THE REPUBLIC OF UGANDA

e-Government Interoperability Framework Reference Architecture

Project: THE REPUBLIC OF UGANDA CONSULTANCY SERVICES FOR THE DEVELOPMENT OF A GOVERNMENT ENTERPRISE ARCHITECTURE (GEA) AND E-GOVERNMENT INTEROPERABILITY FRAMEWORK (E-GIF)

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1.Introduction

1.1. Background

The National Vision 2040[1] stipulates that ICT has enormous opportunities that Uganda can exploit to transform the economy through: building a robust and trusted high speed ICT infrastructure; manufacturing ICT products; improving the availability of digital content and e-products; automating Government processes and inter-agency connectivity & innovation; developing platforms on which the private sector can co-create with the Government; offering new value-added services to the public; and establishing incubation centres, among others.

The Digital Uganda Vision (DUV)[2] has declared a vision (*A Digitally Empowered Society and Knowledge Economy*) and mission *(To Transform Uganda into a digitally enabled society that is innovative, productive, and competitive).* The DUV is an overarching 20-year ICT development framework that is aligned with the Uganda Vision 2040. It aims to harmonise Uganda's transformative policies, strategies, initiatives, and other governance frameworks for the expedient realisation of national development aspirations.

The e-Government Interoperability Framework Reference Architecture (GIRA) is a reference architecture focused on the design of end-to-end interoperable digital public services. The GIRA is composed of the most salient Architecture Building Blocks (ABBs) needed to promote cross-sector interactions between Ministries Departments, Agencies and Local governments (MDA/LGs.)

This paper is part of the project for the development of a Government Enterprise Architecture and e-Government Interoperability Framework for Uganda. The objective of the project is to develop a Government Enterprise Architecture and e-Government Interoperability Framework and provide the necessary policy and technical recommendations for its sustainable and systematic implementation.

The GIRA is an **architecture content metamodel** defining the most salient architectural building blocks needed to build interoperable e-Government systems. The GIRA provides a **common terminology** that can be used by people working for public administrations in various architecture and system development tasks

Alignment with e-GIF and TOGAF. The GIRA is aligned with the Ugandan Interoperability Framework (e-GIF) The views of the GIRA correspond to the interoperability levels in the e-GIF: legal, organisational, semantic, and technical. The GIRA reuses terminology and paradigms from TOGAF® such as architecture building blocks and views. This not only assures a high level of quality but also allows architects to easily understand the GIRA and relate it to existing work.

[1] http://www.npa.go.ug/uganda-vision-2040/

[2] https://ict.go.ug/initiatives/digital-uganda-vision/

The reference architecture targets the following users within the MDAs:

- **Architects**, Enterprise Architects as well as Solution Architects who are responsible for the design of solution architectures
- **Business analysts** responsible for assessing and studying the impact of changes in the (external) environment on IT systems
- **Portfolio managers** responsible for maintaining of assets related to the design and implementation of eGovernment solutions and for making investment decisions on these assets.

The GIRA has the objective to respond to the above needs by supporting users in the following scenarios:

- **Designing**: accelerate the design of eGovernment solutions that support the delivery of interoperable digital public services (across borders and sectors).
- **Assessing**: provide a reference model for comparing existing architectures in different policy domains and thematic areas, to identify focal points for convergence and reuse.
- **Communicating and sharing:** help documenting the most salient interoperability elements of complex solutions and facilitate the sharing of (re)usable solutions.
- **Discovering and reusing**: ease the discovery and reuse of interoperability solutions.

1.2. Methodology: frameworks, standards, tools

In this section we will list and describe shortly main frameworks, standards and tools have been applied for building the GIRA:

- The Uganda e-Government Interoperability Framework (e-GIF),
- The Open Group Architecture Framework (TOGAF),
- The Architecture Development Method (ADM),
- The Enterprise Architecture Modelling Language ArchiMate®,
- Archi®, a modelling toolkit for creating ArchiMate models and sketches,
- The European Interoperability Reference Architecture (EIRA©)

e-GIF.[3] The Ugandan Interoperability Framework (e-GIF) is the agreed approach to the delivery of the Government of Uganda's (GOU's) public services in an interoperable manner. It defines the basic interoperability guidelines in the form of common principles, models, and recommendations. The GIRA is aligned with the e-GIF. The views of the GIRA correspond to

[3] Uganda e-Government Interoperability Framework (e-GIF). Draft version, March 2021

the interoperability levels in the e-GIF: legal, organisational, semantic and technical interoperability.

TOGAF®.[4] The Enterprise Architecture framework TOGAF® is used by GOU for developing Government Enterprise Architecture. TOGAF is a generic framework. The TOGAF standard considers an "enterprise" to be any collection of organizations that have common goals.

Although all of the TOGAF documentation works together as a whole, it is expected that organizations will customize it during adoption, and deliberately choose some elements, customize, exclude, and/or create others.

TOGAF is based on four interrelated areas o Framework f specialization called architecture domains:

- **Business architecture** which defines the business strategy, governance, organization, and key business processes of the organization
- **Data architecture** which describes the structure of an organization's logical and physical data assets and the associated data management resources
- **Applications architecture** which provides a blueprint for the individual systems to be deployed, the interactions between the application systems, and their relationships to the core business processes of the organization with the frameworks for services to be exposed as business functions for integration
- **Technical architecture**, or technology architecture, which describes the hardware, software, and network infrastructure needed to support the deployment of core, mission-critical applications

GIRA reuses terminology and paradigms from TOGAF® such as architecture patterns, building blocks and views. This not only assures a high level of quality but also allows architects to easily understand EIRA© and relate it to existing work.

[4] https://pubs.opengroup.org/architecture/togaf9-doc/arch/

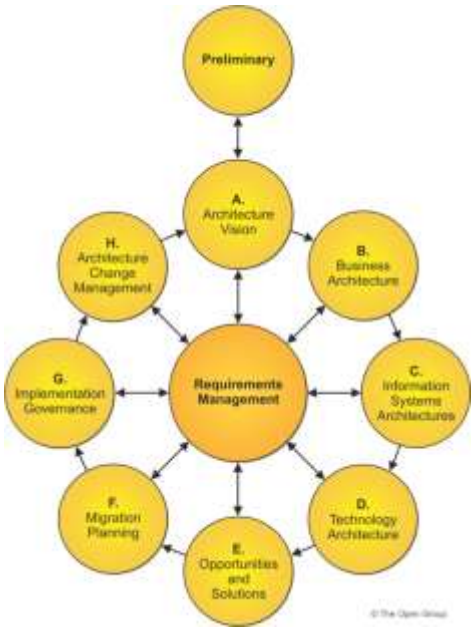

Figure 1 Basic structure of the ADM

ADM. The TOGAF ADM forms the core of TOGAF. It is a reliable, proven method for developing an Enterprise Architecture that meets the business needs of an organisation, utilising the other elements of TOGAF, and other architectural assets available to the organisation.

The ADM is a generic method for architecture development, which has been designed to deal with most system and organisational requirements. However, it will often be necessary to modify or extend the ADM to suit specific needs.

The basic structure of the TOGAF ADM is shown in Figure 1. Throughout the TOGAF ADM cycle, there needs to be frequent validation of outputs against original expectations, both those from the whole TOGAF ADM cycle, and those from the particular phases of the method.

The ADM is iterative over the whole process, between phases and within phases; for each iteration of the ADM, a fresh decision must be taken on:

- The breadth of coverage of the enterprise to be defined
- The level of detail to be defined
- The extent of the time horizon aimed at, including the number and extent of any intermediate time horizons
- The architectural assets to be leveraged in the GOU

ArchiMate®.[5] The ArchiMate® modelling language is an open and independent Enterprise Architecture standard that supports the description, analysis and visualisation of architecture within and across business domains. ArchiMate is one of the open standards hosted by The Open Group® and is fully aligned with TOGAF®. ArchiMate® aids stakeholders in assessing the impact of design choices and changes. All views and viewpoints of GIRA are visualised by using the ArchiMate® language.

[5] https://www.opengroup.org/archimate-forum/archimate-overview

Archimate 3.1 Notation Overview by Orbus Software is presented in

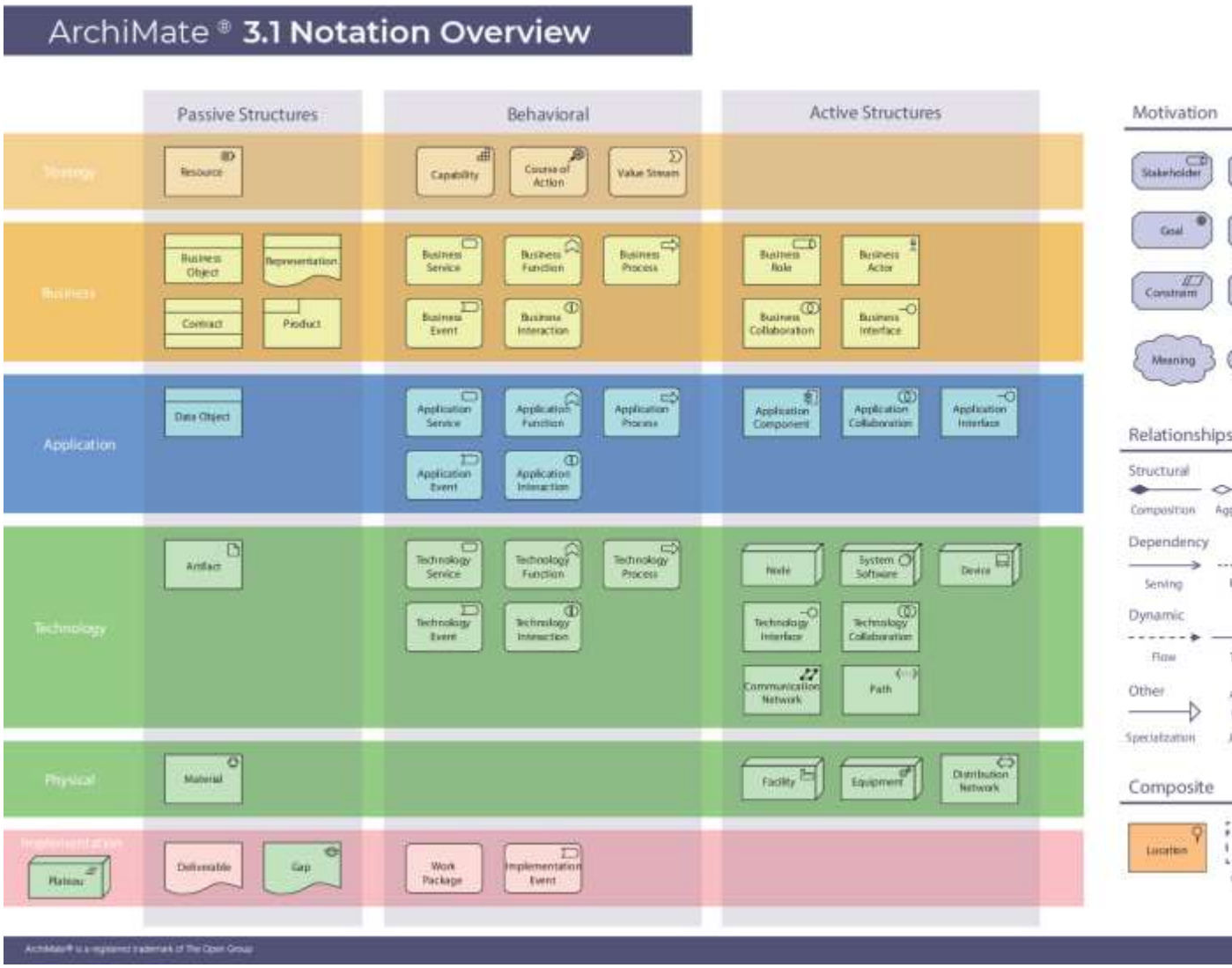

Figure 2 ArchiMate Notation by Orbus Software

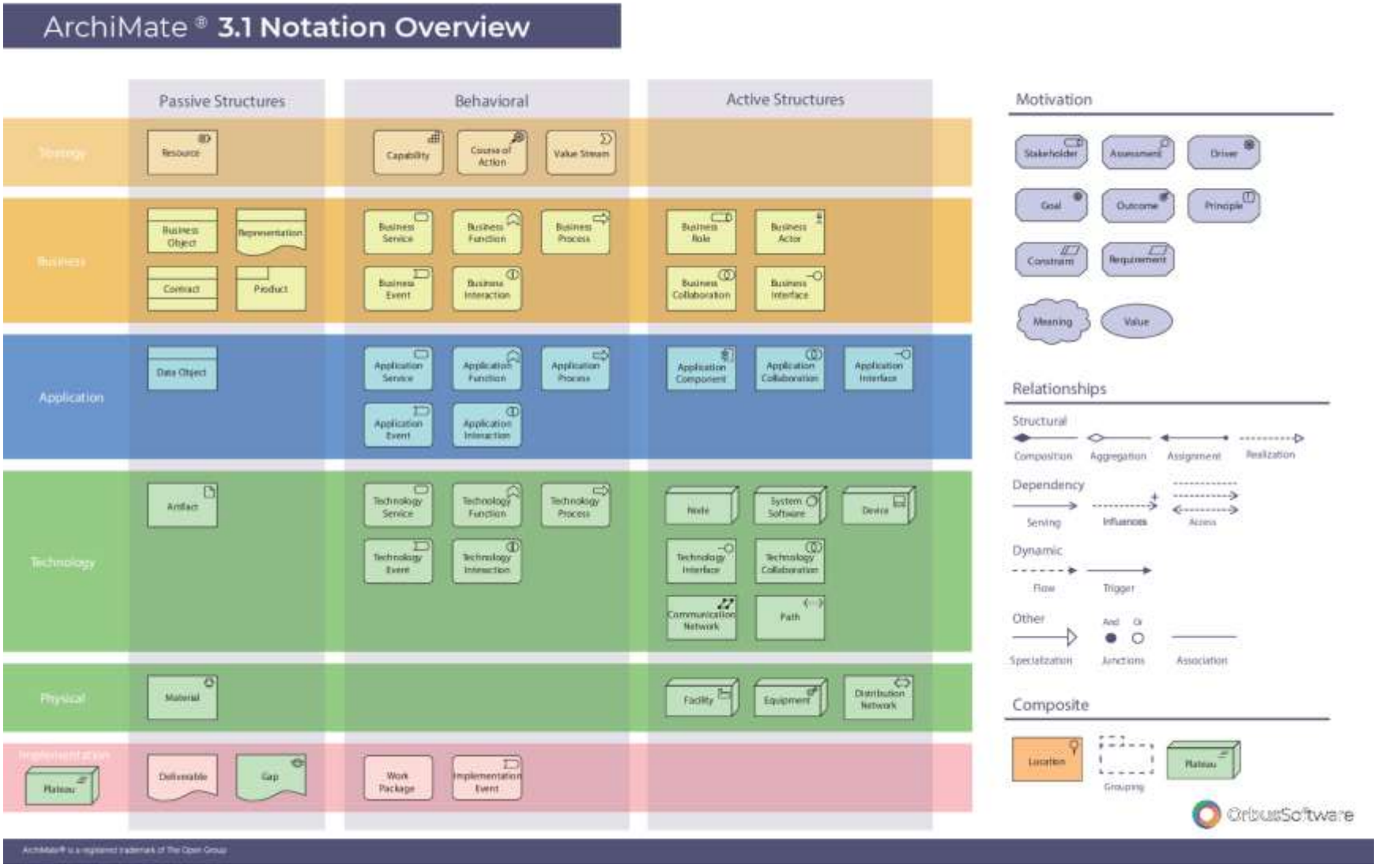

Figure 2 ArchiMate Notation by Orbus Software

Archi®.[6] The Archi® modelling toolkit is targeted toward all levels of Enterprise Architects and Modellers. It provides a low cost to entry solution to users who may be making their first steps in the ArchiMate® modelling language, or who are looking for an open source, cross-platform ArchiMate® modelling tool for their company or institution and wish to engage with the language within a TOGAF® or others Enterprise Architecture framework. GIRA is modelled by using Archi®.

