suppose there is a private company that provides mediator services of renting land parcels, and there is a farmer that wants to rent one for agricultural use with the help of this company (item 1). The farmer has several choices among various land parcels, and, hence, asks the company first to provide the maps of the identified areas to study them in order to make an informed decision with respect to which land parcel to rent. To process the request of the farmer, the company uses internet (item 2: IP v4), passes through the necessary authentication and authorization procedures (item 3: LDAP) and interacts in a secured way (item 7: SAML) via the exposed application interfaces (item 4: SOAP, WMS) of the land use services of the government (item 5) with the eLand Registry system (item 8). In turn, item 6 provides the interoperability glue at the process, data, and infrastructure levels that is necessary to process the request. For example, to describe metadata about geo-data it is used ISO 19115, while for describing metadata about geo-services it is used ISO 19119 (as required by CSW), a map request is handled with WMS, etc. This request requires integrating data from some other systems beside eLand Registry, such as the forestry cadastre. This is needed to check if the land parcel under consideration is in the forest area, which cannot be exploited for agricultural use. Finally notice that for each legacy system the adaptors have to be developed in order to use these systems under the government service bus.

2.2.4 Beyond data formats: documentation and development standards

In the last twenty years, following the so called "software crisis" a significant amount of efforts in Software Engineering has been devoted to making development activities more predictable and delivered systems of higher quality.

These activities have led to the formalization of standard development processes for software (starting from the Waterfall model, proposed by Royce in the seventies to the Agile development processes, emerged in the nineties), to the definition of techniques for assessing and evaluating effort and quality (e.g., function points, metrics), to the collection of body of knowledge and best practices related to project development (e.g., PRINCE2, PMBOK, Vee-Model), to framework to asses process maturity (e.g., CMMI), see the Appendix for a brief description of the PMBOK methodology.

As software systems (and in particular, e-Government systems) are becoming more complex, we believe that an interoperability framework has to address not only problems related to formats (i.e., the way in which data is stored) and architectures, but also aspects related to the standardization of the documentation, and of the development process to deliver (software) systems. The adoption of such standards, in fact, helps make development and deployment more predictable, simplifies issues related to maintenance and extensions of existing systems, and favors integration (since interfaces and data formats are documented).

Thus, even though practical issues or constraints (e.g., related to the way in which systems get procured) might not allow to have an eGIF that enforces aspects related to, e.g., documentation and development standards, we believe that any action that tries and moves towards the adoption of such standards will help maintaining eGIF4M in the longer term.

2.2.5 Standardization lifecycle for keeping eGIF4M "healthy"

Standards live, evolve, and become obsolete. Most, if not all the eGIF initiatives, define a lifecycle for the adopted standards. The lifecycle, in fact, allows the evolution of eGIF plans to better accommodate changing requirements of the Government and changing technologies, while, at the same time, maintaining some control, by making the standards adopted or obsolete in a predictable way.

According to [3,4,5,6] most of the eGIF's studies have identified three basic categories for standards:

- Emerging, including all the standards that are gaining wide adoption.
- Current, including all the standards currently in use.
- Fading, including all the standards whose popularity and use are in decline.

In order to make this classification operational we can distinguish some sub-states that more precisely indicate the status of adoption:

1. **Emerging:** it includes all the standards that the Government is considering for introduction. We distinguish:
    a. **Future**. It encompasses all the standards that are **not** in use in the Government (and not included in any of the states below) – no matter what the reason is (not needed, future consideration, and so on).
    b. **Assessed.** The standard has been evaluated and approved by the eGIF commission for experimental introduction. The standard is not yet in use.
    c. **Experimented.** An assessed standard has been deployed and it is in use in a "controlled" environment (e.g., in the scope of a new project; by some Government agencies). The experimentation has the goal of assessing usefulness of the standard. The standard runs in parallel with other "Current" standards. A deadline is defined for a final assessment and evaluation, which will lead to a change of state (e.g., from "Experimented" to "Future"; from "Experimented" to "Current").
2. **Current:** it includes all the standards that the Government is currently using. We distinguish two levels that encode the prescription for the standard.
    a. **Possible.** It refers to a standard that can be used for data and services. Adoption is not compulsory. A standard can be kept in this state to, e.g., improve flexibility (not all the Agencies have the possibility of switching to a corresponding mandatory standard, or

it might not make sense for them to switch to the standard), while, at the same time, moving towards a common reference framework.

b. **Mandatory.** The standard is officially adopted. Government bodies are required to deliver services, documents, etc, using the mandatory format.

3. **Fading:** it includes all the standards that are not is use anymore. When a format is in the "fading" state, no new document, service, etc can be produced in the "faded" format. Furthermore, we distinguish two sub-cases, according to the policy chosen for historical data:

   a. **Disappearing.** Government bodies are required to migrate all data to the new format. A deadline is set for the migration.

   b. **Remaining.** Old data does not need to be migrated (The Government ensures readability of the format by maintaining support for the applications that read the data).

To maintain overall consistency of the eGIF4M plan, certain constraints apply. For instance, to be part of the standardization, a data format/service has to have at least one "possible" format. As another example, it would be strange (or at least inefficient) to have two different "mandatory" standards that cover the same data type.

The lifecycle proposed above, however, allows for quite some flexibility. For instance, "loose" regulation policies can be implemented by setting some formats in the "possible" state. Costs of migrating old data can be mitigated by putting an obsolete standard into the "fading/remaining" state (although this implies that software/hardware systems to read the old data have to be maintained).

No matter what the chosen lifecycle is the following factors are essential for interoperability to work in the longer term:

- **Data collection.** It is important to keep an eye on the standards being defined and adopted in other countries, to guarantee the possibility of improve usability and adoptability of the standards. It is also important to maintain and eye on the requirements of the different government bodies in order to ensure that the standard adopted match with the needs.
- **Regular revision of the standards in use and of the lifecycle itself.** It is important to revise on a regular basis the list of standards, their status, and the list of (non standard) formats in use, in order to get a precise view on the status of interoperability. The revision process, together with the conditions and actors responsible of changing the state of each standard, has to be precisely defined and regulated for an eGIF to be successful.
- **Enforcement policies.** Interoperability brings overall benefits for the Government, but its introduction might add, in the shorter term, an additional overhead. In order to help promote interoperability, therefore, it might be necessary also to define enforcement policies, to promote adoption and discourage non-virtuous behaviors.

2.3 Organizational implementation

Organizational implementation is articulated as (i) interoperability maturity model and (ii) organizational reference structure.

2.3.1 eGIF4M interoperability maturity model (IMM)

One important aspect of eGIF4M is providing the ability to measure the level of adoption and diffusion of the interoperability framework. Such capability, in fact, allows decision makers and program managers to understand more precisely the level of adoption, the impact, and the success of eGIF4M. Moreover, it allows to plan actions meant to improve the delivery of services through the adoption of the interoperability framework.

Various models exist to measure the maturity of organizations in developing systems (e.g., CMMI [17], ISO/IEC 15504 [21], Bootstrap [19], Trillium [20]) and, more specifically, to measure the level of interoperability, see, e.g., [22,23]; see also the family of standards identified by SEI [24, 25, 26] as well as the works in [27,28] for surveys. All models share a common approach, which is based on:

- identification of the targets of evaluations, for which the maturity level has to be determined (for instance, an organization or a system);
- a set of maturity levels (for instance, initial, managed, defined, measured, and optimized);
- a set of goals, that define what has to be measured (for instance, procedures, applications, infrastructures, and data).
- a method to determine the maturity level. This can be accomplished, for instance, by assigning the maturity level demonstrated by the target of evaluation in achieving each goal. A transformation function, e.g., as a (weighted) average of the scores, can be used to determine the total level of maturity.

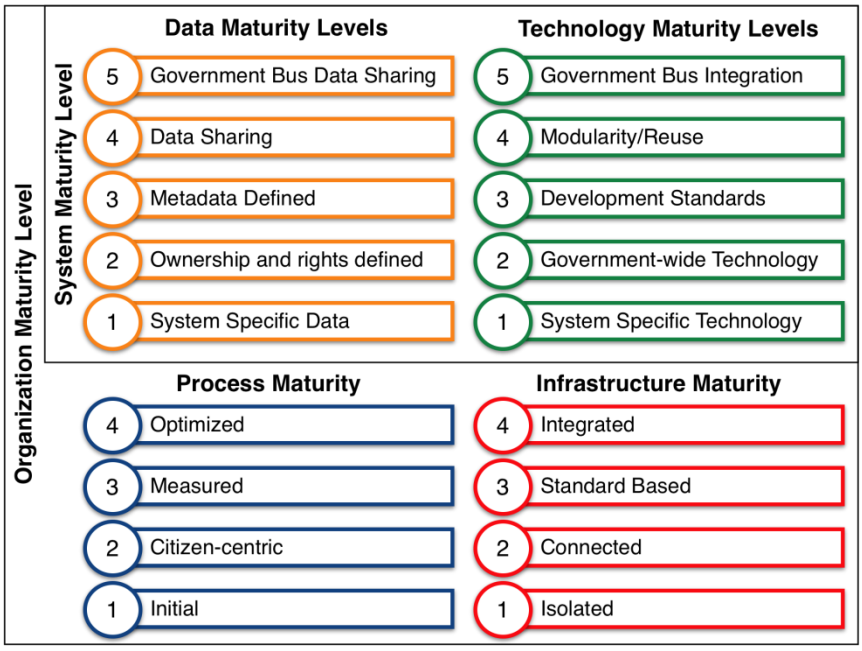

Table 1. Interoperability Maturity Model

The approach we propose in eGIF4M, see Table 1, is based on an adaptation of some of the models described above to provide a measurement system which is closer to the needs of Mozambique. Specifically, the model has two targets of evaluation: (i) organizations, and (ii) software development (system) projects. Notice that targeting projects is a peculiarity of eGIF4M, which allows to more easily manage inter-departmental projects and raise awareness of interoperability as early as possible in the development cycle.

The assessment of (software development) projects is performed on the most recent artefacts (e.g., requirements, design, prototype, implementation) and is meant to measure two dimensions: level of data interoperability (for which we revised the Conceptual Interoperability levels of the LISI approach [22]) and technical maturity, meant as the level of adoption of standard technologies for the development (for which we devised specific goals, being loosely inspired by the work in [18]).

The assessment of organizations is based on the PAID attributes (Process, Applications, Infrastructure, and Data) of the LISI model. For process and infrastructure we adapted the LISI model, whereas for applications and data we reuse the model adopted for projects.

We expect various benefits from the adoption of the model, among which the possibility of measuring the penetration of interoperability at different levels of granularity (government, agency, and systems), the identification of criticalities in the implementation of the framework, and raising awareness on interoperability opportunities and advantages

2.3.2 Organizational structure

eGIF4M includes a complex set of initiatives, which needs a well defined cross-departmental organization and clear horizontal processes to be managed and coordinated. The goal of this set of activities is individuating and/or setting up a reference structure in the Government which will become responsible of guiding the interoperability initiative, both at the strategic level and the technical level.

To achieve that, two kinds of organizations need to be established:

- a *inter-agency and inter-ministry committee* responsible of defining the enforcement policies and the incentives for the diffusion of standards. The policies and standards, to be of any effect, have to be approved by a Government's authorized body and procedures and accountable people/agencies have to be individuated to make sure they are applied.
- an *operational group* responsible for the execution of the eGIF4M plan and to report to the inter-agency committee. Individuate, in the structure, a reference person accountable for the execution of the plan (e.g., a project manager).

The operational group that will take charge of eGIF4M implementation needs therefore to be composed of personnel having two complementary profiles: ICT Architects and ICT Project Managers. The former are devoted to supporting all the technical aspects of EGIF4M maintenance, including management of the standardization lifecycle and supporting PA agencies in the technical adoption of standards and guidelines, while the latter should be in charge of managing the

Government Service Bus and the Case Studies and the enforcement of eGIF4M in ICT Government projects.

To achieve that, the ICT Architects should be familiar with the three technological areas involved in the process, that is: networking technologies, process and data semantic representation and integration (an ICT Architectural group can combine profiles specialized in one of these areas). Moreover, they should master government processes and have a clear understanding of Mozambique government central and local administrations. ICT Project Managers need to have a technical background on ICT but need to be more knowledgeable with ICT project management methodologies, best practices and tools.

This organization should be managed by the person in charge of the overall coordination of EGIF4M (i.e., the owner of this interdepartmental project), who is also responsible for the budget of the initiative and of the relationship and reporting to the inter-agency committee responsible for the enforcement of policies.

Finally, there should be a clear influence and responsibility of this organization on the maintenance of the government map of ICT systems, since the two initiatives are strictly related.

Figure 7 illustrates the main interactions and the main functions of the agencies responsible for the implementation of eGIF4M (some functions and interactions are not in the diagram to keep it simple). Rectangles represent organizational structures and rounded rectangles functions (or outputs).

The Operational Group is accountable for the maintenance of the information set (that is, all the documentation necessary for the interoperability initiative) and for the definition of the strategy/maintenance of the interoperability platform. The group, moreover, coordinates and provides support to ICT projects and to agencies related to interoperability.

Functions of the operational group are guaranteed by the endorsement of the inter-agency committee on interoperability, which, in turn, is endorsed both by the Government and by the Agencies.