EIRA.[7] The European Interoperability Reference Architecture (EIRA©) is an architecture content metamodel defining the most salient ABBs needed to build interoperable e-Government systems. The EIRA© provides a common terminology that can be used by people working for public administrations in various architecture and system development tasks.

1.3. Context

The Ugandan GIRA is an important part of the activities for building an e-Government Enterprise Architecture (GEA). By GEA we mean the structure of e-Government components, their inter-relationships, and the principles and guidelines governing their design and evolution over time.

The purpose of an Enterprise Architecture is to optimize the fragmented architectural processes (both manual and automated) into an integrated environment that is responsive to change and supportive of the delivery of the business strategy.

The Enterprise Architecture framework TOGAF® is used by the GOU for developing a Government Enterprise Architecture. TOGAF® is generic framework. The TOGAF® standard considers an "enterprise" to be any collection of organizations that have common goals.

The core of TOGAF® is Architecture Development Method (ADM). ADM is a multi-phase, iterative approach to develop and use an Enterprise Architecture to shape and govern business transformation and implementation projects.

We distinguish the following steps/levels in the GEA lifecycle:

1. **Preliminary Phase**. The strategy of the Ugandan e-Society and e-Government has been fixed in vision papers and legislations. Numerous studies on the situation of the Ugandan e-Government have been carried out. The inception report[8] includes a review of existing e-Government policy documents and Ugandan readiness assessments for building eGovernment architecture.

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[6] https://www.archimatetool.com/

[7] https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/solution/eira/about

[8] Inception report for Government Enterprise Architecture and E-Government Interoperability Framework for Uganda. Report was carried out by e-Governance Academy in March 2020

2. **e-GIF**. e-GIF provides the implementation strategy for GEA. It defines basic interoperability guidelines in the form of common principles, models, and recommendations for interactions between public institutions. In terms of TOGAF®, e-GIF covers all phases of the ADM cycle, primarily the Vision phase. The purpose of e-GIF is to describe the strategic level of GEA as it depicted in Figure 3 (left side).

3. **e-Government Interoperability Reference Architecture (GIRA**). In terms of TOGAF® the GIRA is a reference architecture focused on the interoperability of digital public services. It is composed of the most salient Architecture Building Blocks needed to promote interactions between public administrations. GIRA covers, in terms of TOGAF®, the core phases of ADM: business architecture, information systems architecture and technology architecture Figure 3 (right side) mainly. The ADM vision phase will be reviewed and refined.

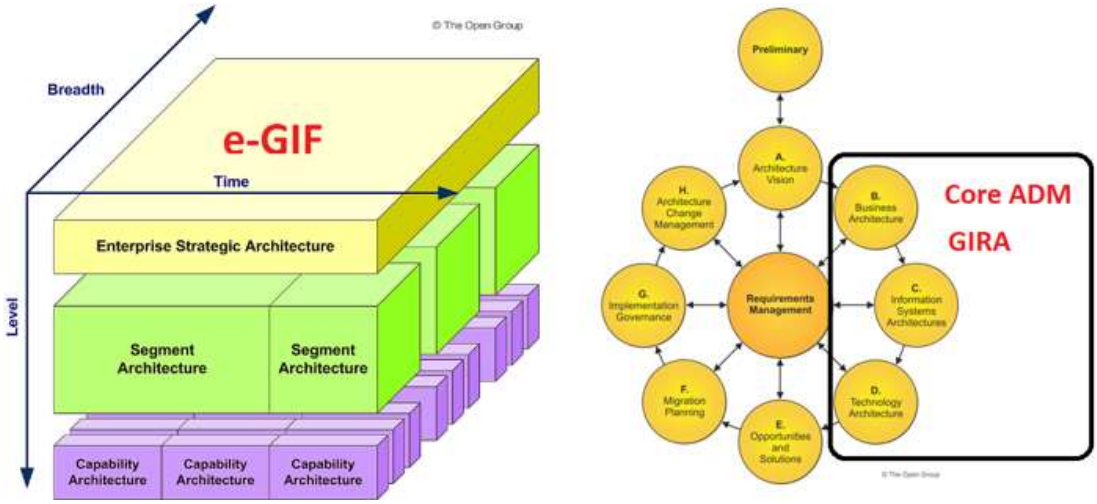

Figure 3 e-GIF covers all ADM phases on strategy level. The GIRA covers the core components of ADM: business, information systems and technology architectures.

4. **Security architecture.** Security architecture is the viewpoint of GEA. All phases of ADM cycle contain security and privacy aspects.

5. **Implementation plan of GEA.** This step results in the implementation plan and road map highlighting the required activities, resources and timelines as well as cross-government governance structures to ensure compliance and uptake of the developed GIRA In terms of ADM it covers phases E and F.

6. **Governance of GEA.** Building, monitoring, managing, and steering of the implementation of GEA is in focus of this step. Building GEA is an iterative process. Some components might need to be renewed; some components might need to be added. Sometimes it is reasonable to restart a new lifecycle from the beginning. In terms of ADM, it covers phases G and H.

1.4. Key concepts and key enablers of GIRA

The key concepts of the GIRA are defined as follows:

e-GIF interoperability level. The e-GIF is a set of guidelines for developing public services. Figure 4 depicts the interoperability levels of the EIF. They cover legal, organisational, semantic and technical interoperability. Each level deserves special attention when a new GOU public service is established.

e-GIF principle. The e-GIF outlines 12 underlying principles of GOU public services. These general principles of good administration are relevant to the process of establishing GOU public services. They describe the context in which GOU public services are decided and implemented. They complement one another regardless of their different natures, e.g. legal or technical. More information on the EIF interoperability levels and principles can be found in the GOU Interoperability Framework (e-GIF).

GIRA view. The GIRA consists of several views, including one view for each of the e-GIF interoperability levels. The GIRA views contain a graphical notation of the GIRA ontology.

GIRA viewpoint. The GIRA provides several viewpoints that conform to GIRA views, the viewpoints provide a perspective with specific stakeholder's concern in mind.

Architecture Building Block. Based on the TOGAF® definition, an Architecture Building Block is an abstract component that captures architecture requirements and that directs and guides the development of Solution Building Blocks. An ABB represents a (potentially re-usable) component of legal, organisational, semantic or technical capability that can be combined with other Architecture Building Blocks. An Architecture Building Block describes generic characteristics and functionalities. Architecture Building Blocks are used to describe reference architectures, solution architecture templates or solution architectures of a specific solutions.

Solution Building Block. Based on the TOGAF® definition, a Solution Building Block is a concrete element that defines the implementation and fulfils the required business requirements of one or more Architecture Building Blocks. On the technical view, a Solution Building Block is a specific product or software component and may be either procured or developed.

Reference Architecture. Architecture is the structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time. A reference architecture is a generalized architecture of a solution, based on best-practices, domain neutral and, occasionally, with a focus on a particular aspect. The goal of a reference architecture is reusability; it reduces the amount of work, reduces errors and accelerates the development of solutions. A reference architecture should be based in a [reference] model and in a style. The model covers the ontology of the components and their interrelationships and in the case of GIRA it is ArchiMate®. The architecture style covers the architecture design principles and patterns and in the case of the GIRA it is "Service Oriented Architecture" (SOA). The focus of the GIRA is interoperability in GOU institutions. This definition of "reference architecture" needs to be complemented with the notion of Enterprise Architecture, which is an end-to-end generic domain neutral approach to design the

architecture of an enterprise or a solution. The goal of an enterprise architecture is to align IT-related activities with the overall goal of the enterprise.

Solution Architecture. Based on TOGAF®, a solution architecture is "a description of a discrete and focused business operation or activity and how information systems / technical infrastructure supports that operation. A Solution Architecture typically applies to a single project or project release, assisting in the translation of requirements into a solution vision, high-level business and/or IT system specifications, and a portfolio of implementation tasks". Within the context of the GIRA, the solution architecture describes the specific architecture of a solution. It can be derived from a solution architecture template.

Solution. A solution consists of one or more Solution Building Blocks to meet a certain stakeholder need. Within the context of the GIRA, a solution is usually an Interoperable GOU Solution developed by MDAs that facilitate the delivery of electronic Public Services of information between MDAs or Citizens or Business in support to the implementation and advancement of GOU public policies.

The Key Interoperability Enablers viewpoint in Figure 4models the key interoperability enablers. The viewpoint uses the ArchiMate© motivation extension to assess the structural interoperability readiness, the behavioral interoperability readiness and the governance interoperability readiness of solutions that are necessary to enable the efficient and effective delivery of public services across administrations. GOU public service provision often requires different ADMs to work together to meet end users' needs and provide public services in an integrated way. When multiple organisations are involved, there is a need for coordination and governance by the authorities with a mandate for planning, implementing and operating public services. Services should be governed to ensure: collaboration, seamless execution, reuse of services and data, and development of new services and 'building blocks'.

The Key Interoperability Enablers viewpoint covers all e-GIF interoperability aspects: legal, organisational, semantic and technical. Ensuring interoperability when preparing legal instruments, organisation business processes, data/information/knowledge exchange, services and components that support GOU interoperable digital public services is a continuous task, as interoperability is regularly disrupted by changes to the environment, i.e., in legislation, the needs of businesses or citizens, the organisational structure of public administrations, the business processes, and by the emergence of new technologies.

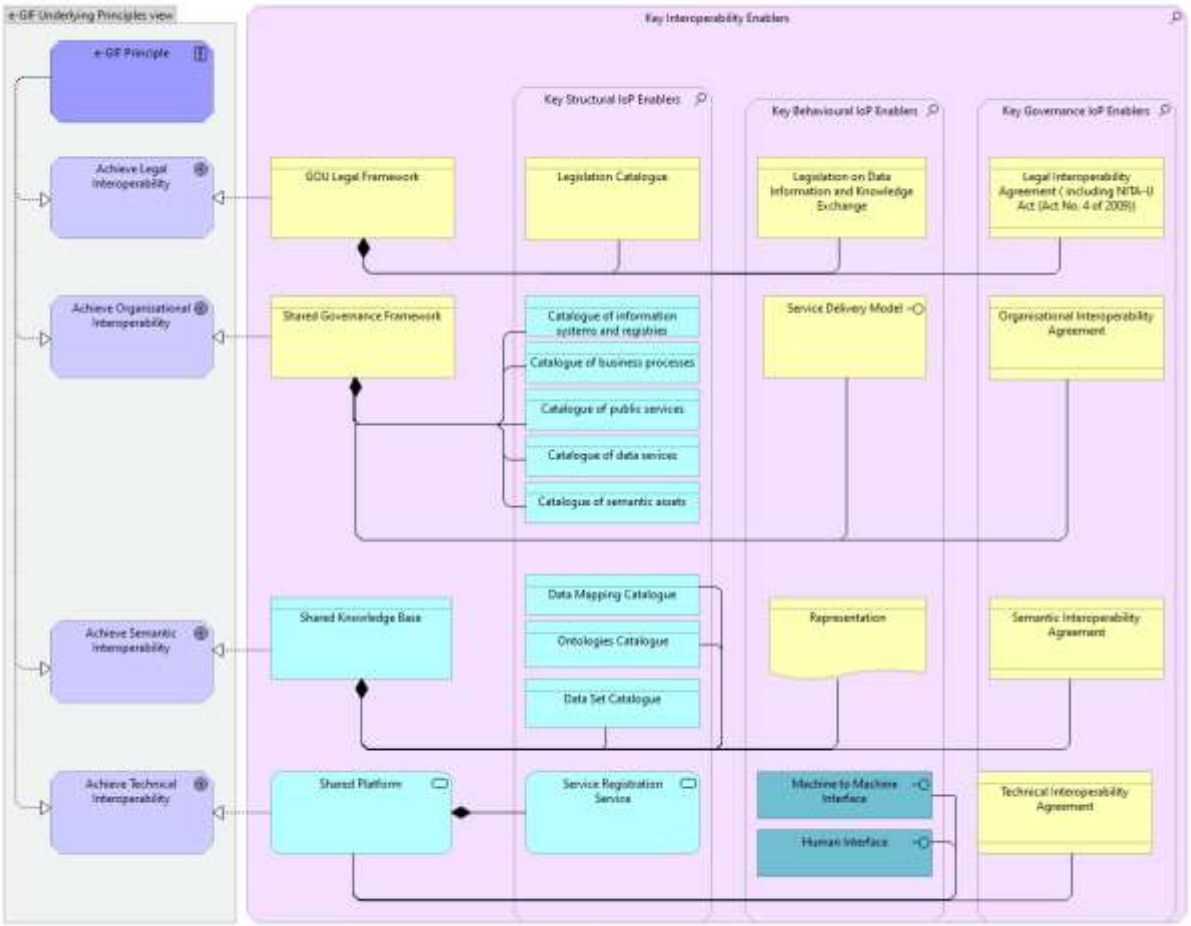

Figure 4 Key enablers of GIRA

This viewpoint selects Architecture Building Blocks of the GIRA that are key enablers for the interoperability of public services:

1. e-GIF [Interoperability Principles] are used to realise the overall goal of [Achieving Interoperability].

2. The goal of [Achieving Legal Interoperability] is realised by a shared legal framework of [re]usable legal resources that enables:

- structural interoperability by legal resources supporting reusing and/or sharing legislation (i.e., legislation catalogue enabling provisioning/consuming legal texts cross ADMs);
- behavioural interoperability by legal resources supporting exchanging capabilities of data, information or knowledge with internal/external peers (i.e. Legislation on knowledge, information and data exchange enabling that data/information/knowledge be provisioned/consumed cross MDAs and cross borders); and
- governance interoperability by legislation supporting the collaboration with internal/external peers exchanging data, information or knowledge (i.e., Legal Interoperability Agreements on legal terms assuring juridical certainty enabling agreed

legal terms/conditions for sharing, reuse and exchange of data/information/knowledge cross MDAs and cross borders).

3. The goal of [Achieving Organisational Interoperability] is realised by a shared governance framework of [re]usable organisational resources that enables:

- structural interoperability by organisational resources supporting reusing and/or sharing of digital public services (i.e., public services catalogue enabling provisioning/consuming public services cross MDAs);
- behavioural interoperability by organisational resources supporting exchanging capabilities of data, information or knowledge with internal/external peers (i.e., service delivery model enabling that data/information/knowledge be provisioned/consumed cross MDAs); and
- governance interoperability by governance resources supporting the collaboration with internal/external peers exchanging data, information or knowledge (i.e., Organisational Interoperability Agreements on organisational terms/conditions enabling sharing, reuse and exchange of data/information/knowledge cross MDAs).

4. The goal of [Achieving Semantic Interoperability] is realised by a shared knowledge base of usable data, information and knowledge resources that enables:

- structural interoperability by semantic resources supporting reusing and/or sharing of data, information and knowledge (i.e., data set catalogue enabling provisioning/consuming data, information and knowledge cross MDAs);
- behavioural interoperability by semantic resources supporting exchanging capabilities of data, information or knowledge with internal/external peers (i.e., Metadata mappings enabling that data/information/knowledge be provisioned/consumed cross MDAs); and
- governance interoperability by semantic resources supporting the collaboration with internal/external peers exchanging data, information or knowledge (i.e., Sematic Interoperability Agreements on interpretations enabling sharing, reuse and exchange of data/information/knowledge cross MDAs

5. The goal of [Achieving Semantic Interoperability] is realised by a shared platform of [re]usable ICT resources (i.e., the platform) that enables:

- Structural interoperability by ICT resources supporting reusing and/or sharing of data, information and knowledge (i.e., service registry service enabling provisioning/consuming [back-office] services cross MDAs);
- Behavioural interoperability by ICT resources supporting exchanging capabilities of data, information or knowledge with internal/external peers (i.e., technical interfaces enabling that data/information/knowledge be provisioned/consumed cross MDAs); and
- Governance interoperability by ICT resources supporting the collaboration with internal/external peers exchanging data, information or knowledge (i.e., Technical Interoperability Agreements on technical terms/conditions enabling sharing, reuse and exchange of data/information/knowledge cross MDAs).

1.5. GIRA Ontology viewpoint

The following list explains the different relationships between the key concepts of GIRA depicted in Figure 5:

- The GIRA has GIRA Views, each GIRA view aligns with one or more e-GIF Interoperability Levels
- Each GIRA view has GIRA Architecture Building Blocks
- The GIRA has GIRA Viewpoints that conform to GIRA Views
- A GIRA Architecture Building Block is modelled as a specialisation of a TOGAF® Architecture Building Block
- A Key Interoperability Enabler is a GIRA Architecture Building Block, which is necessary to enable the efficient and effective delivery of public services across MDAs.
- A GIRA Architecture Building Block has interoperability requirements. An Interoperability Requirement is a statement of an interoperable need that must be realised by a system. Interoperability Requirements can be formulated for all the e-GIF interoperability levels: Legal Interoperability Requirements, Organisational Interoperability Requirements, Semantic Interoperability Requirements, and Technical Interoperability Requirements.
- Interoperability requirements are grouped in Interoperability Aspects. An Interoperability Aspect is an externally observable characteristic or a set of characteristics to be provided/supported by the solution that fulfils partially or internally a stakeholder interoperability need.
- An Interoperability Specification is a document containing agreed normative statements for solution building blocks used in an information exchange context. It can refer to existing standards or specifications. An Interoperability Specification realises an Interoperability Requirement.
- A GIRA Solution Building Block is a realisation of an EIRA© Architecture Building Block and a specialization of a TOGAF® Solution Building Block
- A Solution consists of GIRA Solution Building Blocks and TOGAF® Solution Building Blocks

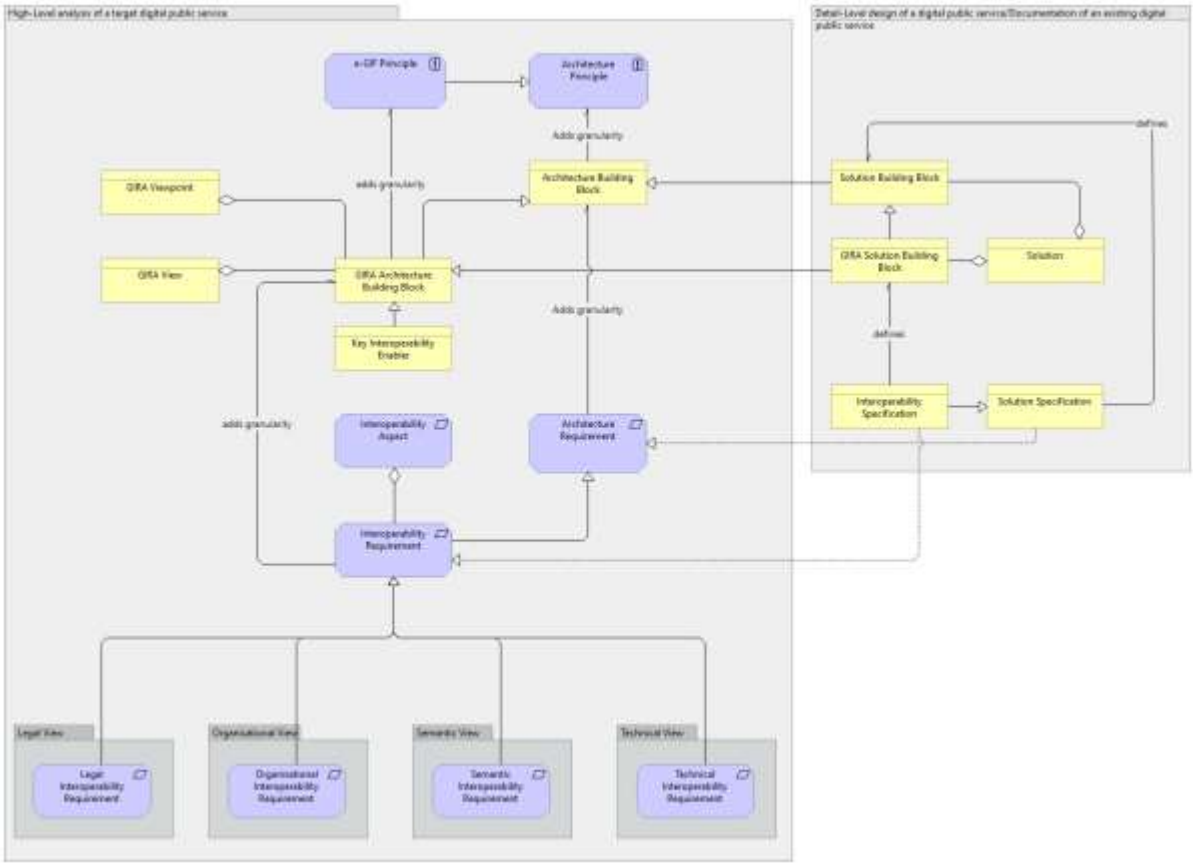

Figure 5 Ontology viewpoint of GIRA.

Ontology viewpoint ABBs used in the figure are described in more details in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using the list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Architecture Principle.

Architecture Requirement

e-GIF Principle

GIRA Solution Building Block

GIRA View.

GIRA Viewpoint.

Interoperability Requirement

Interoperability Specification.

Key Interoperability Enabler

Organisational Interoperability Requirement

Semantic Interoperability Requirement

Solution.

Solution specification

Technical Interoperability Requirement

1.6. Benefits

The use of the GIRA will provide the following benefits, which are explained in the subsequent sections:

- Proving a controlled vocabulary
- Decoupling functionalities in Architectural Building Blocks
- Facilitating the identification of Interoperability Specifications
- Providing the key interoperability enabler Architectural Building Blocks
- Accelerating the development cycle
- Supporting portfolio management decision making
- Supporting public policy formulation

1.6.1. Providing a controlled vocabulary

Being a controlled vocabulary, the GIRA provides a common language of Architecture Building Blocks for the design and comparison of the solution architectures of eGovernment solutions. Architects are thus enabled to easily understand the functionality of other solutions that are based on the GIRA as well as the interfaces to other solutions where those are documented in the same language.

1.6.2. Decoupling functionalities in Architectural Building Blocks

Each Architecture Building Block in the GIRA provides decoupled functionality meaning that the ABBs are autonomous and unaware of the other Architecture Building Blocks within the same context. The autonomous nature of the ABBs is an absolute necessity for reusability, provided that the interfaces are clearly defined. The decoupling also helps in rationalisation exercises where one Solution Building Block can be exchanged with another Solution Building Block, if they both "realise" the same Architecture Building Block.

1.6.3. Facilitating the identification of Interoperability Specifications

The GIRA allows stakeholders/MDAs to effectively communicate with other MDAs when systems across organisational borders have to interoperate. The GIRA facilitates the identification of interoperability specifications and promotes the use of common interoperability specifications based on open standards.

Architects and system owners can then rely on these interoperability specifications to ensure

- stable interfaces between their systems/services and others inside and outside their own organisations, and
- interfaces towards users that take into account non-technical interoperability aspects like usability, inclusiveness and multilingualism.

Public procurers benefit from an easy way to discover relevant specifications for specific types of solutions, and avoid vendor lock-in.

1.6.4. Accelerating the development cycle

The development cycle is accelerated by the increased application of the principles of service-oriented architecture (SOA). Architects are guided naturally towards service-oriented architecture when using GIRA. This then enables consumption of the system's services by other systems and vice versa without additional investments. Development time of new services is often much higher that integration costs of existing services. In addition, reuse at service level helps avoiding costs typically associated with the reuse of applications or components and accelerates the development cycle of new solutions.

1.6.5. Supporting portfolio management decision making

Portfolio managers are, through the common language, provided with a classification schema that allows

- discovery of systems with identical or overlapping functionalities inside the organisation which might be phased out, and
- identification of Solution Building Blocks that could be made more generic

Architects can learn how making Solution Building Blocks more generic can be achieved. The GIRA identifies the ones with high interoperability relevance that should be implemented as modular services. The central functionalities need to be developed and maintained only once, and competing solutions providing the same functionalities can be replaced by more generic ones.

1.6.6. Supporting public policy formulation

The GIRA supports public policy formulation in the form of impact assessments where possible impacts to available solutions are examined during the public policy preparation phase. The assessments are carried out on initiatives expected to have significant economic, social, or environmental impacts. These can be:

- Legislative proposals
- Non-legislative proposals such as financial plans and recommendations for the negotiations of agreements)
- Implementing and delegating acts

1.7. Scope and Structure

This document is addressed to all those experts involved in defining, designing, developing, delivering, and governing public services. The GIRA is applicable to all MDAs in Uganda.

The target group of the interoperability framework is officials in the public sector with the following roles:

- Permanent Secretaries
- Agency Accounting Officers
- Chief executive officers (CEO),
- Heads of Finance,
- Chief Information Security Officers (CISO),
- Chief Information Officers (CIO),
- Head of IT.

The reference architecture is a guideline for the following users within MDAs and the private sector:

- **Architects**, Enterprise Architects as well as Solution Architects who are responsible for the design of solution architectures
- **Business analysts** responsible for assessing and studying the impact of changes in the (external) environment on IT systems
- **Portfolio managers** responsible for maintaining of assets related to the design and implementation of eGovernment solutions and for making investment decisions on these assets.

The GIRA can be used for building domain-specific architecture frameworks in Uganda. These frameworks should remain compatible with the GIRA, and where necessary, extend the scope of the GIRA to capture the specific ABBs of the domain in question.

The GIRA is oriented to the development of a GOU public services ecosystem in which owners and designers of systems and public services become aware of interoperability requirements, MDAs are ready to collaborate with each other and with businesses and citizens, and information flows seamlessly across Uganda.

The e-GIF's scope covers three types of interactions:

- A2A (MDA to MDA), which refers to interactions between MDAs.

- A2B (MDA to business), which refers to interactions between MDAs and businesses.
- A2C (MDA to citizen), which refers to interactions between MDAs and citizens.

It must be noted that the GIRA can also be used for B2B (business to business) and B2C (business to citizens) interactions.

The GIRA content and structure is presented below:

Chapter 1 provides an overview of the GIRA. It includes background information, methodology, context in building the GEA, key concept, ontology, and benefits.

Chapter 2 provides a vision for the GOU enterprise architecture development lifecycle.

Chapter 3 provides business reference architecture. It includes the legal and the organisational views.

Chapter 4 provides data reference architecture. It includes the semantic architecture view.

Chapter 5 provides reference application architecture. It includes the application view.

Chapter 6 provides technical reference architecture. It includes the Infrastructure view.

Chapter 7 is dedicated to the horisontal privacy viewpoint.

Chapter 8 gives viewpoint to the security architecture.

Chapter 9 lists and describes the GIRA architecture building blocks. All other chapters have links to these ABBs.

2. The Vision

2.1. Architecture Principles View

Architecture Principles define the underlying general rules and guidelines for the use and deployment of all IT resources and assets across the GOU. They reflect a level of consensus among the various elements of the GOU and form the basis for making future IT decisions.

The GIRA is aligned with the GOU Interoperability Framework (e-GIF). The views of the GIRA correspond to the interoperability levels in the EIF: legal, organisational, semantic, and technical interoperability. The GIRA reuses terminology and paradigms from TOGAF® such as architecture patterns, building blocks and views.

Five types of architecture principles are distinguished (Figure 6):

- E-GIF underlying principles,
- Digital Public Service Strategy,
- Digital Public Service Design,
- Digital Public Service Operations,
- Improvement (includes principles of DUV)

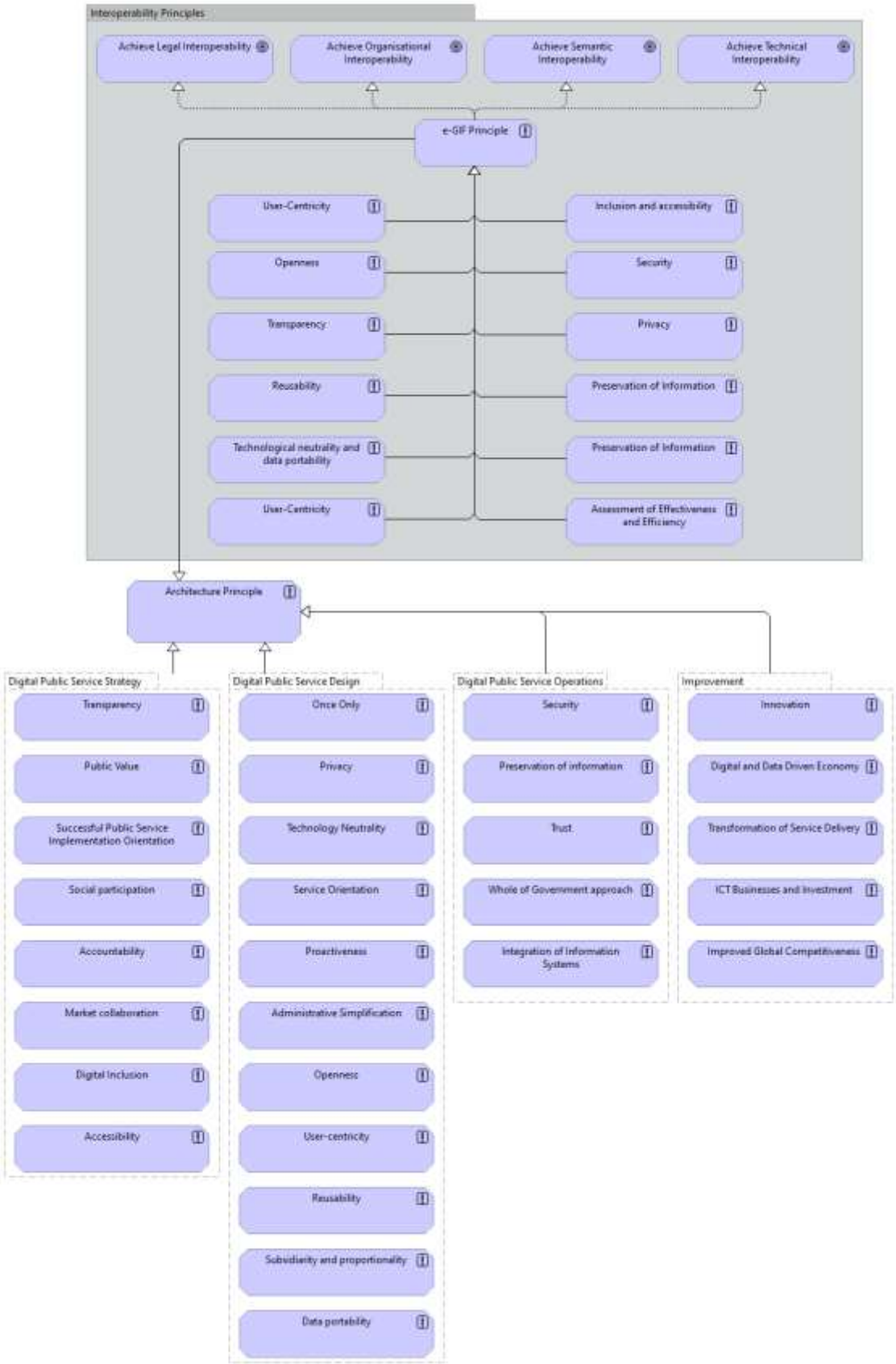

Figure 6 Architecture principles view

2.2. Conceptual model viewpoint

The GOU e-GIF[9] proposes a conceptual model for integrated public services. It is relevant to all governmental levels: local, government bodies, ministerial, national. The model exposes modular and comprises loosely coupled service components interconnected through shared infrastructure. The GIRA is aligned with the e-GIF conceptual model. This model in terms of ArchiMate is depicted in Figure 7.