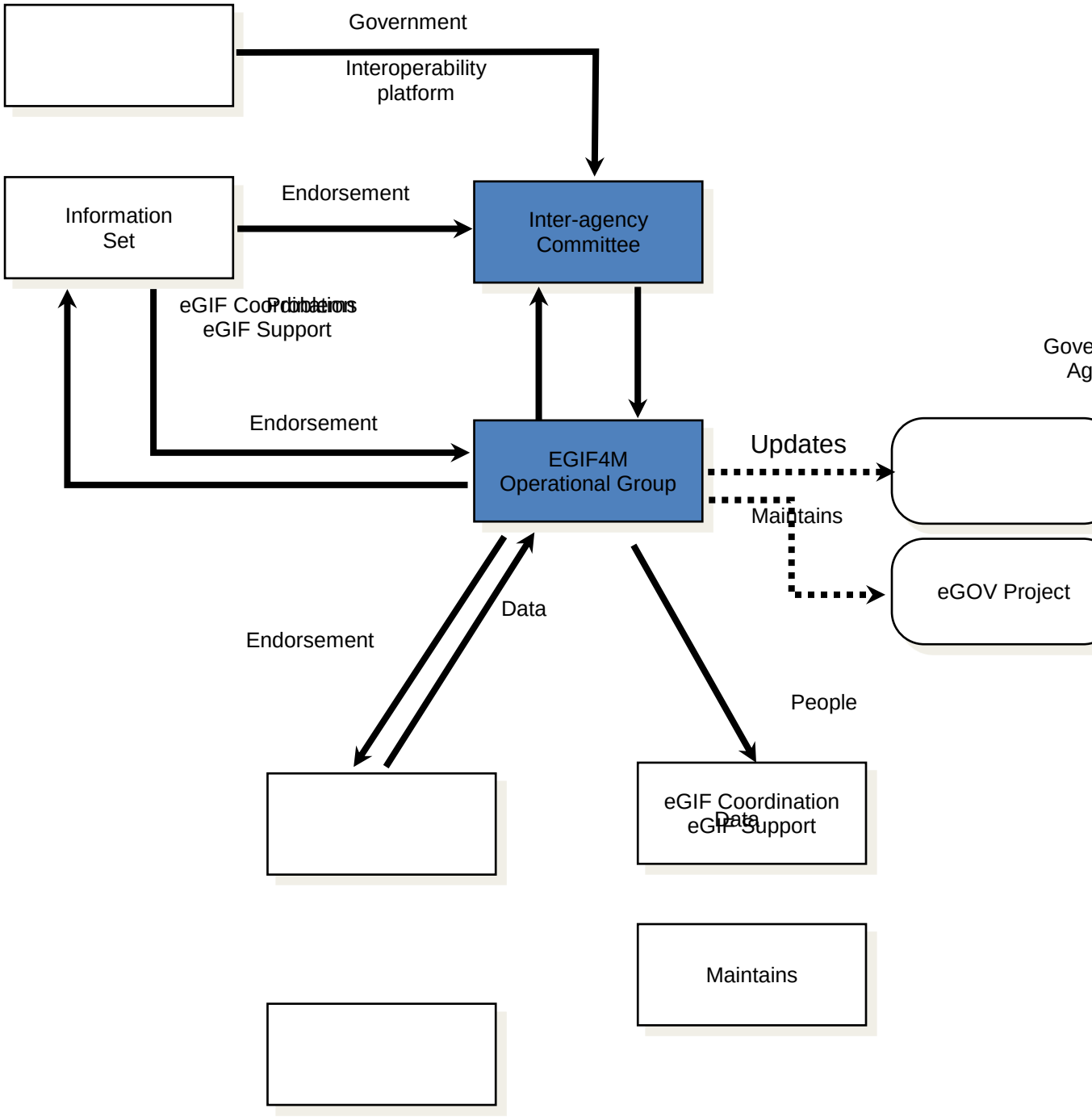

Figure 7. eGIF4M: The main interactions.

2.4 Systemic support actions

Various actions in the plan are meant to help create and disseminate a *culture* of interoperability. These activities include both a set of *horizontal actions*, namely actions whose goals are not "confined" to the Public Agencies and a set of *vertical actions*, namely actions that are focused to the implementation of eGIF.

2.4.1 Horizontal actions

The *horizontal* actions are mainly activities to integrate with other initiatives going on in parallel to the interoperability project. The goal is favoring a mutual

exchange of information and resources that we believe will help all stakeholders. We mention:

- Dissemination, Higher Education, and Mobility. One of the key issues in implementing a sustainable eGIF initiative in a developing country like Mozambique is to grow the skills of the local players, both in the public and private sector, and to better connect them with international initiatives. The plan for dissemination, higher education, and mobility initiatives in eGIF4M therefore includes aspects related to increasing national and international visibility of eGIF4M and the definition of exchange programs between Mozambique's and International Universities. We envisage in particular:
    - setup of an international scientific eGovernment/Interoperability conference;
    - promotion/support for courses at the University/post-University level specifically aimed at improving project management and software development;
    - promotion/support for international exchange programs for students and professors at the University (e.g., framework agreements with other Universities);
    - promotion/support for international specialized training (Master/PhD level) for public servants[4].
- Living Labs. A Living Lab is a system for building future economy in which real-life user-centric research and innovation will be a normal co-creation technique for new products, services and societal infrastructure [http://www.openlivinglabs.eu/]. The establishment of Living Lab Maputo is in its early phases and is expected to see considerable developments during the coming 12-18 months time. We envision and encourage the use of the living labs to foster interoperability initiatives. The goals here are three-folds. First, it allows to involve local actors and local SMEs. Second, it favors a growth of competences and experiences about interoperability at the local level. Third, by fostering collaborations with other living labs it is possible to strengthen international visibility and acquire international competences and know-how.

2.4.2 Vertical actions

The *vertical* actions are instead meant to provide direct support to the implementation of eGIF4M, either in the short or in the longer term. These activities include:

- Funding and international initiatives. It is important to ensure continuous funding in order to support the development of the eGIF plan as well as its eventual subsequent actions also by involving some external funds

[4] It is important here to ensure that training will not remain "per se" - e.g. rather than binding training to an increase of wage, it is better to bind certification to a pre-requisite for promotions/increases in wage - this might require to assess feasibility and, possibly, to re-evaluate current policies/norms.

(beyond government funding).

- Training. At all levels, for all resource involved in the interoperability project, according to specific needs and gaps individuated during the infrastructure setup phase.
- Monitoring (and control). It refers to the activities related to assessing project "health" and, possibly, take corrective actions to ensure deadlines and goals are met. We envisage three different levels at which project monitoring and control can be effective:
    - eGIF4M level: the goal here is evaluating and assessing diffusion and benefits related to the adoption of standards. A good starting point is the "Interoperability Maturity Model". Some metrics, however can be defined to provide finer grained views, such as, e.g., the number/level of adoption of a given standards, the number of standards in the "possible" state; the number of non-integrated services.
    - IT Project level: the goal here is evaluating the level of integration each new solution achieves. In a sense, it corresponds to trying and building interoperability together with the new solutions.
- Ensure/Increase the flow of information. This is necessary to help sharing a vision on the IT systems among all the relevant stakeholder and ensure opportunities are exploited as they arise. It includes activities at different levels of granularity, including:
    - defining a map of the processes and services of the Government;
    - defining and maintaining a map of the IT systems of the Government;
    - provide and share, among the relevant stakeholders, the roadmaps and priorities of the systems.

2.5 eGIF4M: The Plan

2.5.1 Making the Service Delivery Architecture possible

The implementation of the eGIF4M service delivery architecture represents a key milestone in the implementation of the interoperability framework. We envisage the following risks and mitigation actions in its implementation:

- *Scope:* full top-down implementation of the architecture requires a significant effort. We envisage, instead, an incremental approach, through the definition of a few (one or two) significant case studies, whose selection is driven by Mozambique's strategic priorities (e.g., civil identification and land use services), and whose implementation will be based on a few selected delivery channels, such as Internet and one-stop shop. This should facilitate the early adoption of the framework.
- *Coherence of the architecture:* keeping coherence, simplicity and efficiency of the architecture requires clear ownership in the setting up of the vision and in the definition of the strategic lines of development. For this reason

a specific task force within a suitable government unit has to be responsible and accountable for its development (see 2.3.2 Organizational structure).

- *Migration*: in order to be of any use, legacy systems will have to converge (technically, e.g., via adaptors) on the government service bus. The framework uses the maturity model as a tool to measure compliance of the projects with the vision; defines technical standards to which projects migrate and proposes managerial standards (e.g., minimal technical documentation) that will also allow to have third parties migrate solutions, if necessary.

2.5.2 Managing Migration

The migration to the interoperability architecture has to be carefully planned and managed and relies on information that is to be built also during the implementation of the eGIF4M.

For this reason the plan includes activities related to building the vision of the ICT systems and to govern the implementation of the vision, see 2.5.4 Key actions in detail.

Some preliminary considerations, however, can be done at this stage concerning the maturity of ICT solutions in different areas and priorities emerged with discussions with some stakeholders, as well as to shape the context of the pilot scenario case study.

The analysis of the state of the art of eGovernment ICT projects in Mozambique has revealed a heterogeneous situation in terms of the maturity of eGovernment Strategy implementation: in some areas few isolated projects started; in some other departments more effort has been put on ICT development but the projects where still separated in terms of budget, technologies, approach and of course the result was IT solutions not integrated with one another; and finally there are some good examples of converging resources to a single effort, adopting PM and technical methodologies, and leveraging on a common IT infrastructure to develop all the required services.

The analyses of those three cases, including the suggestions on the eGIF actions to be taken, is given below.

1. The more mature initiatives certainly include:
    - Government Electronic Network – GovNet - the government private network which connects most of the Ministries, provincial Governments and other relevant institutions at all levels, providing centralized Internet/Email access, hostage for web pages and applications, as well as, providing the secure environment and quality of services for running sectorial applications.
    - Integrated Public Expenditure and Financial Management System - e-SISTAFE - implemented by the Ministry of Finance, a workflow based system supporting single bank account public administration payments, using a dedicated VPN and including Accounting, Treasury, Suppliers

Payment, Payroll, Budgeting, Government assets and inventory, and Auditing.

These initiatives need to be strengthened and used as good examples of building the critical mass to develop and evolve common systems and functionalities to serve multiple agencies. From the eGIF point of view, it is important to align these projects to the interoperability framework by providing their functionalities as eGovernment Services and integrating to the government service bus where to expose their services. In this way eGIF4M tests its deployment in mature, on-going project without risking their objectives but providing medium-long term benefits in terms of cost and maintenance of the ICT solutions.

2. In the case of Justice and Land Management areas, multiple ICT initiatives started but they are not yet consolidated and integrated as the one discussed above. In terms of increasing interoperability and integration these projects need to be strengthened mainly on two aspects: more users and stakeholders need to be involved in such a way that the benefits are more spread around public administrations, and common standards and processes need to be used in order to reduce the manual activities thus avoiding data duplication and inconsistency. In particular, the aspect of common data formats and data sharing among IT systems is the most critical in these cases. Systems in these areas need to be migrated to the government service bus and be re-implemented as services to be used also by other departments.
3. The less mature area is currently Healthcare, since only recently large ICT efforts started. In this area the main issue for eGIF is to adopt the framework approach since the beginning and to recover the time by learning from the other examples. By developing these systems on top of the government service bus we would reuse the skills made available on the technologies already in place and simplify the integration with the current infrastructures and solutions while adopting standard approaches and make possible cross-processes among public administrations and ministries.

On top of the considerations above, an essential action in the implementation of the interoperability framework is individuating and implementing a solution that demonstrates the advantages of a citizen-centric Government.

The solution could “traverse” the interoperability platform from “top” to “bottom” (i.e., from delivery channels to systems), ideally focusing on a critical process (that is, a process whose refactoring could greatly improve efficiency and efficacy), taking advantage of available delivery channels, and involving different government agencies.

Preliminary analysis — notwithstanding the consideration that such a choice has to be in the hands of the programme manager and of the organizations that will be responsible for the eGIF4M implementation — seems to highlight processes such as the registration of legal entities, land management, civil identification and driving licence management, via the one-stop-shop, as good case studies. In the next section we’ll focus on the *legal entities registration* example, which, at this stage, seems the more relevant to start implementing eGIF4M.

2.5.3 Legal entity registration: one-stop shop case

Here we consider, as the proposed case study, the setup of a project to integrate the "Registration of the Private Sector" in the interoperability platform. As mentioned earlier, this example is quite relevant as it involves various government agencies, whose current level of automation is very low and any improvement to the current situation could be of significant benefit to local entrepreneurship. This service could therefore be re-designed to take advantage of the one-stop-shop and be used as a way to promote integration of existing and new ICT solutions in the service bus.

As a preliminary remark, notice that thinking of this example in isolation is of no help in achieving the interoperability goals. The activities of this project will have to be integrated and coordinated with all the various other activities of eGIF4M described above. While a detailed analysis of benefits, risks, and maturity of the solutions that are needed to re-design the process are some of the considerations that will have to validate (or invalidate) such a starting point by the organizations and people responsible of the implementation of eGIF4M, here we provide a high level description of the activities that will be performed by introducing the proposed case study scenario, its relationship and connections with the Integration platform development project, the architectural framework that is expected to result (as an adaptation of the eGIF architectural framework) and the mapping of the standards which are considered relevant for this context.

As a second remark, we assume that all the conditions mentioned in the "Assumptions" section of this document are being taken care of. Among them, we assume, in particular, that all stakeholders have been involved and are actively supporting the implementation of the project

Finally, for the sake of the example, we make the hypothesis that no automation is currently available and that, therefore, the integration project requires also the development from scratch of new ICT systems (while on the real project there will be also surely the need to integrate some existing departmental system).

To achieve that objective we expect two implementation projects under the eGIF umbrella will start in parallel: the Integration platform development (see Task 3.2 in Section 2.5.4 Key actions in detail), to develop the integration framework and the modelling and adaptation tools, and the Interoperability Project Activation (see Task 3.3 in Section 2.5.4 Key actions in detail), to re-design and implement the selected business processes following the eGIF4M architecture, methodologies and guidelines, built using the infrastructure and tools made available by the framework.

Case study introduction

The One-Stop-Shop (OSS) initiative answers to the need for improving public service delivery to citizens and aims at establishing a favorable atmosphere to the growth of Private Sector. It introduces a citizen-centric service delivery model which should allow time of service and cost reduction, while increasing public administration efficiency and the effectiveness in supporting critical business processes for citizens and businesses. Moreover, an increase of the transparency in the relationship between the society and the public

administration and reduction of errors in the processing of information is also expected as a result of the automation of OSS processes through ICT.

At the current stage of OSS implementation, it lacks of efficient working tools to support the business processes and of an efficient communication system to implement them. For example, there is not yet connection between OSS and offices represented and the cross-departmental processes are not defined; only isolated services of each represented institution are defined. This calls for the introduction of ICT instruments, such as basic communication infrastructure and services, and acquisition of equipment, but also for analyzing and re-engineering the business processes, to be later implemented via Workflow Management tools.

Besides the urgent need to automate the OSS service, the main reason to make Legal entity registration on the OSS a very good case study for eGIF4M implementation is that many back-office departments are involved in supporting OSS processes and services, and therefore is fundamental to take carefully into account interoperability issues while implementing this project.