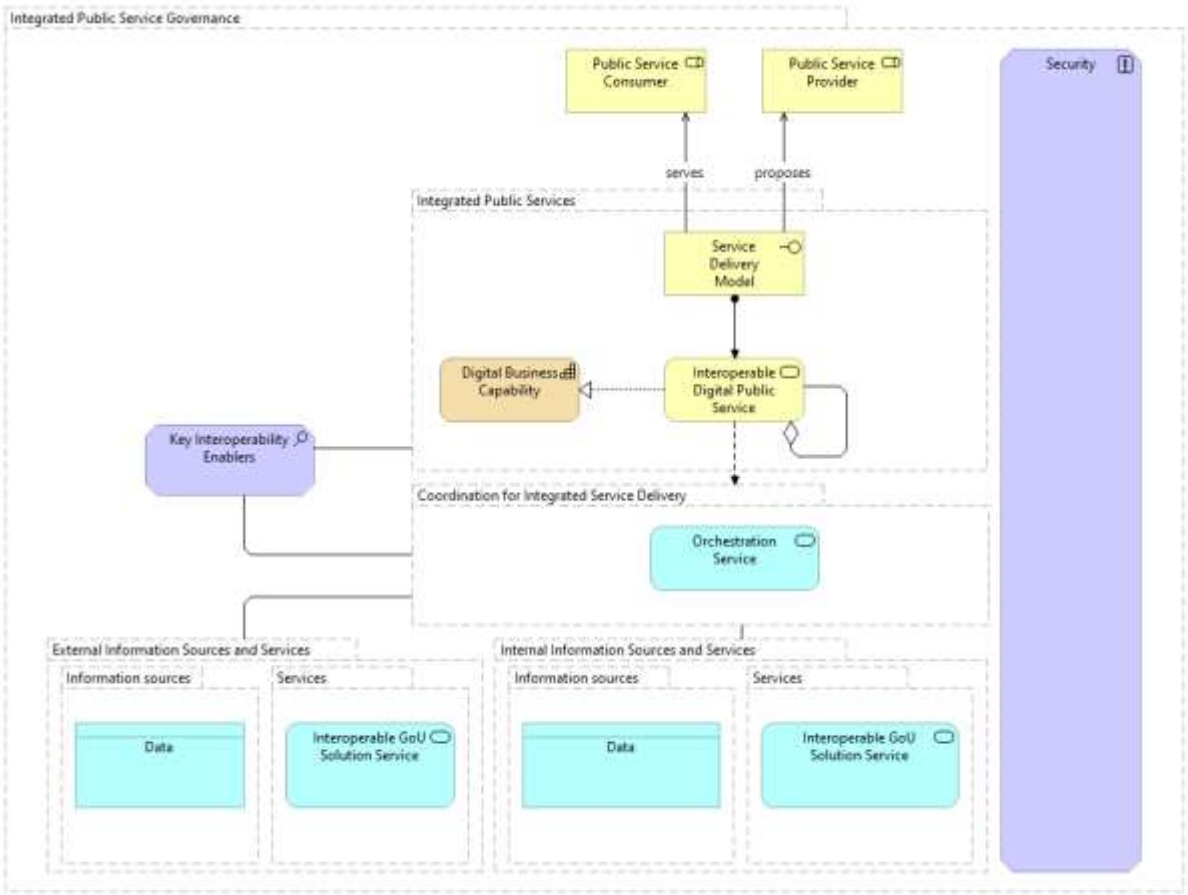

Figure 7 Conceptual model for integrated public services

The Conceptual Model promotes reusability as a driver for interoperability (interoperability by design), recognising that the GOU's public services should reuse information and services that already exist and may be available from various sources inside or beyond the organisational boundaries of the MDAs. Information and services should be retrievable and be made available in interoperable formats. Security and privacy requirements should be considered and measures for the provision of each public service according to risk management plans should

[9] Chapter 5 of GoU e-GIF

be identified. Trust services should ensure secure and protected data exchange in public services.

Conceptual Model viewpoint ABBs used in the figure are described in more details in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using the list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Public Service Consumer

Public Service Provider.

Service Delivery Model.

Orchestration Service

Data

Interoperable Solution Service

2.3. High level viewpoint

The high-level viewpoint of Ugandan interoperability architecture is depicted in Figure 8. The GIRA provides a set of Architecture Building Blocks, important to facilitate interoperability of any GOU solution. Each view is represented by the Architecture Building Blocks needed to deliver an interoperable solution. The high-level viewpoint is structured according to the following architectural views:

- **The Architecture principles view.** The Architecture Principle view shows that Interoperability Specifications realise ABB Interoperability Principles. The interoperability Specifications can be used to define the interoperability aspects for any other of the Architecture Building Blocks.
- **The Legal view.** The GOU Public Policy and GOU legal framework which are the basis of the legal view.
- **The Organisational view**. Public Service can be an aggregation of other Public Services serving Consumers and is provided by a Service Provider. The Public Service is realised by a Business Capability, which can be an aggregation of other Business Capabilities.
- **The Semantic view**. The Semantic view models the most salient Architecture Building Blocks that should be considered in order to support semantic aspects for the End to End design of interoperable digital public services.
- **The Application view.** The application view contains the most salient application Architecture Building Blocks that need to be considered in order to support technical aspects for the End to End design of Interoperable GoU Solutions.
- **The Technical view.** The Technical - Infrastructure view provides an architecture content metamodel for the most salient cross-sectorial infrastructure services, along with the supporting hosting and networking facilities, which shall be considered in order to support technical aspects for the End to End design of Interoperable GOU

Solutions. The difference with the application part of the Technical view is that the Architecture Building Blocks in the infrastructure view are considered to be relevant for solutions in any sector of government.

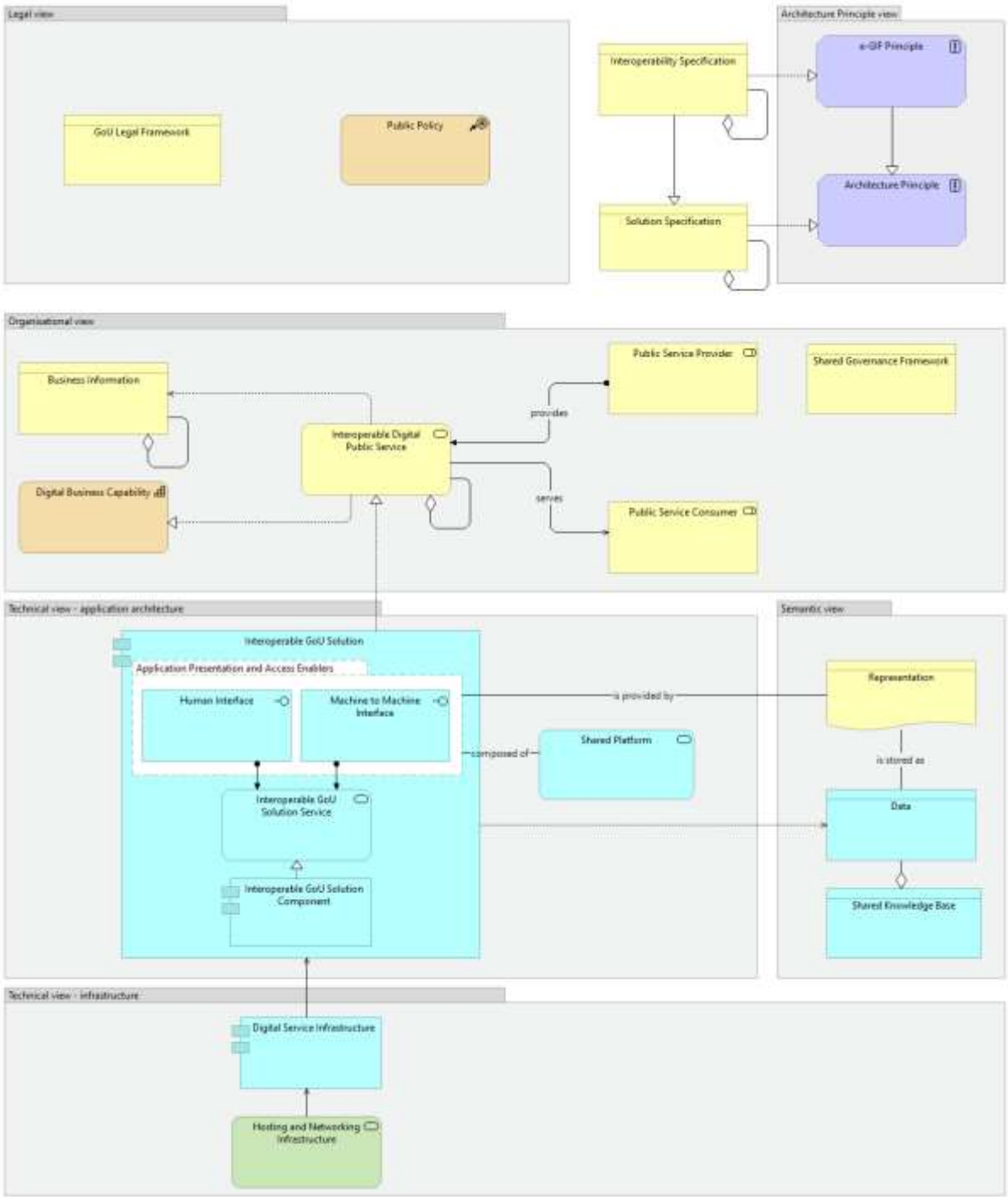

Figure 8. High-level GIRA

Model viewpoint ABBs used in the figure are described in more details in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using the list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Business information

Data

Digital Service Infrastructure

e-GIF Principle

Hosting and Networking Infrastructure

Human Interface

Interoperability Specification

Interoperable Solution Component

Interoperable Solution Service

Machine to Machine Interface

Public Policy

Public Service Consumer

Public Service Provider

Representation

Shared Governance Framework

Shared Knowledge Base

Shared Legal Framework

Shared Platform

2.4. Interoperability Specification viewpoint

An Interoperability Specification is a document formulated as an agreed normative statement in design terms on a legal, organisational, semantic, or technical attribute. It can refer to existing standards or specifications

The Interoperability specification viewpoint models the most salient Architecture Building Blocks that shall be considered when providing interoperability specifications. It provides an overview of Architecture Building Blocks from the different views and depicts them as a taxonomy of interoperability specifications. Each GIRA view has Architecture Building Blocks that support interoperability.

Each view's interoperability specifications serve to define the interoperability aspects of catalogues and registries, addressing both their contents and the respective catalogue or registry as a whole. Given the linked nature of the GIRA views, the interoperability specifications from all views can be considered to affect each individual catalogue or registry. However, the focus in each case is kept within the specific view to best capture the level of detail that each view's specifications deal with.

An Interoperability Specification is a Specification and can be composed of other Interoperability Specifications. This viewpoint selects Architecture Building Blocks from the five different views highlighting the interoperability specification related Architecture Building Blocks of the GIRA.

Interoperability Specification viewpoint is depicted in Figure 9.

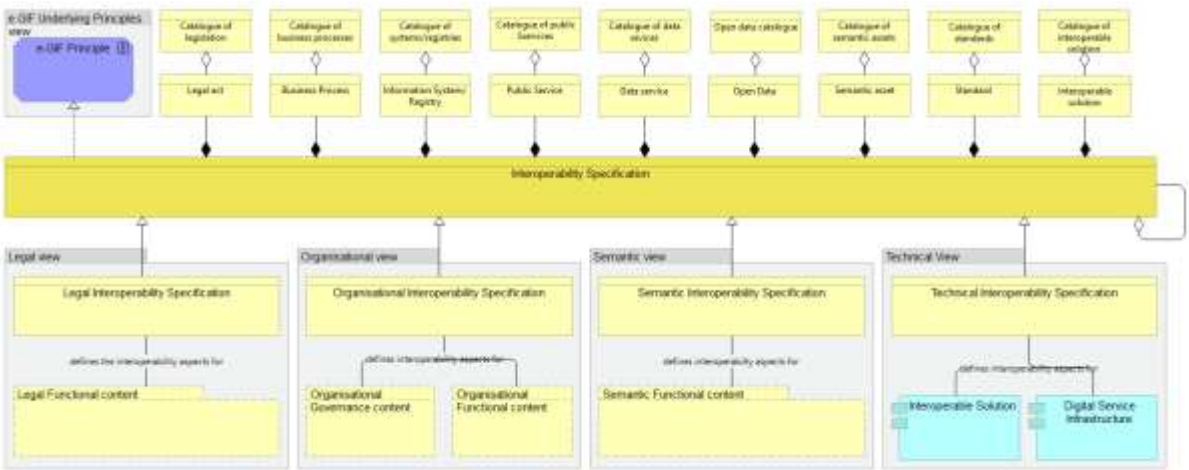

Figure 9 Interoperability Specification viewpoint

3.Business architecture

3.1. GIRA Legal view

The GIRA Legal View models the most salient public policy development enablers and implementation instruments that shall be considered in order to support the End-to-End design of interoperable digital public services. Figure 10 illustrates the most important ABBs of legal architecture.

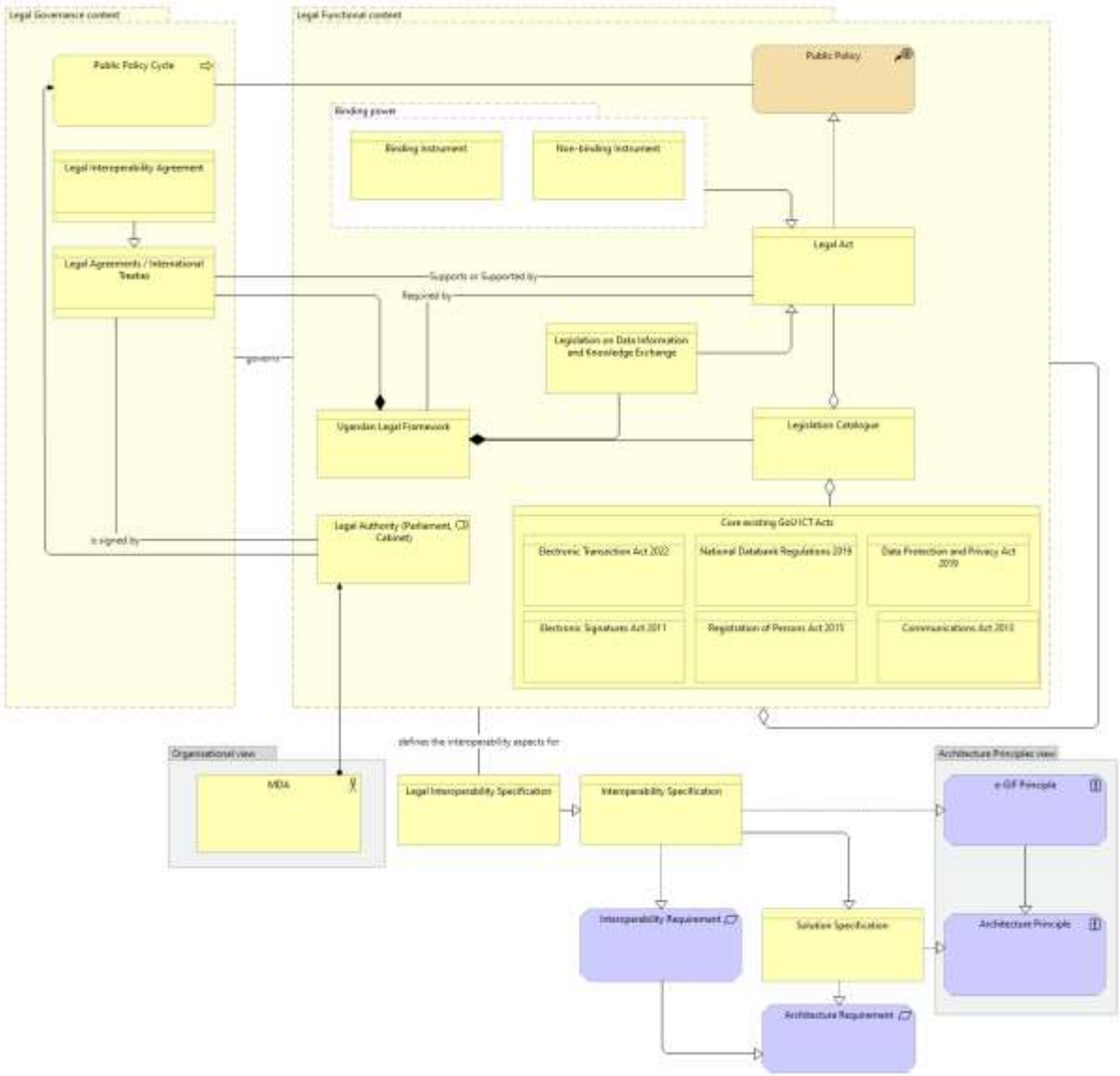

Figure 10 GIRA Legal view

Legal view viewpoint ABBs used in the figure are described in more details in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using the list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Binding Instrument.

Interoperability Specification.

Legal Act

Legal Authority

Legal agreements/ International treaties

Legal Interoperability Agreement

Legal Interoperability Agreement

Legislation Catalogue

Legislation on data information and knowledge exchange

Non-Binding Instrument

Public Policy Cycle

Public Policy

3.2. GIRA Organisational View

The GOU information systems and services operate in a complex and changing environment. Political support is necessary for cross-sectoral efforts to facilitate cooperation between MDAs. Interoperability between MDAs at different administrative levels will only be successful if governments give enough priority and assign resources to their respective interoperability efforts.

The Organisational view models the most salient Architecture Building Blocks that shall be considered in order to support organisational aspects for the End-to-End design of interoperable digital public services.

Figure 11 illustrates the most important ABBs of organisational architecture.

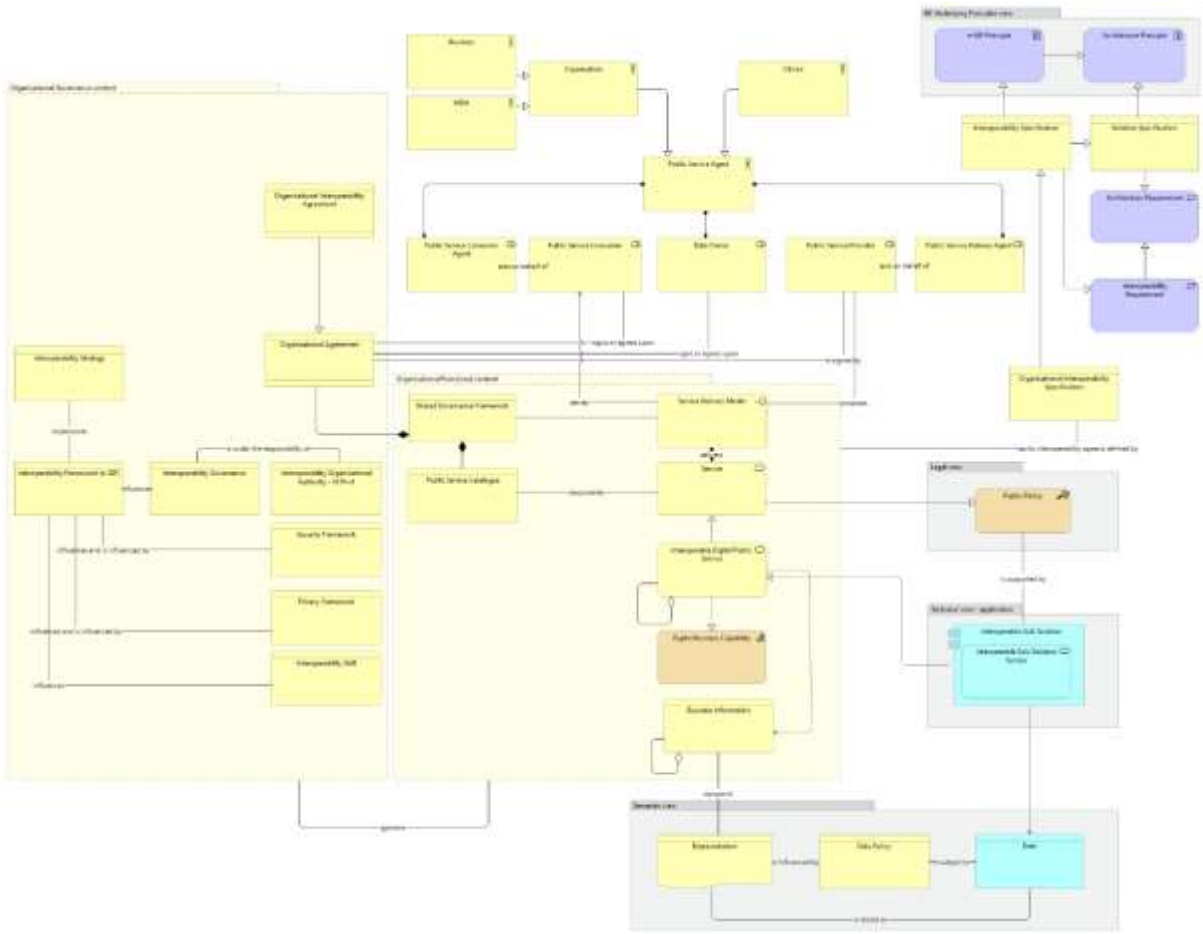

Figure 11 GIRA Organisational View

Organisational view ABBs used in the figure are described in more detail in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using the list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Business Business **information**

Citizen

Data Owner

Interoperability Framework (e-GIF).

Interoperability Governance

Interoperability Organisational Authority

Interoperability Skill.

Interoperability Strategy

Interoperable Digital Public Services.

Organisation

Organisational Interoperability Agreement.

Public Service Agent

Public Service Catalogue

Public Service Consumer

Public Service Provider.

Security Framework

Service Delivery Model.

3.3. Interoperability Governance Viewpoint

There is a need for high level coordination of the e-government activities between the various units of the government. NITA-U SHOULD have the legal rights and competence to take binding decisions.

All government institutions like to modernise their processes by using modern technology. The idea of the coordination is not to centralise all decision making and technical capacities. Vice versa, the idea is to support innovation and service delivery modernisation in every government institution.

The tools of coordination are policies, legislation and regulations, budgeting, monitoring, common standards, allowing nation-wide re-use of data, data exchange, re-use of the software solutions and rapid development of the online services.

The Interoperability Governance viewpoint models the most salient Architecture Building Blocks that refer to decisions on interoperability frameworks, institutional arrangements, organisational structures, roles and responsibilities, policies, agreements and other aspects of ensuring and monitoring interoperability at interagency level. As such, it does not include operational Architecture Building Blocks like interoperability agreements.

Interoperability governance is the key to a holistic approach on interoperability, as it brings together all the instruments needed to apply it.

The organizational view in Figure 12 illustrates the most important ABBs of Governance viewpoint.

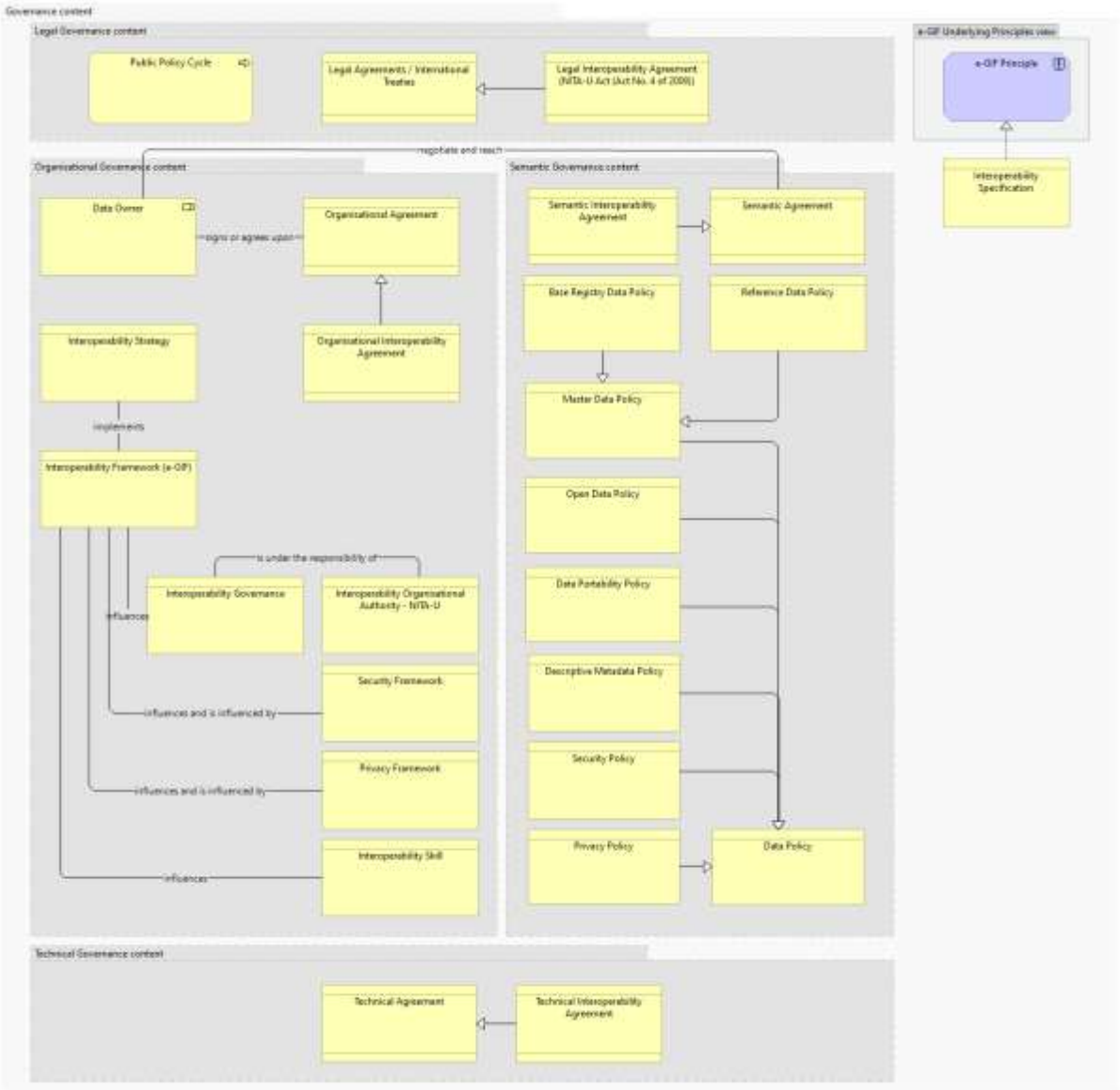

Figure 12 Interoperability Governance viewpoint

Interoperability governance viewpoint ABBs used in the figure are described in more detail in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using the list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Base Registry Data Policy

Data Owner

Data Policy.

Data Portability Policy.

Descriptive Metadata Policy

e-GIF Principle

Interoperability Framework (e-GIF).

Interoperability Governance

Interoperability Organisational Authority

Interoperability Skill.

Interoperability Specification.

Interoperability Strategy

Legal Interoperability Agreement

Master Data Policy.

Open Data Policy

Organisational Interoperability Agreement.

Privacy Policy.

Public Policy Cycle

Reference Data Policy

Security Framework

Security Policy

Semantic Agreement.

Semantic Interoperability Agreement

Technical Agreement.

Technical Interoperability Agreement.

4. Data architecture

The Semantic view models the most salient Architecture Building Blocks that should be considered in order to support semantic aspects for the End-to-End design of interoperable digital public services. Semantic interoperability view in Figure 13 illustrates the most important ABBs of data architecture.

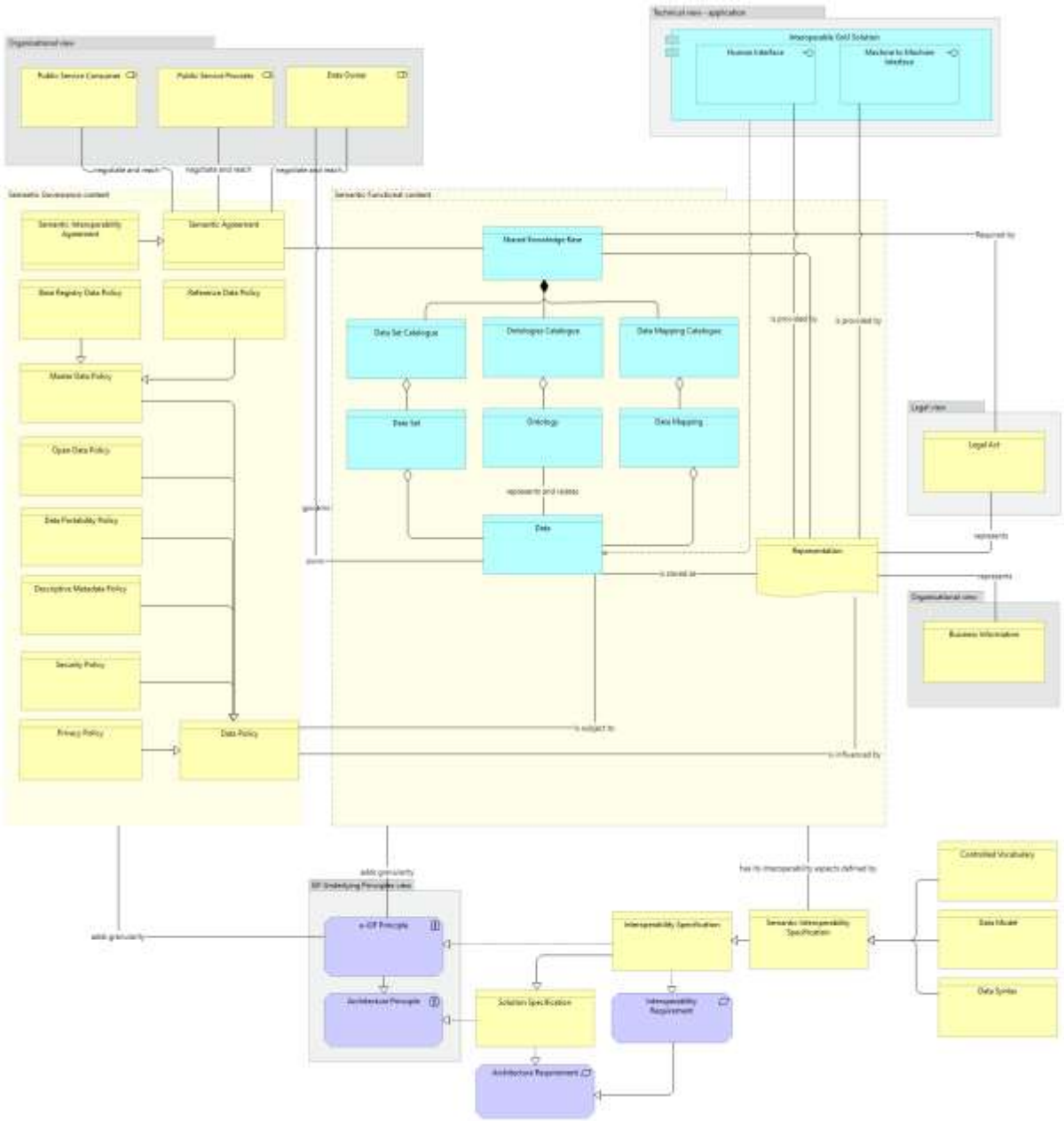

Figure 13 Data interoperability view

Data interoperability viewpoint ABBs used in the figure are described in more detail in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Architecture Requirement

Base Registry Data Policy

Controlled Vocabulary

Data

Data mapping

Data Model

Data Policy.