Project Structure

We envision the project as organized in three phases with the following goals and activities:

- **Phase 1.**
    - **Goals:** delivery of the service through one stop shop. Analysis of the current processes to get a better understanding of the automation possibilities
    - **Activities:** The current process is analyzed and re-engineered to make delivery through the one-stop shop possible. The re-engineering activity takes into account future automation and future integration of ICT systems (to simplify the next phase of the project). Indicators are defined (e.g. time taken to deliver the service). According to the level of implementation of the one stop shop, the initiative is sized and sites selected for the delivery of the service. Resources are trained and the service is made available through the one stop shop. An adequate communication campaign informs of the possibility. Measurements are taken to identify possible improvement areas.
- **Phase 2.**
    - **Goal:** automation of the service (increased efficiency on the back-end). Delivery of (part of) the service through the Internet.
    - **Activities:**
        - Current processes are analyzed to define the CRUD (Create Read Update and Delete) matrix (i.e. what data needs to be managed and what processes/actors manage the data in what ways). Notice that this activity might as well be integrated with the analogous activity in the first phase of the project.

- The architecture for automating the services is defined and so are all the possible integrations with the strategic Government ICT systems. Strong interaction with the people responsible of maintaining the Government systems' map is required. The organizational changes to support the new ICT systems are identified (e.g. some responsibilities on the data might be changed to make the use of the ICT systems more efficient). The corresponding change requests are agreed with the stakeholders. This activity is conducted in strict interaction with the Public Reform Sector project.
- The required systems are implemented and/or updated. Implementation and updates are conducted according to the project and technical standards defined in the specific activity of the eGIF4M project. Information flow might be one way - technical standards are imposed on the implementation - or bidirectional - the implementation suggests standards to adopt - according to maturity of the initiative and constraints, always ensuring convergence of the standards and technologies.
- The required interfaces with the Government Bus (whose implementation is taken care of in a separate activity of the eGIF4M plan) are defined. Implementation of the interfaces is agreed with the Government Bus implementation project.
- The processes are re-engineered/optimized to take into account possible improvements due to the use of ICT systems. Indicators are defined and measured once the system gets in the operations phase.

- **Phase 3.**
  - **Goal:** the service is extended to be delivered on the internet and to provide measurement and status on the internet.
  - **Activities:** The activities are similar to those of phase 2.

Documentation Set and Deliverables

This is an example of some of the deliverables and some of the standards that might be adopted for the project. Notice that deliverables include both artifacts necessary for conducting the project and guiding the software development activities and the systems themselves.

Phase	Deliverable	Format/Standard
All phases	Project Scope statement	Natural language (e.g. doc)
	Project Plan (including risk management plan and budget)	Gantt chart (e.g. mpp) + Natural language (e.g. doc) + Spreadsheets (e.g. excel)
Phase 1	Phase goals and plans	(see above)

	Re-engineering goals	Natural language (e.g. doc)
	Business Architecture (as is and to be)	Natural language (e.g. doc) + Process Model (e.g. UML)
	Support material (e.g. training)	Natural language (e.g. doc + html)
	Measures of the indicators	(According to the means of measuring)
Phase 2	Phase goals and plans	(see above)
	Re-engineering goals	(see above)
	Business Architecture (as is and to be)	(see above)
	System Architecture (including interfaces with Government Bus)	Natural Language (e.g. doc) + UML
	Artifact related to SW development. For instance: Requirements, Design, Unit test plan and result, Acceptance Test plan and result	
	SW system	(according to the standards individuated: see section below for an example)
Phase 3		(similar to phase 2)

Project Architecture and Standards adoption

Figure 8 shows mapping of the eGIF4M standards onto architecture for the one-stop-shop legal entity registration case. Notice that similarly to Figure 6, which focuses on the land use services example, the part on the left of Figure 8 is concerned with the legal entity services. In turn, the part on the right presents the relevant standards. Specifically, for each layer we exemplify the relevant standards, which will be listed below.

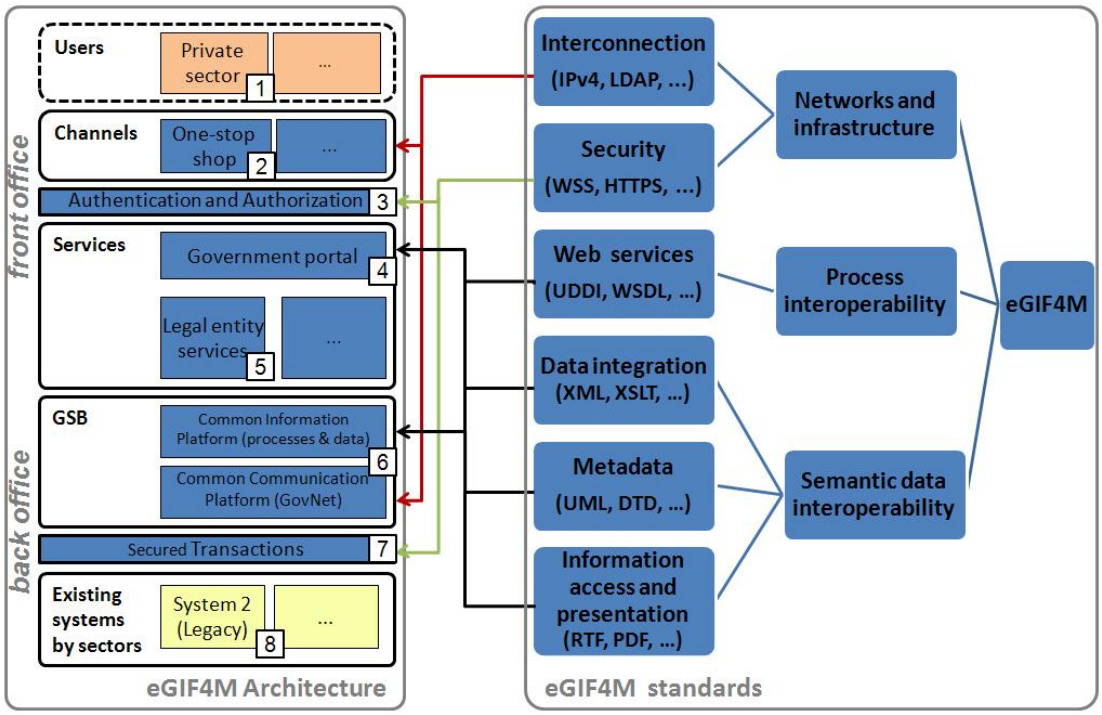

Figure 8. Mapping eGIF4M standards onto case study architecture

We now consider in detail a set of minimal standards to bootstrap the one-stop-shop legal entity registration case. In particular, for each layer we list its constituent sub-categories and concrete standards in each of these:

- *Interconnection (9):* network protocols (IP v4), directory protocols (LDAP v3), file transfer protocols (FTP, HTTP v1.1), mail transfer protocols (SMTP, POP3), network management protocols (SSH), registry services (DNS), and messaging protocols (SOAP v1.2).
- *Security (5):* languages (WSS), network protocols (HTTPS, SSL), mail transfer (S/MIME), and public key infrastructure (RFC2527).
- *Web services (4):* registry services (UDDI v3), description (WSDL, BPEL), and access (SOAP v1.2).
- *Data integration (8):* character sets (ASCII, UTF-8), structured data (XML), data processing (DOM, XSLT, XQuery, SQL), and channel feeds (RSS).
- *Metadata (4):* data modeling (UML, DTD, XMLS, SQL DDL).
- *Information access and presentation (6):* document formats (RTF, PDF), image formats (PNG, JPEG), web content (HTML), and compression (ZIP).

Following the path of eight items marked by numbers in rectangles in Figure 8, suppose there is an initiative in the private sector (item 1) that wants to establish a company, and, hence, it has to undergo through a legal entity registration procedure. This can be fulfilled through one of the delivery channels, such as one-stop-shop (item 2). In order to submit a request for a legal entity registration, the submitting party has to register (item 3) on the government portal (item 4). Once have done this, the electronic legal entity services (item 5) implemented on the portal become available, e.g., the requester can fill out the necessary forms online and download the supporting documentation. In turn,

item 6 provides the interoperability glue at the process, data, and infrastructure levels that is necessary to process the request as required by the government procedures. This includes, for example, querying in a secured way (item 7) the necessary existing systems (item 8) to perform data cross-check and ultimately create a profile for the requested new legal entity.

2.5.3 Key actions: overview

Figure 9 presents a Gantt chart of the key activities. We assume the following time-span and sequencing of activities (the actual implementation of the plan might vary both w.r.t. calendar time and w.r.t. the order in which certain activities can be put):

- Organization Setup: first six months.
- Definition of the architecture and standards: performed by the interoperability organization, with a time-span of a few months to define strategy, guidelines, and standards.
- Development of the interoperability platform and of the interoperability projects: after creation of the organizational structure and with a time-span of one-year and a half.

Support activities run throughout the first three years, including:

- Operations (development and maintenance of the interoperability framework).
- Monitoring and control.
- Systemic support Actions (including dissemination).

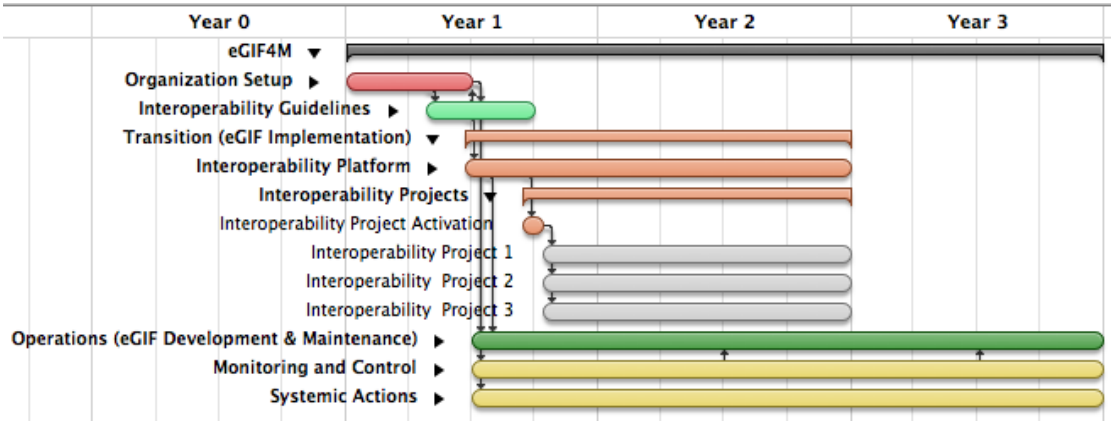

Figure 9. Three year plan: high-level Gantt

2.5.4 Key actions in detail

The plan "translates" the lines of action described above into a set of concrete tasks. Notice that, for the very nature of the initiative, the plan mixes project-related activities (that is, activities that are executed once and for all) and operational activities (that is, activities that will constitute the core duties of the organization in charge of eGIF4M). In the plan we use the labels "OPERATIONS" and "ON A NEED BASIS" to highlight those activities that will help maintain the framework in the long term and that we expect to be delivered multiple times.

Area 1. Setup:

1.1. Organization

1.1.1. Interoperability Team Proposal: proposal of the organizational structure (both the inter-agency and the operational group). Specification of size, duties, processes, budget and interactions with other government agencies. Facilities needed.
Notice that, as a minimum requirement, the interoperability team will be responsible of maintaining lifecycle, standards, IMM, and all the information related to developing the interoperable vision (e.g., ICT system map).

1.1.2. Interoperability Team Build-up: proposal of coordinator and team of the eGIF4M agency. Individuation of facilities. Proposal of the members of the inter-agency coordination team.

1.1.3. Interoperability Team training needs: identification of training needs (if any) and delivery of training.

Interoperability Team: government endorsement. Approval by the Government of deliverables 1.1.1-1.1.3 and activation of the eGIF4M organizational structures.

1.1.4. Interoperability Team Kick-off: appointment of roles and kick-off.

1.2 Dissemination

1.2.1. Website setup and development. The eGIF website (or equivalent repository of information) is the official information center of the interoperability initiative that will be used by all agencies as a reference point for interoperability[5]. The website could contain:

General information: team, activities, status of adoption. Meant for everyone, it is a way of making the information about the team publicly available and for policy makers to get data about progress of the initiative.

Information about process interoperability: list of (interoperable) processes delivered by the Government and reference point (or description and documentation - maybe: events of life). Meant for citizens and government agencies, it is a reliable source of information for service delivery and for process integration.

Information about technical interoperability: minimum documentation standards and technical standards. Meant for government agencies and project managers, it lists the constraints and opportunities new solutions might adhere to.

Dissemination: general information about the project, it is

[5] Other communication means and campaigns will also be needed.

meant to give visibility to the initiative to other Governments, scientists, etc inside and outside Mozambique and foster collaborations, comments, and new opportunities.

1.2.2 Interoperability initiative kick-off event organization. Public or Government event to present to the stakeholders the interoperability team, duties, and plan. *According to funding availability other similar initiatives might as well be considered. The initiative could be held in conjunction with other events.*

Area 2. Guidelines:

2.1 "Push" initiatives. The following activities are meant to define the standardization framework, that is, the standards to adopt, the way in which interoperability shall be achieved, the way in which the agency will work.

The activity can be carried out independently from the current situation. It has to be, of course, subject to a reality check (no sense in setting the "bar" to a position which is unreachable).

2.1.1 eGIF Operational Standards Definition (standards relating to the way in which eGIF is implemented). It includes:

Standards' lifecycle. Definition of the lifecycle of standards (or endorsement of the lifecycle proposed in this document) and approval by the eGIF team and by the inter-agency team.

Interoperability Maturity Model definition. Definition of interopreability maturity model (or endorsement of the one proposed in this document); definition of additional metrics for measuring the progress of the interoperability initiative.

2.1.2 (Technical) Standards Definition

List of technical standards. List of standards of interest. A good starting point might be the list of standards presented in this document.

Definition of the ideal and of the minimum documentation standards for projects/ICT systems. The goal of this activity is defining the minimum set of technical information that has to be provided together with new software systems and the ideal set of documentation The goal is simplifying the achievement of the interoperability goals. Some good starting points for individuating the minimum set of documentation are presented in this document.

2.1.3 Process Definition. These activities include the definition of the way in which the interoperability team operates. It includes at least the specification of the following processes:

Operational standards revision process: definition of the

way in which the eGIF operational standards (the lifecycle and the maturity model) are revised

Standards revision process: definition of the way in which the list of standards is updated. (Both the list of standards and the current positioning in the lifecycle.)

Documentation revision process. The activities of the eGIF are based on some key-documents (such as the Systems' map, the ICT roadmap - see above). This activity has the goal of defining how such documents will be mantained.

IMM data collection and publication process. Definition of the process for the collection of metrics about the development of the interoperability project and the dissemination of results.

2.2 "Pull" initiatives. The following activities refer to tasks meant to collect information about interoperability in the Government and measure the current status of compliance to the interoperability framework. It includes:

List of technical standards currently adopted by agencies. The information integrates and completes the list of technical standards defined above.

Positioning of standards in the lifecycle. The goal is that of understanding the level of adoption of the standards by different agencies.

2.3 Vision Building. This set of activities is meant to provide an accurate view of the "as is" and to define the interoperability roadmap. It includes the following tasks:

2.3.1. Government System Map. Production of the following documents:

2.3.1.1 Government system map (as is). Definition of the system map.

2.3.1.2 Government network infrastructure map (as is) and roadmap (to be). Map of the network infrastructure and roadmap for the development of interoperability.

2.3.1.3 Interoperability Platform Architecture (to be). Definition of the architecture to achieve interoperability (e.g., the one presented in this document).

2.3.2. Government Process Map. Production of the following document:

List of processes/events of life. *The implementation of eGIF4M is based on achieving interoperability at the process level (cfr. citizen-centric government). The list of processes delivered is an important piece of information for drafting the roadmap, for eGIF development, and could also serve as an information point to citizens.*

2.3.3 Systems and Interoperability.

Minimum documentation standards compliance. Collection of information from projects and about ICT systems to verify compliance with the minimum and ideal documentation standards. (Can be "syntactical", e.g., verifying the presence of a document or "semantical", e.g., document inspection.)

Gaps individuation and recovery plan. Based on the information collected above and on the strategic directions defined, definition of the interventions needed in order to fill the "gaps" individuated above. The output is a plan to achieve the minimum set of documentation standards needed to start the "Transition" phase.

Area 3. Transition. This set of activities is meant to enable interoperability at a technical level. It includes the following activities:

3.1 Interoperability Strategy Roadmap (to be). Definition of the roadmap for achieving interoperability. It includes the validation of the approach chosen by the interoperability team, the definition of the priorities, and the definition/refinement of the transition plan. The output is a plan that outlines: the architecture chosen for interoperability, the list of the first processes on which to introduce interoperability, the priorities, and the systems to operate on.

Integration Strategy: government endorsement. Approval by the Government of the interoperability strategy roadmap.

3.2 Integration platform development. Development of the interoperability platform. The activities under the responsibility of the eGIF team might range supervising acquisition of an existing solution or monitoring an external development project to full system development.

3.3 Interoperability Project Activation. In parallel to the implementation of the interoperability platform, activation of the interoperability projects individuated in 3.1.

Projects might have three different goals, presented in order of relevance: delivery of a citizen-centric service (that might include the integration of ICT systems in the interoperability platform); re-factoring of existing systems, to take advantage of the interoperability platform (e.g., to share information); integration of systems with the interoperability platform (to anticipate possible integration needs).

Each project, thus, might contain the following activities:

- Definition of the AS IS: process modeling and system map (taken from 2.3.1).
- Definition of the TO BE: process modeling and list of gaps (specific interventions on the ICT systems that support the processes.
- Delivery plan: plan to deliver the modification to the ICT systems
- ICT system update (implementation of the required interfaces to the Government Bus)

- ICT system implementation (if new systems are necessary for the development of the new processes)
- Implementation of the TO BE (changes to laws, if required to activate the new processes, training, …)
- Experimentation and monitoring of the new solution
- Corrective action definition

3.4 [OPERATIONS] Integration roadmap update. Update of the roadmap, according to actual plan execution.

Area 4. Operations. Tasks performed by the eGIF Team to maintain the interoperability framework and vision in the longer term. It includes cyclical activities, typically repeated on a yearly basis:

4.1 Communication

[OPERATIONS] **4.1.1 Website update.** Regular update of the information on the website.

[OPERATIONS] **4.1.2 Interoperability initiative annual event.** Workshop to present the status of the project, difficulties and opportunities and to present the plan for the coming year. (*According to funding availability other similar initiatives might as well be considered. The initiative could be held in conjunction with other events.)*

4.2 Integration with new Projects

[ON A NEED BASIS] In parallel to the start of new ICT initiatives, support to project managers of the new initiatives in setting the interoperability goals for new systems.

This activity is essential to build new solutions that adhere and exploit, from the beginning, the interoperability platform.

4.3 Efficiency and Efficacy:

[ON A NEED BASIS] Revision of the standards' lifecycle, IMM, and procedures, to simplify or improve the process.

4.4. Standards maintenance:

[OPERATIONS] **4.4.1 Regular update of the standards in use**

[OPERATIONS/ON A NEED BASIS] **4.4.2 Update of the information set:** processes, ICT map, network map

4.5 Monitoring and Control

[OPERATIONS] IMM data collection. Collection of data about IMM compliance.

[OPERATIONS] eGIF development monitoring. eGIF development plan monitoring.

[OPERATIONS] eGIF annual report. Production of the data and information related to the development of the interoperability project.

Area 5. Systemic Actions

[OPERATIONS] Integration with University. It might include: strategic plans, teaching, training, support to mobility, and support to stages.

[OPERATIONS] Integration with living labs. It might include: strategic plans, collaboration on projects, stages, and training.

[OPERATIONS] Continuous training. Training of the resources of the eGIF initiative to keep them up to date with international developments.

Figure 10 summarizes in a Gantt chart the above mentioned activities.

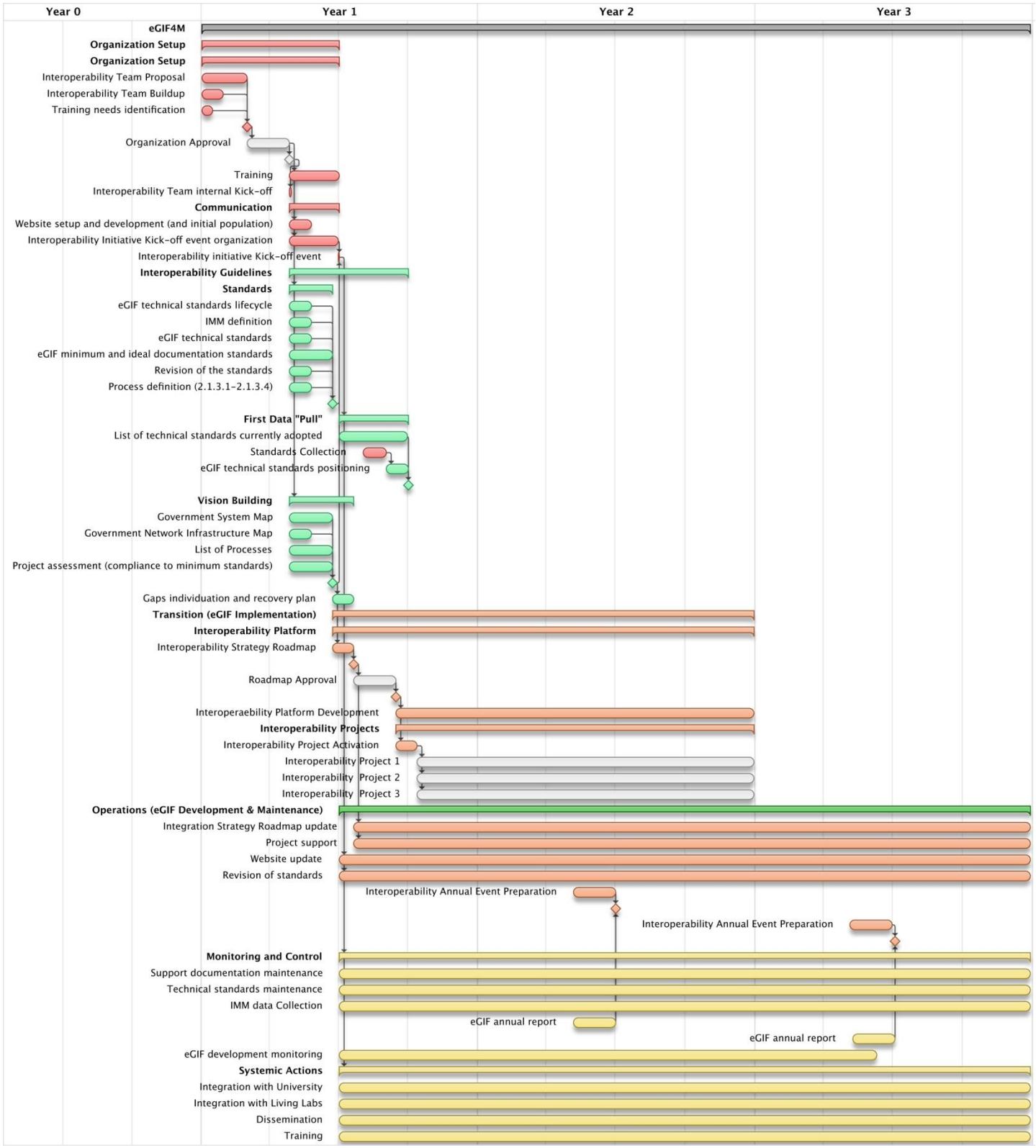

Figure 10. Three year plan: detailed Gantt.

2.5.5 Resources

In this section we provide the resource estimation for the eGIF4M initiative. It is expressed in terms of effort and only for the agency that will coordinate the initiative. Budgeting the initiative in terms of money is, in fact, rather tricky, for the following reasons:

- Cost of profiles. The budgeted cost of various actions depends upon the tariffs of the profiles needed to carry the activity out. These might in turn be subject to Government limitations, local market, etc.
- "Absorbable" costs. Public servants already employed in the Public Administration could carry out some activities of the plan. The effort spent by these profiles in the interoperability effort is, of course, a cost, which however, might not change the budget needs of the Government.
- Plan variability and implementation constraints.
    - The plan can be implemented with different courses of actions (e.g., the policy to implement the interoperability platform - make or buy). Such courses of action have to be chosen and taken by the Government and the Government agencies responsible of carrying the plan out. As such they cannot be anticipated.
    - We can make hypotheses, e.g., on various "periodical" actions, such as the number of meetings needed by the interoperability inter-agency group. Such hypotheses, however, need to be substantiated by the people actually carrying the project out, and depend upon the level of agreement and commitment, project risks, etc., which are quite difficult to anticipate.
    - We can make hypotheses on number of interoperability projects that will be activated in parallel. However, such data depends upon external conditions and factors.

The estimation of the effort has been carried out through a bottom-up analysis of the activities and an estimation of the stakeholders of the effort needed.

We organize the effort for the initiative in two different types of activities: project activities (that need to be carried out once and for all) and regular activities, which need to be carried out periodically, see Table 2. Refer to the list of activities (previous section) to determine which ones are one-shot and which ones are periodical.

The effort refers to the first three years of the project, with the effort raising after months six of the project and peaking at about mid term (first half of year two).

Table 2: The effort estimate.

Type of Activity	**Effort**
Project activity	About 40 man-months
Periodical activities	About 40 man-months per year, in the hypothesis of three/four interoperability project running in parallel (and not including transversal activities, such as training and support to the development of the integration platform)

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Appendices

Below we provide the list of appendices, namely:

- Appendix 1: Interoperability definitions.
- Appendix 2: Stakeholders.
- Appendix 3: Methodology.
- Appendix 4. People interviewed.
- Appendix 5: eGIFs in the world.
- Appendix 6: Standardization bodies.
- Appendix 7: eGIF and Open standards.
- Appendix 8: Reference architectures.
- Appendix 9: eGIF standards.
- Appendix 10: Project Management: PMBOK.

Appendix 1: Interoperability definitions

Below we provide some other definitions for interoperability, in particular, that focus on the technical view point, such as:

- *interoperability is the capability of systems to communicate with one another and to exchange and use information including content, format, and semantics*[6];
- *interoperability is the ability of two or more systems or components to exchange data and use information*[7]*;*

and more in line with that of other eGIF initiatives, such as that of the Government of New Zealand:

- *Interoperability is the ability of government organisations to share information and integrate information and business processes by use of common standards. Government adopting and using common standards to ensure agencies and their partners can work together, and users can access government services and information* [13].

[6] See National Institute of Standards and Technology, 1996
[7] See IEEE STD 610.12.

Appendix 2: Stakeholders

Table 3 provides a list of the stakeholders and some expected benefits of the eGIF4M initiative.

Table 3. eGIF4M Stakeholders.

Stakeholders	Expected benefits
Government	Interoperability simplifies communication and exchange of information among different Government bodies, reduces development costs by promoting standards (and avoiding to "re-invent the wheel"), reduces operational costs by focusing on few key technologies, simplifies digital preservation of data, and favors the implementation of solutions in which data are not uselessly replicated, leading to more accuracy and more integrated views.
Policy makers/ Mozambique	Interoperability increases the availability and the accuracy of information and therefore it is a key-enabler for faster and sounder policy making. Availability and accuracy of data may also be lead to better accountability.
Private sector	Interoperability simplifies procedures and interactions with Businesses, increasing their competitiveness. Moreover, the adoption of standards simplifies the electronic exchange of information with Government and, in the longer term, the development of B2G solutions. The adoption of open standards and reference architectures allows small and medium enterprises to take part in the development of systems for the Government, thus favoring local development. Finally, the know-how and experience of the Government in the adoption of key-technologies might eventually lead to the adoption of the standards by local enterprises, thus favoring B2B solutions.
Citizens	The adoption of standards is a key enabler for the simplification of procedures, and the implementation of e-Government services, thus reducing the time it takes for services to be delivered, increasing transparency, and reducing costs.
Mozambique/ Other Governments	Interoperability can also be seen a first step towards inter-government interoperability (see [UNDP]), that can help create the infrastructure necessary to solve cross-border problems, such as illegal trading and could also help simplify the delivery of services to citizens and businesses across the regions and facilitate trade between countries.