Data Portability Policy.

Data set

Data Set Catalogue

Data Syntax

Descriptive Metadata Policy

Interoperability Requirement

Interoperability Specification.

Master Data Policy.

Ontology

Ontologies Catalogue

Open Data Policy

Privacy Policy.

Reference Data Policy

Representation

Security Policy

Semantic Agreement.

Semantic Interoperability Agreement

Semantic Interoperability Specification

5.Application Architecture

Application - Domain specific view contains the most salient application Architecture Building Blocks that need to be considered in order to support technical aspects for the End-to-End design of Interoperable Solutions.

The view depicts application architecture of any MDA solution. The view does not reflect the use of infrastructure services in detail. Infrastructure view, supporting ABB **Digital Service Infrastructure,** is described in granularity in chapter 6.

Application Interoperability view in Figure 14 illustrates the most important ABBs of application architecture.

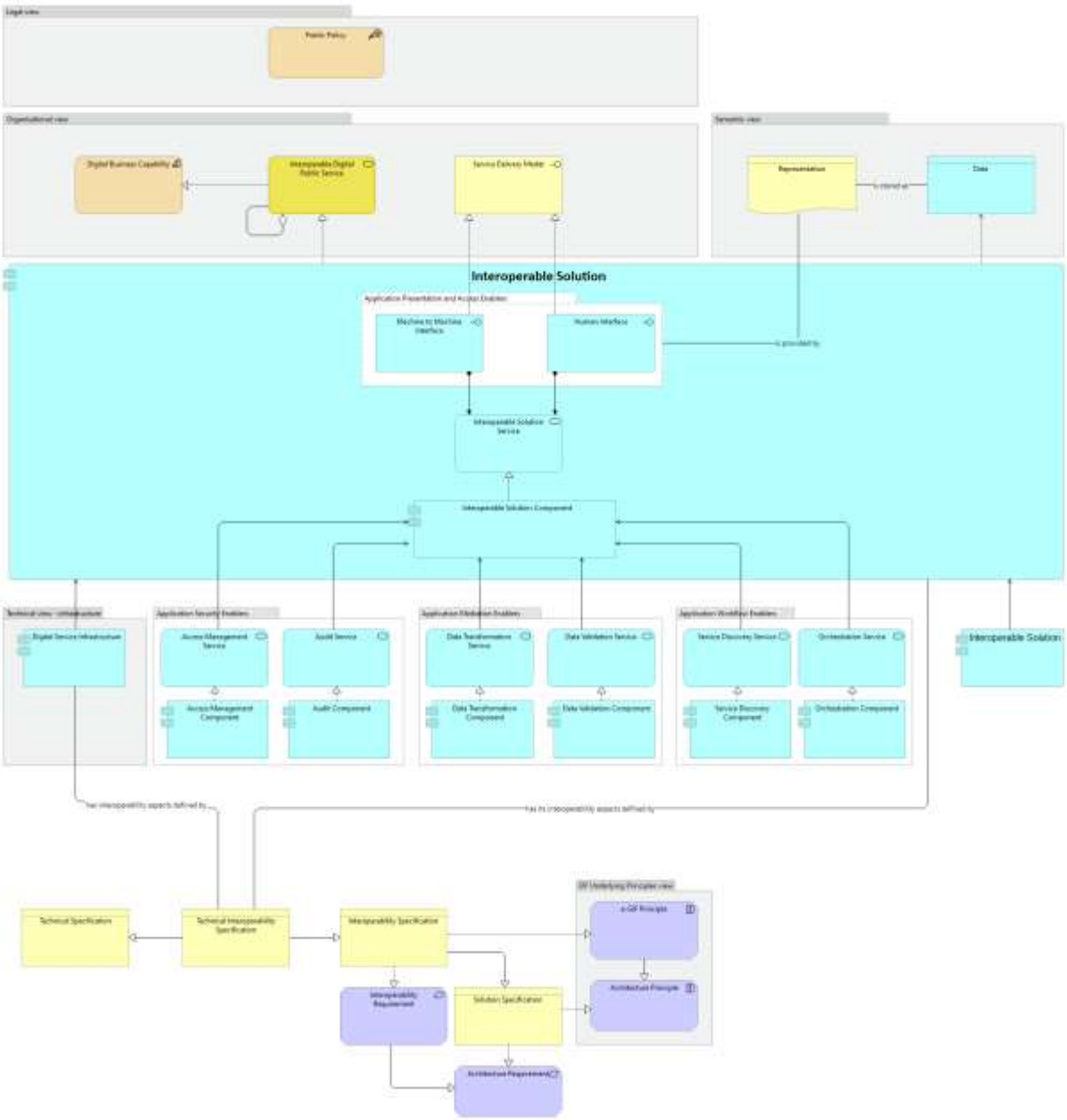

Figure 14 Application architecture view

Application architecture viewpoint ABBs used in the figure are described in more detail in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Access Management Component.

Access Management Service

Audit Component.

Audit Service

Data Transformation Component

Data Transformation Service

Data Validation Component

Data Validation Service

Digital Service Infrastructure

Human Interface

Interoperable Solution

Interoperable Solution Component

Interoperable Solution Service

Machine to Machine Interface

Orchestration Component

Orchestration Service

Service Discovery Service

Technical Interoperability Agreement.

Technical Agreement.

6. Technical architecture

The GIRA Infrastructure view depicted in Figure 15 provides an architecture content metamodel for the most salient cross-sectorial infrastructure services, along with the supporting hosting and networking facilities, which shall be considered in order to support technical aspects for the End-to-End design of Interoperable Solutions. The difference with the application part of the Application view is that the Architecture Building Blocks in the infrastructure view are considered to be relevant for solutions in any sector of government.

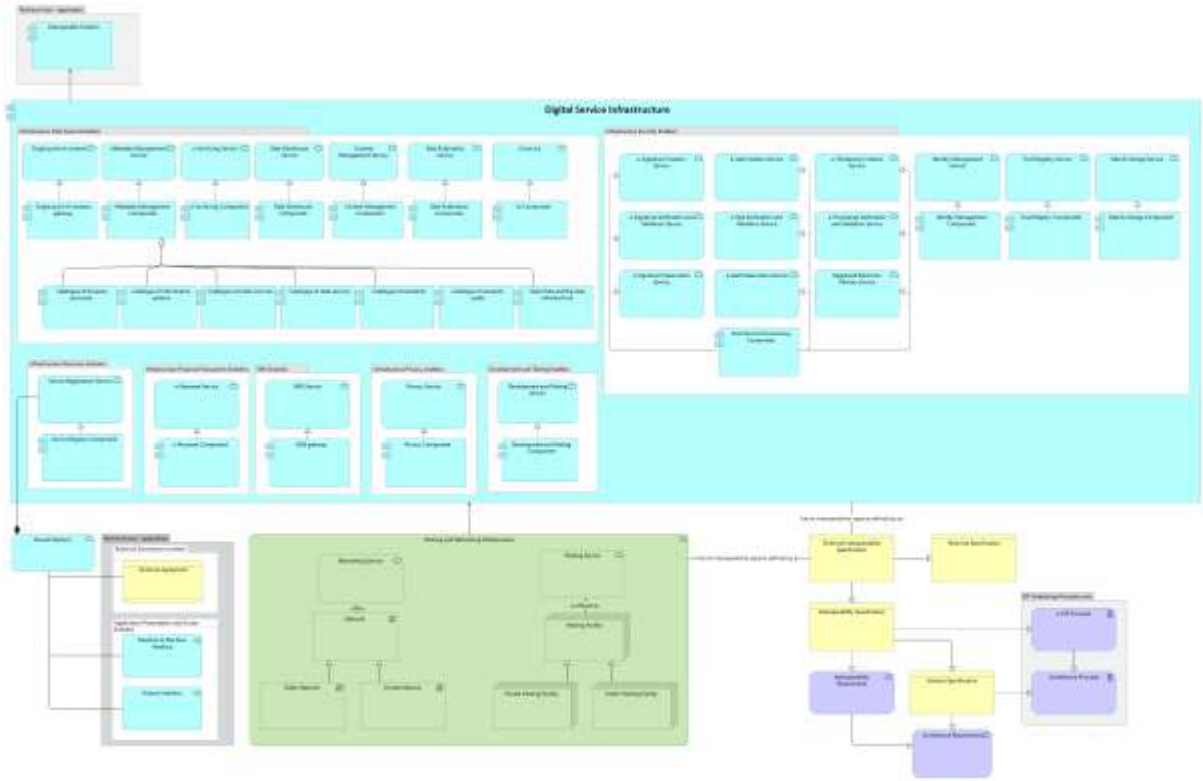

Figure 15 GIRA infrastructure view

Infrastructure architecture viewpoint ABBs used in the figure are described in more detail in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

AI service

Big data infrastructure

Catalogue of business processes

Catalogue of data services

Catalogue of information systems and registries

Catalogue of public services

Catalogue of semantic assets

Catalogue of standards

Content Management Service

Data Exchange Component.

Data Exchange Service.

Data Publication Component

Data Publication Service

Data Warehouse Component

Data Warehouse Service

Access Management Component. e-Archiving Component

e-Archiving Service

e-Payment Component

e-Payment Service

e-Seal Creation Service.

e-Seal Preservation Service.

e-Seal Verification and Validation Service

e-Signature Creation Service

e-Signature Preservation Service

e-Signature Verification and Validation Service

e-Timestamp Creation Service.

e-Timestamp Verification and Validation Service

Hosting Facility

Hosting Service

Identity Management Component

Identity Management Service

Interoperability Requirement

Interoperability Specification.

Metadata Management Component

Metadata Management Service

Network

Networking Service

Point of single contact

Privacy Component

Privacy Service

Private Hosting Facility

Private Network

Public Hosting Facility

Public Network

Registered Electronic Delivery Service

Service Registration Service

Service Registry Component

Shared Platform

Solution specification

Technical Interoperability Specification

Technical Specification.

Trust Registry Component

Trust Registry Service.

Catalogue of business processes

7.Privacy Viewpoint

The Interoperability Privacy viewpoint in Figure 16 highlights the GIRA building blocks that are relevant when implementing the Data Protection and Privacy Act 2019 (DPPA) or assessing an existing architecture against the data protection principles. MDAs must indeed guarantee the citizens' privacy, and the confidentiality, authenticity, integrity, and non-repudiation of information provided by citizens and businesses.

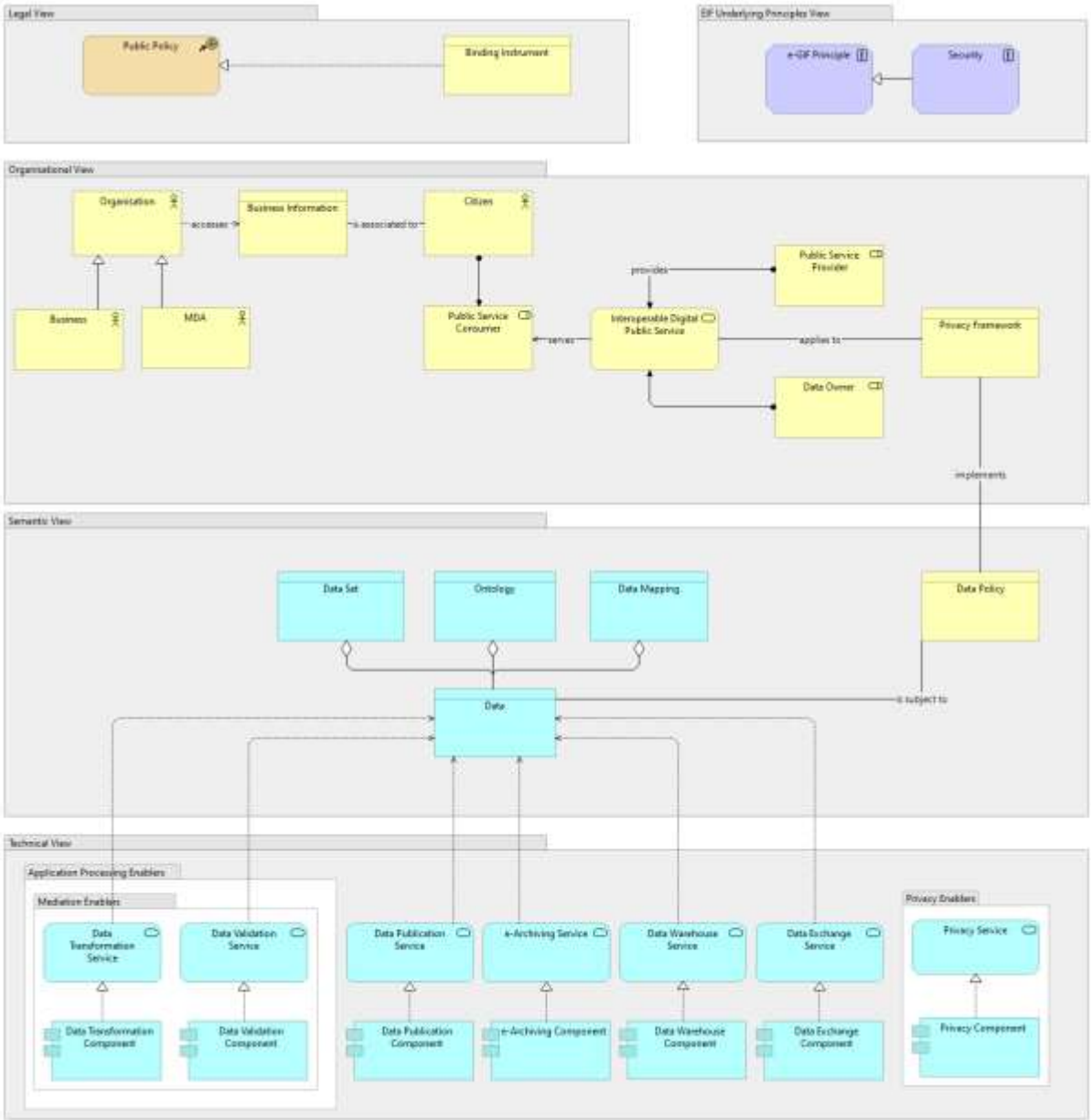

Figure 16 Privacy viewpoint

The selected Architecture Building Blocks from the five different views highlight the Architecture Building Blocks of the GIRA that are relevant with respect to privacy protection:

1. The legal view shows that privacy requirements are coming from a [Public Policy] realised by a [Binding instrument] (the DPPA itself).

2. The organisational view shows that the roles of [Public Service Consumer] and [Public Service Provider] in the delivery of a [Public Service] are impacted. Specific privacy roles are indeed associated to these roles. All [Exchanges of Business Information] are impacted if the associated [Business Information] involve personal data of a [Citizen]. A [Privacy Framework] needs to be associated to the [Business Capability] implemented by the [Exchange of Business Information].

3. The semantic view shows that [Data] and [Data Sets], if involving personal data, are impacted, as a relevant [Data Policy], respecting the [Privacy Framework], needs to be applied.

4. The Technical View shows that many services involving data are impacted by the privacy regulation, such as [Data Transformation Service], [Data Validation Service], [e-Archiving Service], [Data Publication Service], [Data Exchange Service]. Additionally, a [Privacy Service] can be used to ensure compliance.

8.Security viewpoint

Security Architecture (SA) layers in the architecture will be present and pervade through all areas and layers, and cover access to data, systems, and services along with other dimensions of protection from threat, vulnerability exploitation and intrusion.

The Security Architecture viewpoint models the most salient Architecture Building Blocks related to security. Citizens and businesses must be confident that when they interact with public authorities they are doing so in a secure and trustworthy environment and in full compliance with relevant regulations, e.g., the Regulation on electronic identification and trust services. The SA viewpoint of the GEA is illustrated in Figure 17.