Appendix 3: Methodology

Below we outline the methodology used to produce this document. It included the following steps:

1. Analysis of the eGIF initiatives in the rest of the world. The goal of this activity has been that of collecting the best practices and experiences related to the adoption of eGIF in other countries. As pointed out in other parts of this document, this activity has helped outline part of the actions proposed in eGIF4M.
2. Analysis of the state of the art in Mozambique. The goal of this activity has been that of understanding the state of development of eGovernment applications in Mozambique and the main needs perceived by key stakeholders, through interviews and the analysis of documentation.

   Stakeholders include representatives of the Public Administration involved in the implementation of the e-Government and PSR strategic plans, representatives of the Public Administration whose organizations are currently adopting or experimenting new ICT systems in Mozambique, project managers and other key-actors involved in the deployment of ICT solutions, and some representatives of the private sector.
3. Definition of the interoperability requirements. Based on the information gathered at the previous two steps, we individuated some key requirements, various enabling factors, and some key-areas for interoperability.
4. Dissemination and feedback gathering: presentations to key stakeholders and dissemination events have been organized to create a shared and common view on the eGIF4M initiative. This has allowed to gather and to incorporate feedback on the approach and on the key-areas, while, at the same time to help further improve the environment in which interoperability will have to be introduced and experimented.

Appendix 4: People Interviewed

Table 4 provides the list of the people interviewed for the drafting of this document

Table 4. People interviewed.

Ministry of Transport and Communications	Adilson dos Santos Cousin Gomes	IT Department Manager
Ministry of Health	Admir Cambaco	IT Technician
CI	Alberto Bortolan	Head of CI
Public Sector Reform Technical Unit	Alberto Santos Capece	
Public Sector Reform Technical Unit	Alberto Santos Capece	IT Professional
Immigration	Alcândra de Sousa	IT Technician
Cenacarta	Almeirim Carvalho	Deputy National Director
Ministry of State Administration	Arménio Correia	Press & comunication advisor to the Minister of State Administration
Ministry of Home Affairs	Assane Miquidade	IT Department Manager
UTICT	Bicael Francisco	GovNet Team
IA	Carlo lo Cascio	Ambassador
Ministry of Planning and Development	Catija Abdula	IT Professional
UTICT	Flávio Almeida	GovNet Team
UTICT	Heitor Ferreira	GovNet Team
UTICT	Ivone Joaquim	GovNet Team
UTRAFE	Jacinto Muchine	Project manager
UTICT	Joaquim Dindiza	GovNet Team
DINATEF	Joaquim Macuácua	Geoinformatics Professional
ID factory	Jofane	Manager
Ministry of Finance	Jorge Chicamba	Chief Information Security Officer
Ministry of Health	Jorge F. Manuel Tomo	Permanent Secretary
UTRAFE	Jose Murta	Technical advisor

Ministry of Science and Technology	Jussi Hinkkanen	Advisor to the Ministry of Science and Technology
Ministry of Industry and Trade	Laisse Mucavele	IT Department Manager
CI	Laura Virgili	Project Manager at CI
UTICT	Lourino Chemane	Chief Technical Adviser
UTICT	Luís Canhemba	Content Manager for Government Portal
Tribunal Administrativo	Patrício Sande	ICT Adviser of the President of the Tribunal Administrativo
Immigration	Paulino	Manager
TDM	Pedro Wiliamo Matusse	
DINATEF	Raimundo Cossa	National Director
Ministry of Justice	Sérgio Cambaza	IT Department
UTICT	Sérgio Guivala	Security Administrator for GovNet
UTICT	Sérgio Mapsanganhe	System Administrator for GovNet, GovNet Team
Cenacarta	Simão Pedro	Head, Cartography & Remote Sensing Dep
UTICT	Simeão Cambaco	E-Government Specialist
Barclays Bank	Stelios Papadakis	Head of IT
ID factory	Suzete	IT Technician
UTICT	Teotónio Fumo	ICT Specialist

Appendix 5: eGIFs in the world

Table 5 lists the most salient eGIFs in various countries. Some other examples of the eGIFs non considered here include: India, Mauritius, Philippines, Saudi Arabia, Sri Lanka, and Thailand.

Table 5. The most salient eGIFs in various countries.

Country	GIF name and URL	Last version and release date
Australia	Australian Government Technical Interoperability Framework (AGTIF) http://www.finance.gov.au/publications/australian-government-technical-interoperability-framework/index.html	July 2005, v2
Brazil	Standards of Interoperability for Electronic Government (e-PING) https://www.governoeletronico.gov.br/acoes-e-projetos/anexos/E15_677e-PING_v2.0.1_05_12_06_english.pdf	December 2006, v2.01
Denmark	Danish e-Government Interoperability Framework (DIF) http://www.interoperabilityframework.info/Changelog.html	June 2005, v1.2.14
Estonia	Estonian Interoperability Framework http://www.riso.ee/en/information-policy/interoperability	May 2006, v2
EU	European Interoperability Framework for Pan-European e-Government Services (EIF) http://ec.europa.eu/idabc/servlets/Doc?id=19529	2004, v1
Germany	Standards and Architecture for e-Government Applications (SAGA) http://www.apdip.net/projects/gif/country/GE-GIF.pdf	October 2006, v3
Ghana	e-Government Interoperability Framework Policy (Draft) http://www.moc.gov.gh/moc/files/E-GIF/Ghana%20e-GIF%20Policy.pdf	February 2006, v.1
Hong Kong	Hong Kong Special Administrative Region Interoperability Framework http://www.ogcio.gov.hk/eng/infra/download/if_analysis.pdf	December 2006, v6
Malaysia	Malaysian Government Interoperability Framework (MyGIF) http://www.mampu.gov.my/mampu/bm/program/ICT/ISPlan/ispdoc/Interoperability%20Framework.pdf	August 2003, v1
South Africa	MINIMUM INTEROPERABILITY STANDARDS (MIOS) for Information Systems in Government http://www.i-gov.org/images/articles/4760/MIOS_V4.1_final.pdf	September 2007, v4.1
New Zealand	New Zealand e-Government Interoperability Framework (NZ e-GIF) http://www.e.govt.nz/standards/e-gif/e-gif-v-3/e-gif-v-3-total.pdf	February 2008, v3.3
UK	United Kingdom e-Government Interoperability Framework (UK e-GIF) http://www.govtalk.gov.uk/documents/eGIF%20v6_1%281%29.pdf	March 2005, v6.1

USA	FEA Consolidated Reference Model Document http://www.whitehouse.gov/omb/egov/documents/FEA_CRM_v22_Final_July_2007.pdf	July 2007, v2.2

Appendix 6: Standardization bodies

Several international standard bodies promote interoperability of products and services for different ICT technologies. The main standard bodies relevant for eGIF4M are:

1. IEEE – http://www.ieee.org

   The Institute of Electrical and Electronics Engineers, Inc. (IEEE, pronounced Eye-triple-E) is a non-profit, technical professional association of more than 380,000 individual members in 150 countries.

   Through its members, the IEEE is a leading authority in technical areas ranging from computer engineering, biomedical technology and telecommunications, to electric power, aerospace and consumer electronics, among others. Although being not a formal standard organization, the IEEE sponsors consensus-based standardization activities which have led to the development of nearly 900 active standards with 700 more under way.

2. IETF - http://www.ietf.org

   The Internet Engineering Task Force is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual.

   The actual technical work of the IETF is done in its working groups, which are organized by topic into several areas (e.g., routing, transport, security). Much of the work is handled via mailing lists. The IETF holds meetings three times per year.

3. ETSI - http://www.etsi.org

   ETSI (the European Telecommunications Standards Institute), formed in 1988 by the Commission of the European Communities, is a non-profit organization whose mission is to produce the telecommunications standards that will be used for decades to come throughout Europe and beyond. Based in Sophia-Antipolis (south of France), ETSI unites 786 members from 56 countries inside and outside Europe, and represents administrations, network operators, manufacturers, service providers, research bodies and users. The Institute's work programme is determined by its members, who are also responsible for approving its deliverables. As a result, ETSI's activities are maintained in close alignment with the market needs expressed by its members.

4. ISO/IEC - http://www.iso.org

   The International Standards Organization is the source of ISO 9000 and more than 14,000 International Standards for business, government and society.

   ISO is a network of national standards institutes from 147 countries working in partnership with international organizations, governments, industry, business and consumer representatives. A bridge between public and private sectors.

5. ITU-T - http://www.itu.int/net/home/index.aspx

   The International Telecommunications Union (ITU) is a treaty organization of the United Nations which has as members each country on the planet. It is also the oldest telecommunication standards organization, dating back to 1865. The standards work in the ITU is divided into two sections, ITU-Telecommunications (ITU-T) and ITU-Radiocommunications (ITU-R). Each section is organized into Study Groups. Study Groups are divided into Working Parties, and then further divided into Questions. The work in a Question is led by a Rapporteur.

6. W3C - http://www.w3.org

   The World Wide Web Consortium (W3C) "develops interoperable technologies (specifications, guidelines, software, and tools) in order to lead the Web to its full potential as a forum for information, commerce, communication, and collective understanding".

7. Free Software Foundation (FSF) - http://www.fsf.org

   (From their website) The Free Software Foundation (FSF) is a 501(c)3 donor supported charity founded in 1985 and based in Boston, MA, USA. The FSF has a worldwide mission to promote computer user freedom and to defend the rights of all free software users. The FSF has various initiatives related to making software free. We mention the GNU (Gnu is Not Unix) project, that has the goal of building a complete unix-like operating system and that has delivered, over the years, various open systems used in production environments.

8. Open Source Initiative (OSI) - http://www.opensource.org

   The Open Source Initiative (OSI) is a California public benefit corporation founded in 1998. The OSI are the stewards of the Open Source Definition (OSD) and the community-recognized body for reviewing and approving licenses as OSD-conformant. It is the reference point for open source licenses for software. It has some initiatives related to defining open licenses for standards

Appendix 7: eGIF and Open standards

Interoperability is often connected to the concept of "*open* standard" Quoting Wikipedia:

> *"an open standard is a standard [that is] publicly available and has various rights to use associated with it. The terms "open" and "standard" have a wide range of meanings associated with their usage. The term "open" is usually restricted to royalty-free technologies while the term "standard" is sometimes restricted to technologies approved by formalized committees that are open to participation by all interested parties and operate on a consensus basis."*

According Bruce Perens the main advantages of an open standard are:

- Maximize end-user choice: open standards create a fair, competitive market and do not lock the customer into a particular vendor or group.
- No royalty: open standards are free for all to implement, with no royalty or fee. (Although certification of compliance by the standards organization may involve a fee.)
- Availability: open standards are available for all to read and implement.
- No discrimination: open standards do not favor one implementer over another for any reason other than the technical standards compliance of a vendor's implementation.

The advantages described by Perens or, at least, the strategic role ofopen standards, have been recognized by various governments in their eGIF documents [3,4,5,6]:

> *"Except for the UK, open standards are directly referred to in all of the GIFs studied. Further, Australia, Germany, Malaysia and New Zealand explicitly state their preference for the use of open standards over proprietary technologies. In the case of the UK, the GIF referred to international standards (some of which are open standards)."*

This work is no different and it strongly favors the adoption of open standards. On top of the reasons mentioned above, we mention also that open standards are often associated to the concept of free software, a phenomenon started in the eighties by Richard Stallman and the "GNU software foundation" with the goal of developing completely free Unix-like operating systems.

Various meanings have been given to the concept of "free". Suffice here saying that, over the years, the initial concept of "free" as in "freedom to copy, change, and improve a software" (as stated in the GNU software license), has been modified to include both more restrictive and more liberal distribution policies

and uses – such as "free of charge", "free to do anything – including freedom of making modifications proprietary"[8].

Several widely used applications (e.g., Apache, Linux, sendmail, MySQL, gcc, OpenOffice) are distributed under a license that allows free use (e.g., no fees) and, in most cases, free access to the source code.

In the last few years, open source software has obtained the attention of various Public Administrations for the following reasons:

- Availability and adoption costs. Installing a copy of a free software is, by definition … free. The switch to free software, however, might have "hidden" costs, such as, for instance, training, support, and migration of the existing data. Thus, even though the TCO (Total Cost of Ownership), rather than the cost of a new license, is a more accurate measure of the costs associated to adopting a software system, there are various applications and various scenarios in which the adoption of free software might be convenient (e.g., when the costs of training is not significant or is equivalent to that of the competing commercial application).
- Local development. The adoption of open software eliminates some "monopolistic" barriers and allows small and medium enterprises to compete with larger companies to develop, deploy, and support solutions for the Government.
- Neutrality. With the adoption of open source software, the Government does not depend upon a specific vendor or provider for the delivery of its services.

As a result various Public Administrations have partially or completely switched to open source and/or have regulated or promoted the adoption of free over proprietary software, either server-side or client-side. We mention: the Municipality of Münich (Germany) - the largest example in Europe, the Municipality of Wien (Austria), 60 municipalities in the Autonomous Province of Bolzano (Italy), the French Gendarmerie, the French Parliament, Central Scotland Police, Estremadura region in Spain. Italy has a directive related to open-source and an "observatory" related to the adoption of open source[9]. South Africa has an observatory related to open-soruce[10].

[8] See, e.g., the Apache License, the GNU Lesser General Public License, the MIT License. The website http://www.opensource.org provides a list of all the "Open Source Initiative" approved open source licenses.
[9] http://www.osspa.cnipa.it
[10] http://www.oss.gov.za

Appendix 8: Reference architectures

eGovernment interoperability can be achieved via reference architectures and standards [7,9,10].

Service-oriented architecture (SOA) is usually indicated as a reference architecture [9,10]. It describes a set of well-established patterns that help a client application connect to a service. These patterns represent mechanisms used to describe a service, to advertise and discover a service, and to communicate with a service. Most communication middleware systems, such as RPC, CORBA, DCOM, and RMI, rely on these SOA patterns [7,9]. SOA is certainly a good indication to pursue in an eGIF, however, it does not cover all the necessary aspects, and, hence, some other architectures have to be considered as well, see below. Table 6 summarizes the key SOA characteristics [29].

Table 6. Fundamental SOA characteristics.

Capability	Description
Loosely coupled interactions	Services are invoked independently of their technology and location
One-to-one communications	One specific service is invoked by one consumer at a time. The communications are bidirectional.
Consumer based trigger	The flow of control is initiated by the client (the service consumer)
Synchronous	Replies are sent back to the customer in a synchronous way

Event-Driven Architecture (EDA) defines a methodology for designing and implementing applications and systems in which events are transmitted between decoupled software components and services [29]. EDA does not replace, but rather, complements SOA, e.g., while SOA is generally a better fit for a request/response exchange, EDA introduces long-running asynchronous process capabilities. Table 7summarizes the key SOA characteristics.

Table 7. Fundamental EDA characteristics.

Capability	Description
Decoupled interactions	Event publishers are not aware of the existence of event subscribers
Many-to-many communications	Publish/subscribe messaging where one specific event cannot impact many subscribers
Event based trigger	Flow of control that is determined by the recipient, based on an event posted
Asynchronous	Supports asynchronous operations through event messaging

Government Service Bus (GSB) combines EDA and SOA approaches to simplify integration of heterogeneous platforms and environments, similarly [29]. The GSB acts as an intermediary layer to enable communication between different

application processes. A service deployed on a GSB can be triggered by a consumer or an event. It supports synchronous and asynchronous, facilitating interactions between one or many stakeholders, one-to-one or many-to-many communications, thus providing the capabilities of both SOA and EDA paradigms. Therefore, we believe that eGIFs have to be further extended by using GSBs, as for example in eGIF4M.

Appendix 9: eGIF standards

9.1 NETWORKS AND INFRASTRUCTURES

9.1.1 INTERCONNECTION

9.1.1.1 Network protocols

Name:	**IP v4 - Internet Protocol Version**
Status:	Current
Comments:	for migration to IP v6. New hardware should support IP v4 as well as IP v6.
URL:	http://www.ietf.org/rfc/rfc0791.txt

Name:	**IP v6 - Internet Protocol Version 6**
Status:	Future
Comments:	When implementing IP v6, configure routers to “ghost” IP v4
URL:	http://www.ietf.org/rfc/rfc2460.txt

Name:	**IEEE 802.11 - WLAN**
Status:	Current
Comments:	IEEE 802.11 is a set of standards for wireless local area network (WLAN) computer communication, developed by the IEEE LAN/MAN Standards Committee (IEEE 802) in the 5 GHz and 2.4 GHz public spectrum bands. It includes: – 802.11-1997 (802.11 legacy) - original version of the standard IEEE 802.11 was released in 1997 and clarified in 1999, but is today obsolete. – 802.11a - uses the same data link layer protocol and frame format as the original standard, but an OFDM based air interface (physical layer). It operates in the 5 GHz band with a maximum net data rate of 54 Mbit/s, plus error correction code, which yields realistic net achievable throughput in the mid-20 Mbit/s – 802.11b - has a maximum raw data rate of 11 Mbit/s and uses the same media access method defined in the original standard. The dramatic increase in throughput of 802.11b (compared to the original standard) along with simultaneous substantial price reductions led to the rapid acceptance of 802.11b as the definitive wireless LAN technology. – 802.11g - works in the 2.4 GHz band (like 802.11b), but uses the same OFDM based transmission scheme as 802.11a. It operates at a maximum physical layer bit rate of 54 Mbit/s exclusive of forward error correction codes, or about 19 Mbit/s average throughout. 802.11g hardware is fully backwards compatible with 802.11b hardware and therfore is encumbered with legacy issues that reduce throughput when compared to 802.11a by ~21%.
URL:	IEEE 802.11 working group

Name:	**IEEE 802.16 - WiMax**
Status:	Future

Comments:	WiMAX, meaning Worldwide Inter-operability for Microwave Access, is a telecommunications technology that provides wireless transmission of data using a variety of transmission modes, from point-to-multipoint links to portable and fully mobile internet access. The technology provides up to 72 Mbit/s symmetric broadband speed without the need for cables. The technology is based on the IEEE 802.16 standard (also called Broadband Wireless Access).
URL:	http://www.ieee802.org/ http://www.wimaxforum.org/

9.1.1.2 Directory protocols

Name:	**LDAP v3 - Lightweight Directory Access Protocol Version 3**
Status:	Current
Comments:	For access to directory services
URL:	http://www.ietf.org/rfc/rfc1777.txt

9.1.1.3 File transfer protocols

Name:	**FTP - File Transfer Protocol**
Status:	Current
Comments:	Please note that secure file transfer protocols (such as Secure Copy and SSH File Transfer Protocol) are under review. Use restart and recovery. Also FTP security extensions and FTP via Port 80 where applicable.
URL:	http://www.ietf.org/rfc/rfc0959.txt

Name:	**HTTP v1.1 - HyperText Transfer Protocol Version 1.1**
Status:	Current
Comments:	Application level protocol. See for secure HTTP (HTTPS) and TLS usage.
URL:	http://www.ietf.org/rfc/rfc2616.txt

Name:	**WebDAV - World Wide Web Distributed Authoring and Versioning**
Status:	Current
Comments:	A set of extensions to HTTP v1.1 that allows users to collaboratively edit and manage files remotely but avoids access problems with NAT firewalls.
URL:	http://www.ietf.org/rfc/rfc2518.txt

Name:	**Session Control Protocol**
Status:	Future
Comments:	SCP is a simple protocol, which lets a server and client have multiple conversations over a single TCP connection. The protocol is designed to be simple to implement, and is modelled after TCP.
URL:	http://www.w3.org/Protocols/HTTP-NG/http-ng-scp.html

Name:	Secure Copy Protocol
Status:	Current
Comments:	Secure Copy or SCP is a means of securely transferring computer files between a local and a remote host or between two remote hosts, using the Secure Shell (SSH) protocol.
URL:	http://en.wikipedia.org/wiki/Secure_Copy_Protocol

9.1.1.4 Mail transfer protocols

Name:	SMTP - Simple Mail Transfer Protocol
Status:	Current
Comments:	SMTP is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks. SMTP was first defined in RFC 821 (STD 10), and last updated by RFC 5321 (2008), which describes the protocol in widespread use today, also known as extended SMTP (ESMTP).
URL:	http://www.ietf.org/rfc/rfc5321.txt

Name:	POP3 - Post Office Protocol version 3
Status:	Current
Comments:	POP3 is an application-layer Internet standard protocol used by local e-mail clients to retrieve e-mail from a remote server over a TCP/IP connection. The design of POP3 and its procedures supports end-users with intermittent connections (such as dial-up connections),
URL:	http://www.ietf.org/rfc/rfc1939.txt

Name:	IMAP- Internet Message Access Protocol
Status:	Current
Comments:	IMAP is one of the two most prevalent Internet standard protocols for e-mail retrieval. It is an application layer Internet protocol operating on port 143 that allows a local client to access e-mail on a remote server. The current version, IMAP version 4 revision 1 (IMAP4rev1), is defined by RFC 3501. IMAP supports both connected (online) and disconnected (offline) modes of operation. E-mail clients using IMAP generally leave messages on the server until the user explicitly deletes them.
URL:	http://www.ietf.org/rfc/rfc3501.txt

Name:	X.400-
Status:	Current
Comments:	X.400 is a suite of ITU-T Recommendations that define standards for E-mail that has seen use within organizations, and as part of proprietary e-mail products such as Microsoft Exchange. Although X.400 was originally designed to run over the OSI Transport service, an adaptation to allow operation over TCP/IP, RFC 1006, has become the most popular way to run X.400.
URL:	ITU-T Rec. F.400/X.400 |ISO/IEC 10021-1 Message handling system and service overview

9.1.1.5 Network Management Protocols

Name:	SNMP – Simple Network Management Protocol

Status:	Current
Comments:	Simple Network Management Protocol (SNMP) is used in network management systems to monitor network-attached devices for conditions that warrant administrative attention. SNMP is a component of the Internet Protocol Suite as defined by the Internet Engineering Task Force (IETF). It consists of a set of standards for network management, including an application layer protocol, a database schema, and a set of data objects.
URL:	http://tools.ietf.org/html/rfc3411

Name:	**Telnet –Terminal Emulation**
Status:	Current
Comments:	Telnet (Telecommunication network) is a network protocol used on the Internet or local area network (LAN) connections. It was developed in 1969 beginning with RFC 15 and standardized as IETF STD 8, one of the first Internet standards. Typically, Telnet provides access to a command-line interface on a remote machine.
URL:	http://tools.ietf.org/html/rfc854 http://www.iana.org/assignments/telnet-options

Name:	**SSH – Secure SHell**
Status:	Current
Comments:	Secure Shell or SSH is a network protocol that allows data to be exchanged using a secure channel between two networked devices. Used primarily on Linux and Unix based systems to access shell accounts, SSH was designed as a replacement for TELNET and other insecure remote shells, which send information, notably passwords, in plaintext, leaving them open for interception. The encryption used by SSH provides confidentiality and integrity of data over an insecure network, such as the Internet.
URL:	http://tools.ietf.org/html/rfc4252 http://www.dmoz.org/Computers/Internet/Protocols/SSH/

9.1.1.6 Registry services

Name:	**DNS - Domain Name Server**
Status:	Current
Comments:	Use DNS for Internet/Intranet domain to IP address resolution. DNS Security is critical
URL:	http://www.ietf.org/rfc/rfc1035.txt

9.1.1.7 Time protocols

Name:	**NTP v4 - Network Time Protocol Version 4**
Status:	Future
Comments:	De facto standard proposed for use in an all-of-government time standard. Best practice guidelines are available.
URL:	http://www.ntp.org/

Name:	UTC (MSL) - Universal Time Clock (Measurement Standards Laboratory)
Status:	Future
Comments:	De facto standard (accessed from Industrial Research Limited, MSL); proposed for use in an all-of-government time standard. Best practice guidelines are available.
URL:	http://www.irl.cri.nz/msl/services/time/

9.1.1.8 Messaging protocols

Name:	MIME - Multi-Purpose Internet Mail Extension
Status:	Current
Comments:	See also S/MIME and Security layer for secure mail attachments. Do not use Transport Neutral Encapsulation Formats (TNEF) for headers.
URL:	http://www.ietf.org/rfc/rfc2049.txt

Name:	SOAP v1.2 - Simple Object Access Protocol
Status:	Current
Comments:	Lightweight protocol intended for exchanging structured information in a decentralised, distributed environment.
URL:	http://www.w3.org/TR/2007/REC-soap12-part1-20070427/

Name:	XMPP Extensible Messaging and Presence Protocol
Status:	Future
Comments:	XML protocol for real-time messaging. Taken from UK Technical Standards Catalogue Version 6.2.
URL:	http://www.ietf.org/rfc/rfc3920.txt

9.1.1.9 Voice Over Internet Protocols (VOIP)

Name:	SIP Session Initiation Protocol
Status:	Future
Comments:	A protocol for initiating, modifying, and terminating an interactive user session that involves multimedia elements such as video, voice and instant messaging. Has greater take-up than H.323. Taken from UK Technical Standards Catalogue Version 6.2. Codec required.
URL:	http://www.ietf.org/rfc/rfc3261.txt

Name:	RTP Real-time Transport Protocol
Status:	Future
Comments:	Defines a standardised packet format for delivering audio and video over the Internet and is frequently used in conjunction with RTSP, H.323 or SIP.
URL:	http://www.ietf.org/rfc/rfc3550.txt

Name:	H.323 v2 H.323 Version 2
Status:	Future
Comments:	An umbrella recommendation from the ITU-T, which defines the protocols to provide audiovisual communication sessions on any packet network. Taken from UK Technical Standards Catalogue Version 6.2. Codec required.
URL:	http://en.wikipedia.org/wiki/H323

Name:	G.711
Status:	Future
Comments:	ITU-T standard for audio companding; primarily used in telephony.
URL:	http://en.wikipedia.org/wiki/G729

Name:	G.729
Status:	Future
Comments:	An audio codec for voice that compresses voice audio in chunks of 10 milliseconds; is mostly used in VOIP applications for its low bandwidth requirement.
URL:	http://en.wikipedia.org/wiki/G729

Name:	IAX – Inter Asterisk eXchange
Status:	Future
Comments:	IAX is the Inter-Asterisk eXchange protocol native to Asterisk PBX and supported by a number of other softswitches and PBXs. It is used to enable VoIP connections between servers as well as client-server communication. IAX now most commonly refers to IAX2, the second version of the IAX protocol. The original IAX protocol has been deprecated in favor of IAX2. The IAX2 protocol was published as an informational (non-standards-track) RFC 5456 by discretion of the RFC Editor in February 2009.
URL:	http://www.rfc-editor.org/authors/rfc5456.txt http://www.icesi.edu.co/blogs_estudiantes/asterisk/

9.1.2 SECURITY

9.1.2.1 Languages

Name:	WSS - Web Services Security
Status:	Current
Comments:	A technical foundation for implementing security functions such as integrity and confidentiality in messages implementing higher-level Web services applications
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wss

Name:	WS-Security policy - Web Services Security Policy Language

Status:	Current
Comments:	This specification indicates the policy assertions that apply to Web Services Security: SOAP Message Security, WS-Trust, and WS-Secure Conversation.
URL:	http://specs.xmlsoap.org/ws/2005/07/securitypolicy/ws-securitypolicy.pdf

Name:	**WS-Trust Web Services Trust Language**
Status:	Future
Comments:	Uses the secure messaging mechanisms of WS-Security to define additional primitives and extensions for security token exchange to enable the issuance and dissemination of credentials within different trust domains.
URL:	http://www-128.ibm.com/developerworks/library/specification/ws-trust/

Name:	**WS-Secon** - Web Services Secure Conversation Language
Status:	Future
Comments:	The Web Services Secure Conversation Language (WS-SecureConversation) is built on top of the WS-Security and WS-Policy models to provide secure communication between services.
URL:	http://www-128.ibm.com/developerworks/library/specification/ws-secon/

Name:	**SAML v1.1 - Security Assertion Markup Language Version 1.0**
Status:	Future
Comments:	Secure messaging and security token framework. See Access and Presentation layer. OpenSAML is an implementation of SAML.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=security

Name:	**SAML v2.0 - Security Assertion Markup Language Version 2.0**
Status:	Future
Comments:	Secure messaging and security token framework. A subset of SAML 1.1, elements are Under Development as part of the All-of-government Authentication project. See Access and Presentation layer. OpenSAML is an implementation of SAML.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=security

Name:	**xACML v2.0 - Extensible Access Control Markup Language Version 2.0**
Status:	Future
Comments:	XML Schema for creating policies and automating their use to control access to disparate devices and applications on a network.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=xacml