Security is a primary concern in the provision of public services. When public administrations and other entities exchange official information, the information should be transferred, depending on security requirements, via a secure, harmonised, managed and controlled network. Transfer mechanisms should facilitate information exchanges between administrations, businesses, and citizens. Appropriate mechanisms should allow secure exchange of electronically verified messages, records, forms, and other kinds of information between the different systems; should handle specific security requirements and electronic identification and trust services such as electronic signatures/seals creation and verification; and should monitor traffic to detect intrusions, changes of data and other type of attacks.

Security Framework is Agreed governance approach focusing on protection aspects on data, information and knowledge assets and organisational resources handling them. More specifically, the Security Framework comes in the form of the Web Application Security Architecture Framework (WASA Framework). It focuses solely on the security architecture of web applications that enable and run e-services. The WASA Framework is intended as an easy-reading guide and a practical Toolkit for GoU's public sector organisations who seek support for protecting their web application for two scenarios:

- Guidance for developing new secure web applications applying security-by-design principle from scratch
- Guidance on validating security controls of existing web applications (i.e., security assessment/auditing, security/penetration testing).

Combining two well-respected security methodologies, SABSA and OWASP ASVS, and customising to meet the needs of GoU, the WASA Framework derives from business attributes (requirements) technical security requirements of web applications while keeping the methodological overhead as slim as possible.

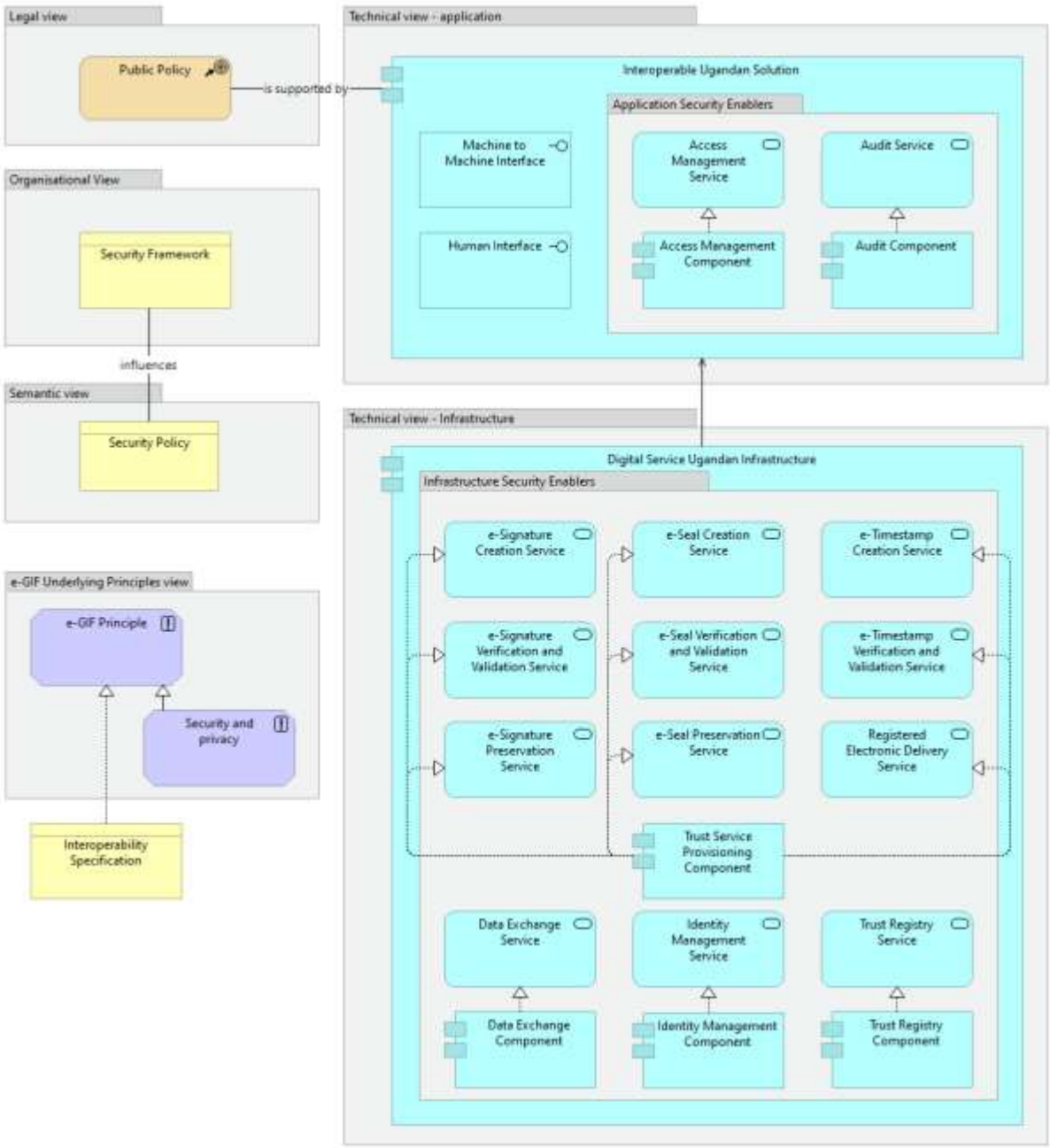

Figure 17 Security viewpoint

Security viewpoint ABBs used in the figure are described in more detail in the Architecture Building Blocks chapter on page 47. You can navigate to the specific descriptions using list of ABBs below ("Ctrl+Click" on the name brings you to the description and "Alt+left arrow key" brings you back here).

Access Management Component.

Access Management Service

Audit Component.

Data Exchange Component.

Data Exchange Service.

e-GIF Principle

e-Seal Creation Service.

e-Seal Preservation Service.

e-Seal Verification and Validation Service

e-Signature Creation Service

e-Signature Preservation Service

e-Signature Verification and Validation Service

e-Timestamp Creation Service.

e-Timestamp Verification and Validation Service

Identity Management Component

Identity Management Service

Registered Electronic Delivery Service

Security Framework

Trust Registry Component

Trust Registry Service.

Catalogue of business processes

9. Architecture Building Blocks

Access Management Component. Implements the functionalities of allowing users to make use of IT services, data, and/or other assets. Access management helps to protect the confidentiality, integrity, and availability of assets by ensuring that only authorised users are able to access or modify the assets.

Access Management Service. Shares the functionality of allowing users to make use of IT services, data, and/or other assets. Access management helps to protect the confidentiality, integrity, and availability of assets by ensuring that only authorized users are able to access or modify the assets.

AI service. Artificial Intelligence as a Service is the third party offering of artificial intelligence outsourcing. AI as a service allows individuals and companies to experiment with AI for various purposes without large initial investment and with lower risk.

Architecture Building Block. An Architecture Building Block (ABB) is a constituent of the architecture model that describes a single aspect of the overall model. An Architecture Building Block describes generic characteristics and functionalities. Architecture Building Blocks are used to describe reference architectures, solution architecture templates or solution architectures of a specific solutions. Source TOGAF®: https://pubs.opengroup.org/architecture/togaf9-doc/arch/chap03.html#tag_03_8.

Architecture Principle. Architecture Principles define the underlying general rules and guidelines for the use and deployment of all IT resources and assets across the enterprise. They reflect a level of consensus among the various elements of the enterprise, and form the basis for making future IT decisions. Source TOGAF® 9.2 The Open Group: https://pubs.opengroup.org/architecture/togaf9-doc/arch/chap20.html#:~:text=Architecture%20Principles%20define%20the%20underlying,for%20making%20future%20IT%20decisions.

Architecture Requirement is a requirement of the highest possible level of granularity for an Architectural Building Block, formulated as an agreed normative statement of a To-Be GOU Public Service

Audit Component. Implements the functionality of providing support for the principle of accountability, which is holding the users of a system accountable for their actions within the system and is detecting policy violations. The audit policy defines the elements of an information system which need to be traced, for example to assure traceability of actions: what, how, when, where and with what.

Audit Service. Shares the audit functionality of providing support for the principle of accountability, which is holding users of a system accountable for their actions within the system, and detection of policy violations. The audit policy defines the elements of an information system which need to be traced, for example to assure traceability of actions: what, how, when, where and with what.

The Audit Service ABB is salient for technical interoperability because it defines the elements of an information system which need to be traced, for example to assure traceability of user actions. ADMs should ensure that a 'data access and authorisation plan' which determines

who has access to what data and under what conditions, to ensure privacy. Unauthorised access and security breaches should be monitored and appropriate actions should be taken to prevent any recurrence of breaches.

Base Registry Data Policy. A Data Policy applying to a trusted authentic source of information under the control of an appointed public administration or organisation appointed by government.

Base registries are reliable sources of basic information on items such as persons, companies, vehicles, licenses, buildings, locations, and roads and are authentic and authoritative and form, separately or in combination, the cornerstone of public services.

The Base Registry Data Policy ABB is salient for semantic interoperability because base registries include "authorative sources of information", that need to be properly governed and made available. EIF's includes base registries in the conceptual model for integrated public services and describes it as "the cornerstone of Ugandan public service delivery".

Big data infrastructure. Big data infrastructure entails the tools and agents that collect data, the software systems and physical storage media that store it, the network that transfers it, the application environments that host the analytics tools that analyze it and the backup or archive infrastructure that backs it up after analysis is complete.

Binding Instrument. The Binding Instrument ABB is relevant for interoperability as, by being a specialisation of the Legal Act, it makes mandatory the implementation of the policy (and therefore the underlying interoperability implications).

Business. Economic operator with a legal entity entitled to perform a private activity for a profit. The Business ABB is salient for organisation interoperability because organisations can play the role of consumers of Public Services.

Business information. Organisationally constructed meaning describing business facts, assets, or opinions that are exchanged in the context of a public service to support its delivery. Examples include an invoice, a medical prescription, a driving license. The Business Information ABB is salient for organisational interoperability because it represents the entity being exchanged between organisations. Its interoperability needs to be guaranteed by means of organisational and semantic interoperability specifications.

Catalogue of business processes. Inventory of business processes with comprehensiveness and trustiness value.

Catalogue of data services. The repository ensures the interoperability of public sector information systems and the reuse of technical, organisational and semantic resources. The service repository is an addition to the metadata kept in the Database of Databases and includes specifications for all web services and a detailed description of government services (including business process descriptions). The repository describes the machine interface of services. This information is needed for establishing machine-machine data exchange.

Catalogue of information systems and registries. This component provides metadata about government registries and information systems: the name of; owner; type; list of services; information about registration and approval; technical architecture; legal acts; SLA; security parameters; logical structure of data (data objects, data fields, parameters of fields).

Catalogue of public services. The repository describes human interfaces of public services. This information can be used for building citizen portals.

Catalogue of semantic assets. The repository provides information about reusable components: semantic assets, guidelines, etc.

Catalogue of standards. NITA-U has developed a Standards Catalogue that contains a complete list of NITA-U standards available in the standards library. These standards have been developed through consensus by industry, consumers, government departments, research organizations, universities and private institutions.

Citizen. An individual is a principal that provides and/or consumes Public Services. A citizen has rights because of being born in Uganda or because of being given rights. The Citizen ABB is salient for organisation interoperability because citizens can play the role of consumers of Public Services.

Content Management Service. A Content Management System (CMS) is responsible for:

- developing Website templates and functionalities assigning appropriate user permissions and workflows providing trainings to the web working group
- developing tools and web controls to speed up and facilitate the work of the web working group
- giving support and advice to the web working group
- ensuring continuity of service and performance
- ensuring security and accessibility on the website
- ensuring disaster recovery processes and backup procedures
- setting up the website information architecture within the CMS
- setting up alert procedures and analytics on usage of the platform.

The Content Management Service ABB is salient for technical interoperability because it provides and shares the functionalities of dynamic creation, distribution, and analysis of contents (images, videos, etc.). Catalogues help others to find reusable resources (e.g., services, data, software, data models). Various types of catalogues exist, e.g., directories of services, libraries of software components, open data portals, registries of base registries, metadata catalogues, catalogues of standards, specifications and guidelines. Commonly agreed descriptions of the services, data, registries, and interoperable solutions published in catalogues are needed to enable interoperability between catalogues.

Controlled Vocabulary. A controlled vocabulary is an organised arrangement of words and phrases used to index content and/or to retrieve content through browsing or searching. It typically includes preferred and variant terms and has a defined scope or describes a specific domain.

The Data Model ABB is salient for semantic interoperability because it ensures compatible interpretations of words and phrases used to index content and/or to retrieve content through browsing or searching.

Data. Data are symbols obtained through an encoding process of business information or a legal act.

Data Exchange Component. Implements the functionality that enables the secure exchange of messages, records, forms, and other kinds of data between different ICT systems.

Data Exchange Service. Shares the functionality that enables the secure exchange of messages, records, forms, and other kinds of data between different ICT systems.

Data mapping. Data mapping is an equivalence relationship between two data items with ontological value. Data mapping is used for a wide variety of tasks, including:

- Data mediation between a data source and a destination.

- Data transformation

- Identification of data relationships as part of data lineage analysis.

- Discovery of hidden sensitive data such as the last four digits of a social security number hidden in another user id as part of a data masking or de-identification project.

- Consolidation of multiple databases into a single database and identifying redundant columns of data for consolidation or elimination.

The Data Mapping ABB is a key interoperability enabler because it supports to achieve legal behavioural interoperability by enabling the exchange of data, information, and knowledge between digital public services.

Data Mapping Catalogue. Indexed inventory of data mappings with comprehensiveness and trustiness value. This ABB is a key interoperability enabler for sharing/PROVISIONING and reusing/CONSUMING Data.

Data Model. A collection of entities, their properties, and the relationships among them, which aims at formally representing a domain, a concept or a real-world thing.

The Data Model ABB is salient for semantic interoperability because it ensures compatible interpretations of data exchange.

Data Owner. Data owners are either individuals or teams who make decisions such as who has the right to access and edit data and how it is used. Owners may not work with their data every day but are responsible for overseeing and protecting a data domain. Data owners are accountable for the quality, integrity, and protection of their data space.

The Data Owner ABB is salient for organisational interoperability because it is responsible for the management of the data generated or consumed by the public service. The identification of Data Owners is important for accountability since it clearly identifies a person/team responsible of controlling the compliance of data, and for the definition of policies and standards of public service data.

Data Policy. A set of broad, high level principles which form the guiding framework in which data management can operate. The Data Policy ABB is salient for semantic interoperability because it provides a guiding framework to manage data and information according to interoperability principles.

Data Portability Policy. The data portability policy implements the right to data portability. It regulates the exchange of data, allowing data subjects to obtain data that a data controller holds on them and to reuse it for their own purposes.

Individuals are free to either store the data for personal use or to transmit it to another data controller. The data must be received "in a structured, commonly used and machine-readable format".

The right to data portability applies:

- To personal data that an individual has given to a data controller.
- When the processing is carried out by automated means; and
- Where the processing is based on the individual's consent or for the performance or a contract.

The Data Portability Policy ABB is salient for semantic interoperability because it regulates how data can be exchanged and its reuse.

Data Publication Component. Implements the functionality of making data available for common use. The Data Publication Component ABB is salient for technical interoperability because it provides the implementation of the functionalities to make public data freely available for use and reuse by others unless restriction apply.

Data Publication Service. Shares the functionality of making data available for common use. The Data Publication Service ABB is salient for technical interoperability because it provides the functionalities to make public data freely available for use and reuse by others unless restriction apply

Data set. The Semantic view models the most salient Architecture Building Blocks that should be considered in order to support semantic aspects for the End-to-End design of interoperable digital public services.

Data Set Catalogue. Indexed inventory of data sets with comprehensiveness and trustiness value. This ABB is a key interoperability enabler for sharing/PROVISIONING and reusing/CONSUMING Data. The Data Set catalogue ABB is a key interoperability enabler because it supports to achieve semantic structural interoperability by ensuring the provision/consumption of data by digital public services.