Name:	**Liberty ID-WSF v2.0 Liberty Alliance ID-WSF 2.0**

Status:	Future
Comments:	For consideration where app-to-app federated identity required and SAML V2.0 profiles not sufficient.
URL:	http://www.projectliberty.org/resources/specifications.php

Name:	**XML - Enc XML-Encryption syntax and processing**
Status:	Current
Comments:	Taken from UK Technical Standards Catalogue Version 6.2.
URL:	http://www.w3.org/TR/xmlenc-core/

9.1.2.2 Network protocols

Name:	**HTTPS - HyperText Transfer Protocol running over SSL**
Status:	Current
Comments:	See SSL v3 below
URL:	http://www.ietf.org/rfc/rfc2818.txt

Name:	**SSL v3.0 - Secure Sockets Layer Version 3**
Status:	Current
Comments:	Use for encrypted transmission of any data quantity between web browser and web server over TCP/IP. Used for HTTPS (HTTP in an SSL/TLS stream) to open a secure session on Port 443. May also be used for secure TCP transport (e.g. VPN). Note: TLS v1.0 is SSL v3.1
URL:	http://wp.netscape.com/eng/ssl3/ssl-toc.html

Name:	**IPsec - Internet Protocol Security**
Status:	Current
Comments:	Authentication header standard taken from NZSIT/SIGS.
URL:	http://www.ietf.org/rfc/rfc2402.txt

Name:	**ESP IP - Encapsulation Security Protocol for VPN**
Status:	Current
Comments:	Requirements taken from NZSIT/SIGS.
URL:	http://www.ietf.org/rfc/rfc2406.txt

Name:	**S-HTTP - Secure HyperText Transfer Protocol**
Status:	Current

Comments:	For individual messages, created by SSL running under HTTP.
URL:	http://en.wikipedia.org/wiki/S-HTTP

Name:	**TLS v1.0 - Transport Layer Security**
Status:	Current
Comments:	RFC 2616 upgrade mechanism in HTTP 1.1; initiate Transport Layer Security over an existing TCP connection. Does not yet interoperate with SSL v3.
URL:	http://www.ietf.org/rfc/rfc2246.txt

9.1.2.3 Mail transfer

Name:	**S/MIME v3 0 - Secure Multi-Purpose Internet Mail Extensions Version 3**
Status:	Current
Comments:	Use MIME when security is not a concern. Use S/MIME encryption when not using the Messaging Transport protocols.
URL:	http://www.ietf.org/rfc/rfc2633.txt

9.1.2.4 Public Key Infrastructure (PKI)

Name:	**RFC2527 Internet X.509 - Public Key Infrastructure Certificate Policy and Certification Practices Framework**
Status:	Current
Comments:	Produced by the Public-Key Infrastructure X.509 group, or PKIX, a working group of the Internet Engineering Task Force dedicated to creating RFCs and other standards documentation on issues related to public key infrastructure (PKI) based on X.509 certificates. Note: Agencies wishing to implement any new PKI system must contact the ICT Branch of the State Services Commission for advice.
URL:	http://www.ietf.org/rfc/rfc2633.txt

9.1.2.5 Smart cards

Name:	**ISO/IEC 7816**
Status:	Future
Comments:	ISO/IEC 7816 is an international standard related to electronic identification cards, especially smart cards, managed jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). It is an extension of ISO/IEC 7810. It is edited by the Joint technical committee (JTC) 1 / Sub-Committee (SC) 17. ISO 7816-1 Physical characteristics ISO 7816-2 Dimensions and location of the contacts ISO 7816-3 Electronic signals and transmission protocols ISO 7816-4 Industry commands for interchange ISO 7816-5 Number system and registration procedure for application identifiers

	ISO 7816-6	Interindustry data elements
URL:	http://www.cardwerk.com/smartcards/smartcard_standard_ISO7816.aspx	

9.2 PROCESS INTEROPERABILITY

9.2.1 WEB SERVICES

9.2.1.1 Registry services

Name:	**ebXML RIM and RS v2.1 - E-business Extensible Markup Language, Registry Information Model, and Registry Services Version 2.1**
Status:	Future
Comments:	Open standard application for Registry Information and Records Services in an e-business context, as an alternative to Web Services.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=regrep

Name:	**ebXML RIM and RS v3.0 - E-business Extensible Markup Language, Registry Information Model, and Registry Services Version 3.0**
Status:	Future
Comments:	Open standard application for Registry Information and Records Services in an e-business context, as an alternative to Web Services.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=regrep

Name:	**UDDI v3 - Universal Description, Discovery and Integration Version 3**
Status:	Current
Comments:	An open standard for describing, publishing, and discovering network-based software components.
URL:	http://www.uddi.org/

9.2.1.2 Description

Name:	**WSDL v1.1 Web Services Description Language Version 1.1**
Status:	Future
Comments:	Specifies the location of the service and the operations, or methods, the service exposes.
URL:	http://www.w3.org/TR/2001/NOTE-wsdl-20010315

Name:	**WSDL v2.0 Web Services Description Language Version 2.0**
Status:	Future
Comments:	
URL:	http://www.w3.org/TR/wsdl20/

Name:	**WSBPEL - Web Services Business Process Execution Language**
Status:	Future
Comments:	Lets users describe business process activities as web services and define how they can be

	connected to accomplish specific tasks.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsbpel

Name:	**FWSI - Framework for Web Services Implementation**
Status:	Future
Comments:	Defines methods and functional components for broad, multi-platform, vendor-neutral cross-industry implementation of Web services
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=fwsi

Name:	**CPPA - ebXML Collaboration Protocol Profile and Agreement**
Status:	Future
Comments:	Describing how trading partners engage in electronic business collaborations through the exchange of electronic messages
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ebxml-cppa

Name:	**EBXML - BP ebXML Business Process**
Status:	Future
Comments:	Providing a standards-based business process foundation that promotes the automation and predictable exchange of business collaboration definitions using XML
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ebxml-bp

Name:	**BPEL4WS - Business Process Execution Language for Web Services**
Status:	Future
Comments:	Lets users describe business process activities as web services and define how they can be connected to accomplish specific tasks.
URL:	http://www-128.ibm.com/developerworks/library/specification/ws-bpel/

9.2.1.3 Access

Name:	**SOAP v1.1 - Simple Object Access Protocol Version 1.1**
Status:	Current
Comments:	For Web Services Transport. E-GIF v3.3 recommends SOAP v1.2, but adopts SOAP v1.1 because of feedback from agencies that this is the version currently supported in many common development products.
URL:	http://www.w3.org/TR/2000/NOTE-SOAP-20000508/

Name:	**SOAP v1.2 - Simple Object Access Protocol Version 1.2**
Status:	Current

Comments:	Previous versions of the e-GIF adopted SOAP v1.2. E-GIF v3.3 recommends SOAP v1.2, but adopts SOAP v1.1 because of feedback from agencies that this is the version currently supported in many common development products.
URL:	http://www.w3.org/TR/2001/WD-soap12-20010709/

9.2.1.4 Messaging

Name:	**ebXML MSG - E-Business Extensible Markup Language Messaging Services**
Status:	Future
Comments:	
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ebxml-msg

Name:	**WSRM Web Services Reliable Messaging**
Status:	Future
Comments:	WS-Reliability 1.1 provides a standard, interoperable way to guarantee message delivery to applications or Web services.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsrm

9.2.1.5 GeoServices

Name:	**WFS - Web Feature Service**
Status:	Future
Comments:	Open Geospatial Consortium International.
URL:	http://www.opengeospatial.org/standards/wfs

Name:	**WMS - Web Map Service**
Status:	Future
Comments:	Open Geospatial Consortium International
URL:	http://www.opengeospatial.org/standards/wms

Name:	**WCS - Web Coverage Service 1.1.0**
Status:	Future
Comments:	Open Geospatial Consortium (OGC)
URL:	http://www.opengeospatial.org/standards/wcs

Name:	**NZGMS - New Zealand Government Geospatial Metadata Standard**
Status:	Future
Comments:	Land Information New Zealand leads this standard. See also: http://www.linz.govt.nz/resources/geospatial/xml/schema/nzgm-profile-pt1v1.2.pdf

URL:	http://www.e.govt.nz/standards/e-gif/geospatial-information

Name:	**ESA - Emergency Services and Government Administration Core Data Specification**
Status:	Future
Comments:	Land Information New Zealand leads this standard. The most current version is V1.9.7 published in 2004. See also http://www.linz.govt.nz/core/topography/projectsandprogrammes/emergencyservices/index.html.
URL:	http://www.e.govt.nz/standards/e-gif/geospatial-information

9.2.1.6 Compliance

Name:	**WS-I Basic Profile v1.2 Web Services – Interoperability Organisation Basic Profile**
Status:	Future
Comments:	Profiles provide implementation guidelines for how related web services specifications should be used together for best interoperability. To date, WS-i has finalised the Basic Profile, Attachments Profile and Simple SOAP Binding Profile. The Authentication Standards Secure Messaging Working Group will develop a 'secure messaging over web services' profile from the WS-i profiles during 2008.
URL:	http://www.ws-i.org/profiles/BasicProfile-1.2.html

Name:	**WSS-I Basic Profile v1.1 Web Services Security – Interoperability Organisation Basic**
Status:	Future
Comments:	Draft 1.1 Basic Security Profile accepted by OASIS.
URL:	http://www.ws-i.org/Profiles/BasicSecurityProfile-1.1.html

9.3 SEMANTIC DATA INTEROPERABILITY

9.3.1 DATA INTEGRATION

9.3.1.1 Primary character set

Name:	ASCII - American Standard Code for Information Interchange
Status:	Current
Comments:	Minimum set of characters for data interchange.
URL:	http://www.columbia.edu/kermit/ascii.html

Name:	UTF-8 - UCS Transformation Format (8-bit encoding)
Status:	Current
Comments:	UTF-8 is a variable length character encoding for Unicode. It can represent any character in the Unicode character set, yet is backwards compatible with ASCII.
URL:	http://www.ietf.org/rfc/rfc2279.txt

Name:	UTF-16 - UCS Transformation Format (16-bit encoding)
Status:	Future
Comments:	UTF-16 is a variable length character encoding for Unicode. It can represent any character in the Unicode character set, yet it backwards compatible with ASCII.
URL:	http://www.ietf.org/rfc/rfc2781.txt

9.3.1.2 Structured data

Name:	XML v1.0 - Extensible Markup Language Version 1.0
Status:	Current
Comments:	Preferred option for structured data transport.
URL:	http://www.w3.org/TR/REC-xml

9.3.1.3 Batch/bulk data

Name:	XML - Extensible Markup Language
Status:	Current
Comments:	XML 1.0 is preferred for structured data transport. Parties must agree on file header records before exchange.
URL:	http://www.answers.com/main/ntquery?method=4&dsid=1512&dekey=comma+delimited&gwp=8&curtab=1512_1

Name:	CSV - Comma-Separated Values
Status:	Current
Comments:	Certain implementations of XML may fail in bulk/batch mode; in which case agencies may use deprecated standard of CSV. Parties must agree on file header records before exchange.
URL:	http://www.answers.com/main/ntquery?method=4&dsid=1512&dekey=comma+delimited&gwp=8&curtab=1512_1

9.3.1.4 Data processing

Name:	SAX Simple API for XML
Status:	Future
Comments:	Parser for large volume repetitious batch transfers. Open standard for navigating and updating XML documents.
URL:	http://www.w3.org/DOM/

Name:	DOM Document Object Model
Status:	Current
Comments:	Parser for transactional exchanges. SAX is a Java API for navigating XML documents.
URL:	http://www.w3.org/DOM/

Name:	XSLT - eXtensible Stylesheet Language Transformations
Status:	Current
Comments:	A language used by XSL for transforming XML documents into other XML documents.
URL:	http://www.w3.org/TR/xslt

Name:	XPath eXtensible Stylesheet Language Transformations
Status:	Current
Comments:	XPath is a language for addressing parts of an XML document, designed to be used by both XSLT and XPointer.
URL:	http://www.w3.org/TR/xpath

Name:	XQuery 1.0 - XML Query Language
Status:	Current
Comments:	A query language that can express queries across diverse data sources including structured and semi-structured documents, relational databases, and object repositories, whether physically stored in XML or viewed as XML via middleware.
URL:	http://www.w3.org/TR/xquery/

Name:	XLink 1.0 - XML Linking Language
Status:	Future
Comments:	A linking language that allows elements to be inserted into XML documents in order to create and describe links between resources.
URL:	http://www.w3.org/TR/xlink/

Name:	SQL – Structured Query Language
Status:	
Comments:	SQL is a database computer language designed for the retrieval and management of data in relational database management systems (RDBMS), database schema creation and modification, and database object access control management
URL:	http://www.jcc.com/sql.htm

Name:	SPARQL - Query Language for RDF
Status:	Future
Comments:	This specification defines the syntax and semantics of the SPARQL query language for RDF. SPARQL can be used to express queries across diverse data sources, whether the data is stored natively as RDF or viewed as RDF via middleware.
URL:	http://www.w3.org/TR/rdf-sparql-query/

9.3.1.5 Content syndication and channel feeds

Name:	RSS 1.0 Really Simple Syndication
Status:	Current
Comments:	RSS is a lightweight multipurpose extensible metadata description and syndication format. RSS is an XML application, conforms to the W3C's RDF Specification and is extensible via XML-namespace and/or RDF based modularization.
URL:	http://web.resource.org/rss/1.0/

Name:	RSS 2.0 Really Simple Syndication
Status:	Current
Comments:	An alternative to RSS 1.0 that also enjoys wide support from the community.
URL:	http://www.rssboard.org/rss-specification

Name:	ATOM 1.0 Syndication Format
Status:	Future
Comments:	XML-based syndication format. Development was motivated by the existence of many incompatible versions of the RSS syndication format.
URL:	http://www.ietf.org/rfc/rfc4287

Name:	GeoRSS Geospatial Resource Syndication Service
Status:	Future
Comments:	Geographically Encoded Objects for RSS feeds
URL:	http://www.georss.org/gml

9.3.1.6 Business Transactions

Name:	UBL - Universal Business Language
Status:	Future
Comments:	Defining a common XML library of business documents (purchase orders, invoices, etc.)
URL:	http://www.oasis-open.org/committees/ubl/

9.3.1.7 Health sector

Name:	HL7 - Health Level 7
Status:	Future
Comments:	An international standard adopted by the health sector. Is converging on HL7 Version 2.4 for laboratory results and National Health Index (NHI).
URL:	http://www.hl7.org/

9.3.2 METADATA

9.3.2.1 Data modelling

Name:	UML - Unified Modelling Language
Status:	Future
Comments:	UML - is OMG's specification, and the way the world models not only application structure, behavior, and architecture, but also business process and data structure.
URL:	http://www.uml.org/

Name:	ER - Entity Relationship Model
Status:	Future
Comments:	Entity-relationship modeling is a relational schema database modeling method, used to produce a type of conceptual schema or semantic data model of a system, often a relational database, and its requirements in a top-down fashion.
URL:	http://en.wikipedia.org/wiki/Entity-relationship_model

Name:	RDF - Resource Description Framework
Status:	Current
Comments:	An XML file format to describe metadata. RDF is used by RSS1.0 (see below).
URL:	http://www.w3.org/RDF/

Name:	OWL - Web Ontology Language
Status:	Future
Comments:	An XML file format to describe metadata.
URL:	http://www.w3.org/TR/owl-features/

Name:	SKOS - Simple Knowledge Organization System
Status:	Current
Comments:	A common data model for sharing and linking knowledge organization systems via the Web.
URL:	http://www.w3.org/TR/skos-reference/

Name:	SAWSDL - Semantic Annotations for WSDL and XML Schema
Status:	Future
Comments:	Common interface between semantic descriptions and non-semantic (e.g., WSDL) descriptions.
URL:	http://www.w3.org/TR/sawsdl/

Name:	XMI - XML Metadata Interchange
Status:	Future
Comments:	Enables easy interchange of metadata between modelling tools such as UML and remote metadata repositories.
URL:	http://www.omg.org/technology/documents/formal/xmi.htm

Name:	XML v1.0 - Extensible Markup Language Version 1.0
Status:	Current
Comments:	Meta-language to create tags to define, transit, validate, and interpret data.
URL:	http://www.w3.org/TR/REC-xml/

Name:	XML v1.1 - Extensible Markup Language Version 1.1
Status:	Current
Comments:	Note: “Structured data” refers to XML Schema v1.0.
URL:	http://www.w3.org/TR/2002/WD-xml11-20020425/

Name:	GML - Geography Markup Language
Status:	Future
Comments:	GML is an XML grammar for expressing geographical features. GML serves as a modeling language for geographic systems as well as an open interchange format for geographic transactions on the Internet.

URL:	http://www.opengeospatial.org/standards/gml

Name:	**W3C schema definitions - World Wide Web Consortium Schema Definitions**
Status:	Current
Comments:	Use when other schemas customised for use by government agencies are not specifically identified.
URL:	http://www.w3.org/TR/xmlschema-1/

Name:	**DTD - Document Type Definition**
Status:	Current
Comments:	Describes multiple elements and attributes for XML.
URL:	http://www.w3.org/TR/REC-html40/intro/sgmltut.html

Name:	**UBL - Universal Business Language**
Status:	Future
Comments:	Naming and design rules for schema design
URL:	http://www.oasis-open.org/committees/sc_home.php?wg_abbrev=ubl-ndrsc

Name:	**UMCLVV (for CVLs) - UBL Methodology for Code List and Value Validation**
Status:	Future
Comments:	Used for contextual validation in XML instances of sets of coded values expressed outside of the instances.
URL:	http://www.oasis-open.org/committees/document.php?document_id=23703

Name:	**UN/EDIFACT - United Nations Directories for Electronic Data Interchange for Administration, Commerce and Transport**
Status:	
Comments:	The EDIFACT standard provides: (i) a set of syntax rules to structure data, (ii) an interactive exchange protocol (I-EDI), (iii) standard messages which allow multi-country and multi-industry exchange.
URL:	http://www.unece.org/trade/untdid/welcome.htm

9.3.2.2 Name and address

Name:	**xNAL v2 - Extensible Name and Address Language Version 2**
Status:	Future
Comments:	xNAL (OASIS) v3 as part of OASIS CIQ v3 being drafted; will be incorporated into e-GIF following a successful pilot.
URL:	http://www.oasis-open.org/committees/ciq/ciq.html#4

9.3.2.3 Customer relationship

Name:	xCIL - Extensible Customer Information Language
Status:	Future
Comments:	The superset of xNAL specifying formats for customer information elements such as phone and fax number, email address, date of birth, gender, etc. xCIL is already under consideration by several agencies and is being piloted in the web-based Change-of-Address Notification project.
URL:	http://www.oasis-open.org/committees/ciq/ciq.html#7

Name:	xCRL - Extensible Customer Relationships Language
Status:	Future
Comments:	Part of the xCIL and xNAL family of standards specifying formats for relationships between customers.
URL:	http://www.oasis-open.org/committees/ciq/ciq.html#8

Name:	CIQ - Customer Information Quality
Status:	Future
Comments:	XML Specifications for defining and managing Customer (also called "Party") information/profile (including customer/party relationships).
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ciq

9.3.2.4 Business reporting

Name:	xBRL - Extensible Business Reporting Language
Status:	Future
Comments:	Working Group underway, led by Inland Revenue.
URL:	http://www.xbrl.org/Home/

9.3.2.5 Statistical data and metadata

Name:	SDMX - Statistical Data and Metadata Exchange
Status:	Future
Comments:	The SDMX Content-Oriented Guidelines recommend practices for creating interoperable data and metadata sets using the SDMX technical standards. They are envisaged to be applicable generically across statistical subject-matter domains.
URL:	http://www.sdmx.org/

9.3.2.6 Namespace

Name:	OIDS - Schema Object Identifiers
Status:	Future
Comments:	The ICT Branch of the State Services Commission maintains 2.16.544.101 as the Government OID Arc.
URL:	http://en.wikipedia.org/wiki/Object_identifier

Name:	URN - Uniform Resource Name
Status:	Future
Comments:	A way of unambiguously defining each element type and attribute name in an XML document.
URL:	http://www.e.govt.nz/standards/e-gif/urn-namespace

9.3.3 Information access and presentation

Besides the open standard listed above, a number of content formats are envisaged to be used for document sharing, audio and video production and delivery, and for data compression.

These formats are not mandatory to be used by public agencies but it is expected they cover most of the need of the administrations. Other formats may have problems in being used and shared with other agencies and therefore these one should be promoted.

9.3.3.1 Document formats

Name:	DOC
Status:	
Comments:	DOC is a format for word processing documents; most commonly for Microsoft Word.
URL:	http://www.microsoft.com/interop/docs/OfficeBinaryFormats.mspx#EAB

Name:	RTF – Rich Text Format
Status:	
Comments:	RTF is a document file format for cross-platform document interchange.
URL:	http://www.microsoft.com/downloads/details.aspx?FamilyId=DD422B8D-FF06-4207-B476-6B5396A18A2B&displaylang=en

Name:	ODFOA v1 - Open Document Format for Office Applications Version 1 DocBook
Status:	
Comments:	Several candidates for agencies to save documents in an open, XML format.
URL:	http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=office

Name:	TXT – Text File
Status:	
Comments:	TXT is a format for files consisting of text usually contain very little formatting (e.g., no bolding or italics). The precise definition of the .txt format is not specified, but typically matches the format accepted by the system terminal or simple text editor.
URL:	http://en.wikipedia.org/wiki/Text_file

Name:	PPT – Microsoft Power Point
Status:	
Comments:	PPT is a format for presentations.
URL:	http://www.microsoft.com/interop/docs/OfficeBinaryFormats.mspx#EAB

Name:	PDF – Portable Document Format
Status:	
Comments:	PDF is a file format for document exchange.
URL:	http://www.adobe.com/devnet/acrobat/pdfs/pdf_reference_1-7.pdf

9.3.3.2 Image formats

Name:	GIF – The Graphics Interchange Format
Status:	
Comments:	GIF is a bitmap image format, which supports up to 8 bits per pixel, allowing a single image to reference a palette of up to 256 distinct colors chosen from the 24-bit RGB color space. It also supports animations and allows a separate palette of 256 colors for each frame.
URL:	http://www.w3.org/Graphics/GIF/spec-gif89a.txt

Name:	PNG – Portable Network Graphics
Status:	
Comments:	PNG is a an extensible file format for the lossless, portable, well-compressed storage of raster images.
URL:	http://www.w3.org/TR/2003/REC-PNG-20031110/

Name:	TIFF – Tagged Image File
Status:	
Comments:	TIFF is a flexible, adaptable file format for handling images and data within a single file, by including the header tags (size, definition, image-data arrangement, applied image compression) defining the image's geometry.
URL:	http://partners.adobe.com/public/developer/tiff/index.html

Name:	JPEG
Status:	
Comments:	JPEG is a method of compression for photographic images. The JPEG standard specifies both the codec, which defines how an image is compressed into a stream of bytes and decompressed back into an image, and the file format used to contain that stream.
URL:	http://www.w3.org/Graphics/JPEG/itu-t81.pdf

Name:	BMP - Bitmap
Status:	
Comments:	BMP is an image file format used to store bitmap digital images.
URL:	http://atlc.sourceforge.net/bmp.html#_toc381201084

9.3.3.3 Audio formats

Name:	WAV – Wave form audio format
Status:	
Comments:	WAV is a Microsoft and IBM audio file format standard for storing an audio bit stream on PCs.
URL:	http://www.microsoft.com/whdc/device/audio/multichaud.mspx

Name:	MP3 – Mpeg 1 Audio Layer 3
Status:	
Comments:	MP3 is a digital audio encoding format using a form of lossy data compression.
URL:	http://en.wikipedia.org/wiki/MP3

9.3.3.4 Video formats

Name:	DMF - DivX Media Format
Status:	
Comments:	DMF includes a codec, a player and a media container format.
URL:	http://en.wikipedia.org/wiki/DivX

Name:	MPEG
Status:	
Comments:	MPEG is a family of standards used for coding audio-visual information (e.g., movies, video, music) in a digital compressed format.
URL:	http://www.mpeg.org/

Name:	AVI – Audio Video Interleave
Status:	

Comments:	AVI is a multimedia container file by Microsoft.
URL:	http://msdn.microsoft.com/en-us/library/aa451196.aspx

Name:	**QuickTime**
Status:	
Comments:	QuickTime is a multimedia container file that contains one or more tracks, each of which stores a particular type of data: audio, video, effects, or text.
URL:	http://www.apple.com/quicktime/

9.3.3.5 Web content formats

Name:	**HTML v4.01 - HyperText Markup Language Version 4.01**
Status:	Current
Comments:	For web content. See Web Standards and Recommendations v1.0.
URL:	http://www.w3.org/TR/html401/

Name:	**XHTML - eXtensible HyperText Markup Language**
Status:	Current
Comments:	XHTML is a markup language that has the same depth of expression as HTML, but also conforms to XML syntax.
URL:	http://www.w3.org/TR/2001/REC-xhtml11-20010531/

9.3.3.7 File compression

Name:	**ZIP**
Status:	Current
Comments:	The ZIP file format is a data compression and archive format.
URL:	http://en.wikipedia.org/wiki/ZIP_(file_format)

Name:	**GZIP**
Status:	Current
Comments:	GZIP is a GNU ZIP compression utility.
URL:	http://www.gzip.org/

Name:	**RAR – R**oshal **AR**chive
Status:	Current
Comments:	RAR is a proprietary archive file format that supports data compression, error recovery, and file spanning.
URL:	http://www.rarlab.com/

Appendix 10. Project Management: PMBOK

The Project Management Body of Knowledge collects the best practices that have to be adopted for project management, be it a software development project or any other kind of project. It has been adopted as a IEEE standard: IEEE Std 1490-2003.

The PMBOK distinguishes five process groups and nine knowledge areas. The process groups include the phases in which a project can be structured:

- Initiation, namely all the activities leading to the setup of a project
- Planning, namely all the activities leading to the definition of the resources and the definition of a plan for the project
- Execution, namely all the activities related to the actual execution of the project
- Monitoring, namely all the activities related to ensuring that the project is remains on scope, on budget, on time or to realize deviations from the initial plan
- Closing, namely all the activities related to close the project, assess the benefits and hand the product of the project over.

The knowledge areas include the techniques to be applied in the different groups to manage a project. In particular:

- Project Integration Management, namely all the techniques that can be used to ensure the project "fits" in the organization's goals
- Project Scope Management, namely all the techniques that can be used to ensure that the project goals do not change or, more loosely, that any change to the project goals is controlled and managed
- Project Time Management, namely all the techniques that can be used to ensure that the project remains on time.
- Project Cost Management, namely all the techniques that can be used to ensure that the project remains on budget
- Project Quality Management, namely all the techniques that can be used to ensure that the output of the project satisfies the agreed-upon quality requirements
- Project Human Resources Management, namely all the techniques that can be used to manage human resources
- Project Communication Management, namely all the techniques that can be used to manage communication about the project and the project results
- Project Risk Management, namely all the techniques that can be used to identify, manage, and control threats and opportunities
- Project Procurement Management, namely all the techniques that can be used to manage procurement of the resources necessary for the project.

The techniques identified by the project areas and the process groups form a matrix, as presented in Table 8.

Table 8. PMBOK methodology at a glance [source: PMBOK].

	INITIATING	PLANNING	EXECUTING	CONTROLLING	CLOSING
INTEGRATION	Develop Project Charter; Develop Preliminary Project Scope	Develop Project Management Plan	Direct and Manage Project Execution	Monitor and Control Project Work; Integrated Change Control	Close Project
SCOPE		Scope Planning; Scope Definition; Create WBS		Scope Verification; Scope Control	
TIME		Activity Definition; Activity Sequencing; Activity Resource Estimation; Activity Duration Estimating; Schedule Development		Schedule Control	
COST		Cost Estimating; Cost Budgeting		Cost Control	
QUALITY		Quality Planning	Perform Quality Assurance	Perform Quality Control	
HUMAN RESOURCES		Human Resource Planning; Staff Acquisition	Develop Project Team; Manage Project Team		
COMMUNICATIONS		Communications Planning	Information Distribution	Performance Reporting	Manage Stakeholders
RISK		Risk Management Planning; Risk Identification; Qualitative Risk Analysis; Quantitative Risk Analysis; Risk Response Planning		Risk Monitoring and Control	
PROCUREMENT		Plan Purchase and Acquisitions; Plan Contracting	Request Seller Responses; Select Sellers; Contract Administration		Contract Closure