Data Syntax. Data Syntax is a set of rules defining the way in which data is put together with appropriate identifiers, delimiters, separator character(s), and other non-data characters to form messages. The Data Syntax ABB is salient for semantic interoperability because it provides the rules establishing how data must to be written.

Data Transformation Component. Implements the functionality of conversion of data from one data representation to another. The Data Transformation Component ABB is salient for technical interoperability because it enables the implementation of the functionalities to transform internal data structures to common and agreed interoperable formats.

Data Transformation Service. Shares the functionality of conversion of one data representation to another. The Data Transformation Service ABB is salient for technical interoperability because it provides the functionalities to transform internal data structures to common and agreed interoperable formats.

Data Validation Component. Implements the functionality of referring to any activity aimed at verifying that the value of a data item comes from a given set of acceptable values. Data validation may be followed by corrective actions, such as data editing or data imputation. In statistics, imputation is the process of replacing missing data with substituted values. The Data Validation Component ABB is salient for technical interoperability because it allows the implementation of the functionality to validate if data received (or to be sent) is compliant with common and agreed interoperable formats.

Data Validation Service. Shares the functionality of referring to any activity aimed at verifying that the value of a data item comes from a given set of acceptable values. Data validation may be followed by corrective actions, such as data editing or data imputation.

Data Warehouse Component. A data warehouse Component is part of the central repository where raw data is transformed and stored in queryable forms. It is an information system that contains historical and commutative data from single or multiple sources. It simplifies reporting and analysis process of the organisation. The Data Warehouse Component ABB is salient for technical interoperability because it provides and shares the functionality for the short or medium-term preservation of records and information in electronic form in order to ensure their temporal legibility, reliability, and integrity, and to ease their management.

Data Warehouse Service. A data warehouse is a central repository where raw data is transformed and stored in queryable forms. It is an information system that contains historical and commutative data from single or multiple sources. It simplifies reporting and analysis process of the organization. The Data Warehouse Service ABB is salient for technical interoperability because it provides and shares the functionality for the short or medium-term preservation of records and information in electronic form in order to ensure their temporal legibility, reliability and integrity, and to ease their management

Descriptive Metadata Policy. A Data Policy aiming at making data discoverable and identifiable. It may mandate elements such as title, abstract, author, and keywords.

The Descriptive Metadata Policy ABB is salient for semantic interoperability because metadata facilitates opening and sharing data by providing the appropriate format, description of the content, high level of quality in order to achieve interoperability. Ensure that open data is accompanied by high quality, machine-readable metadata in non-proprietary formats, including a description of their content, the way data is collected and its level of quality and the license terms under which it is made available. The use of common vocabularies for expressing metadata is recommended.

Development and Testing Service. Development and testing service is a complicated process to design and testing an application or software in order to meet a particular business or personal objective, goal or process.

Digital Service Infrastructure. Infrastructure which enables networked services to be delivered electronically, typically over the internet, providing Ugandan interoperable services of common interest for citizens, businesses and/or public authorities, and which are composed of core service platforms and generic services. The Digital Infrastructure Service ABB is salient for technical interoperability because it a central element through which interoperability is ensured.

e-Archiving Component. Shares the functionality of enabling the permanent or long-term

storage of selected (by an authority) electronic documents or information for preservation purposes like their enduring research value and memory aid.

The GIRA differentiates between document management, record management and e-archiving as follows:

- Document management is primarily about day-to-day use of electronic documents (create/update/delete/versioning) within the operational environment.
- Record management is primarily about ensuring that information (e.g., in form of an electronic document or database record) is available for business and legal purposes (e.g. to proof and track the handling of contracts). If an electronic document or information is becoming a record (an authority declares it as a record), that electronic document or information needs to be handled by the record management service (based on specific business or legal reasons (e.g., contract negotiation)).
- e-Archiving is primarily about storing records which have been selected (by an authority) for permanent or long-term preservation due to their enduring research value and as a memory aid. An electronic document or information which a) is managed by the document management service or the record management service and b) is no longer needed for business or legal purposes or day-to-day activities, and c) still has value for research purposes or as a memory aid, the electronic document should be managed by the e-archiving service.

The e-Archiving Component ABB is salient for technical interoperability because it provides the implementation of the functionalities for the long-term or permanent preservation of records and information in electronic form in order to ensure their temporal legibility, reliability and integrity.

e-Archiving Service. Shares the functionality of enabling the permanent or long-term storage of selected (by an authority) electronic documents or information for preservation purposes like their enduring research value and memory aid.

e-GIF Principle. Underlying principle stipulated by the Uganda Interoperability Framework.

e-Payment Component. Implements the functionality of executing payment transactions where the consent of the payer to execute a payment transaction is given by means of any telecommunication, digital or IT device. The e-Payment Component ABB is salient for technical interoperability because it provides the implementation of functionalities of executing payment transactions.

e-Payment Service. Shares the functionality of executing payment transactions where the consent of the payer to execute a payment transaction is given by means of any telecommunication, digital or IT device. The e-Payment Service ABB is salient for technical interoperability because it enables the possibility of executing payment transactions by any means of telecommunication, digital or IT device.

e-Seal Creation Service. Shares the functionality of signing data in electronic forms on behalf of a legal person. **An 'electronic seal'** means data in electronic form, which is attached to or logically associated with other data in electronic form to ensure the latter's origin and integrity. The 'creator of a seal' is a legal person who creates an electronic seal.

e-Seal Preservation Service. Shares the functionality of extending the trustworthiness of the qualified electronic signature beyond the technological validity period.

e-Seal Verification and Validation Service. Shares the functionality of the verification of documents that are signed electronically.

e-Signature Creation Service. Shares the functionality of signing data in electronic form by a natural person. **An 'electronic signature'** means data in electronic form which is attached to or logically associated with other data in electronic form, and which is used by the signatory to sign.

e-Signature Preservation Service. Shares the functionality of extending the trustworthiness of the qualified electronic signature beyond the technological validity period.

e-Signature Verification and Validation Service. Shares the functionality of the verification of documents that are signed electronically.

e-Timestamp Creation Service. Shares the functionality of the verification of timestamps used for establishing evidence that a give piece of data existed at a given point in time. An **'electronic time stamp'** means data in electronic form which binds other data in electronic form to a particular time establishing evidence that the latter data existed at that time.

e-Timestamp Verification and Validation Service. Shares the functionality of the verification of timestamps used for establishing evidence that a given piece of data existed at a given point in time.

ABB is salient for technical interoperability because it provides all the functionalities to host the Interoperable Solutions (high availability and high-performance hosting infrastructure). **Hosting and Networking Infrastructure.** Shares the functionalities for i) hosting Interoperable Ugandan Solutions and ii) providing the necessary networks for operating these solutions.

Interoperability Framework (e-GIF). An agreed governance approach to interoperability for organisations that wish to collaborate towards the joint delivery of public services. Within its scope of applicability, it specifies a set of common elements such as vocabulary, concepts, principles, guidelines, and recommendations.

The Interoperability Framework ABB is an interoperability enabler because it helps achieve organisational interoperability by defining a set of rules, practices, and a commonly agreed approach to the delivery public services.

Interoperability Governance. Set of organising rules assuring the functioning of an Interoperability Framework. These rules include structures, roles, responsibilities, policies, standards, specifications, practices, decision making and operational procedures. The Interoperability Governance ABB is an interoperability enabler because it helps achieve organisational interoperability.

Interoperability Organisational Authority – NITA-U. An organisation having the powers to govern the interoperability of public administration. The Interoperability Organisational Authority ABB is an interoperability enabler because it helps achieve organisational interoperability by ensuring political and/or administrative governance of the interoperability capabilities of an organisation.

Interoperability Requirement. An Interoperability Requirement is a requirement of the highest possible level of granularity for a GIRA ABB, formulated as an agreed normative statement in functional terms on a legal, organisational, semantic, or technical attribute of a To-Be GOU Public Service

Interoperability Skill. Expertise in organising, implementing, and managing interoperability in digital public services. The Interoperability Skill ABB is an interoperability enabler because it helps achieve organisational interoperability by removing a barrier to implement interoperability policies.

Interoperable Solution. A solution developed by ADMs that facilitate the delivery of electronic Public Services between ADMs (or Citizens and Business) in support to the implementation and advancement of Public Policies.

Interoperable Solution Component. Interoperable GOU Solution Component represents the encapsulation of a functionality provided by an Interoperable GOU Solution. The Interoperable GOU Solution Component ABB is salient for technical interoperability because it is a central element of the e-GIF conceptual model for integrated public services. It represents all the functionalities provided by Interoperable Solutions.

Interoperable Solution Service. Represents an explicitly defined shared application behavior of an Interoperable Solution. The Interoperable Solution service ABB is salient for technical interoperability because it is a central element of the e-GIF conceptual model for integrated public services. It represents the generalisation of all application services provided by Interoperable Solutions.

Interoperability Specification. An Interoperability Specification is a document formulated as an agreed normative statement in design terms on a legal, organisational, semantic, or technical attribute. It can refer to existing standards or specifications.

Interoperability Strategy. The overarching strategic plan in the area of interoperability. The Interoperability Strategy ABB is an interoperability enabler because it helps achieve organisational interoperability by setting up the vision and principles for the development of the interoperability capabilities. The e-GIF implements Ugandan Interoperability Strategy.

Interoperable Digital Public Services. An Interoperable digital public service is a service provisioned by or on behalf of a MDA in fulfilment of a public policy goals servicing to users either citizens, businesses, or other public administrations. A GOU public service comprises any public service supplied by ADM, either to one another or to businesses and citizens. Once or more Digital Public Service can realize one Digital Business Capability.

The Public Service ABB is salient for organisational interoperability because it is the central element around which interoperability needs to be ensured.

GIRA Architecture Building Block is a requirement of an intermediate level of granularity, in alignment with at least one e-GIF principle, formulated as an agreed normative statement in functional terms on a legal, organisational, semantic, or technical attribute of a To-Be GOU Public Service.

GIRA Solution Building Block is a concrete component of an intermediate level of granularity, that it implements one or more GIRA Architecture Building Blocks of an GOU's Public Service, formulated as an agreed normative statement in design terms on a legal, organisational, semantic, or technical attribute of an GOU's Public Service. On the technical view, a Solution Building Block is a specific software component that it might be either procured or developed of a To-Be Interoperable GOU Solution or that it is integrated in an As-Is GOU Solution

GIRA View. The GIRA consists of several architecture views, including one view for each of the e-GIF interoperability levels. The GIRA views contain a graphical notation of the GIRA ontology. TOGAF®: An architecture view is a representation of a system from the perspective of a related set of concerns. https://pubs.opengroup.org/architecture/togaf9-doc/arch/chap03.html#tag_03_17.

GIRA Viewpoint. The GIRA provides several viewpoints that conform to GIRA views. The viewpoints provide a perspective with specific stakeholder's concern in mind. TOGAF®: A specification of the conventions for a particular kind of architecture view. Source https://pubs.opengroup.org/architecture/togaf9-doc/arch/chap03.html#tag_03_18.

Hosting Facility. The equipment supporting the hosting of Interoperable Solutions and their components, usually embodied in a building. The Hosting Facility ABB is salient for technical interoperability because it provides all the equipment supporting the hosting of interoperable solutions and their components.

Hosting Service. Shares the functionalities of a hosting provider, typically a high availability and high-performance hosting infrastructure that is being comprised, among other elements, of back-end web server instances and application servers for hosting and serving both static and dynamic sites. The Hosting Service

Human Interface. A boundary set of means enabling the exchange of data between an individual and a service. This ABB is a key interoperability enabler for assessing compatible interfaces. The Human interface ABB is a key interoperability enabler because it supports to achieve technical behavioral interoperability by enabling the exchange of data, information, and knowledge between digital public services and individuals.

Identity Management Component. Implements the functionality of user authentication. `**Electronic identification'** means the process of using person identification data in electronic form uniquely representing either a natural or legal person, or a natural person representing a legal person. **'Authentication'** means an electronic process that enables the electronic identification of a natural or legal person, or the origin and integrity of data in electronic form to be confirmed.

Identity Management Service. Shares the functionality of user authentication.

Interoperability Requirement is a requirement of the highest possible level of granularity for an GIRA ABB, formulated as an agreed normative statement in functional terms on a legal, organisational, semantic, or technical attribute of a To-Be GOU Public Service

Interoperability Specification. An Interoperability Specification is an agreed normative statement on a legal, organisational, semantic, or technical level. It can refer to existing

standards or specifications.

Interoperable Solution Component. Interoperable Ugandan Solution Component represents the encapsulation of a functionality provided by an Interoperable GOU Solution.

Interoperable Solution Service. Represents an explicitly defined shared application behaviour of an Interoperable Ugandan Solution.

Key Interoperability Enabler. A Key Interoperability Enabler is a GIRA ABB, which is necessary to enable the efficient and effective delivery of public services across ADMs.

Legal Act. Formalised set of rules on a subject potentially including requirements concerning digital public services. The granularity of the requirements might be of high level or detail level. Requirements of high-level granularity contain generic/abstract functional requirements like principles and/or recommendations with considerable degrees for transposition/execution and of not binding nature. On the other side, requirements of detail-level granularity imply a limited degree for transposition/execution, and they contain specific/concrete functionalities, solution components, data, procedures, and/or technical specifications or standards to be used.

The Legal Act ABB is salient for interoperability because it helps achieve legal interoperability by ensuring compatible legal/juridical certainty in the exchange of information.

Legal agreements/ International treaties. Under international law, a treaty is any legally binding agreement between states (countries). A treaty can be called a Convention, a Protocol, a Pact, an Accord, etc.; it is the content of the agreement, not its name, which makes it a treaty.

Legal Authority. It is an entity with entitled powers. The powers that a public administration exercises during the above-mentioned life cycle are of the following four types: Legislation, control (monitoring, enforcing, sanctioning, etc.), economic (taxes, subsidies, expenditures, funding, etc.) and (public service) provision.

The Legal Authority ABB is salient for interoperability because it supports legal interoperability by providing reliability and trustworthiness of the Legal Interoperability Agreement.

Legal Interoperability Agreement. A legal interoperability agreement is a legal resource formalising governance rules enabling collaboration between digital public services (NITA-U Act (Act No. 4 of 2009)).

The Legal Interoperability Agreement ABB is a key interoperability enabler because it supports legal interoperability by enabling the seamless exchange of data, information, and knowledge.

Legal Interoperability Specifications. A Legal Interoperability Specification is a document of the highest possible level of granularity on a GIRA SBB, formulated as an agreed normative statement in design terms. It can refer to existing standards or specifications.

The Legal Interoperability Specification ABB is relevant for interoperability because it helps achieve legal interoperability by addressing the core legal interoperability background for solutions.

Legislation Catalogue. Indexed inventory of legal documents with comprehensiveness and trustiness value.

This ABB is a key interoperability enabler because it supports to achieve legal structural interoperability by enabling sharing/provisioning and reusing/consumption of legislation on digital public services.

Legislation on data information and knowledge exchange. Legal act on the exchange

of data, information, and knowledge between different agents (private and public) at national and/or cross-border level.

The Legislation on Data, information, and Knowledge Exchange ABB is a key interoperability enabler because it supports to achieve legal interoperability by ensuring legal/juridical certainty and determinacy in the exchange of data, information, and knowledge.

Machine to Machine Interface. A boundary set of means enabling the exchange of data between a service and other services.

Master Data Policy. A Data Policy applying to the authoritative, most accurate data that is available about key business entities, used to establish the context for business transactions and transactional data.

The Master Data Policy ABB is salient for semantic interoperability because Master Data is used to establish the context for business transactions and transactional data by providing accurate data usually stored and available for reuse by other parties. Its management should be prioritised.

Metadata Management Component. Implements the functionalities for the i) creation, ii) storage, iii) categorisation and iv) retrieval of metadata.

The Metadata management Component ABB is salient for interoperability because it provides the implementation of the functionalities to manage metadata. e-GIF recommends to prioritise it: "Put in place an information management strategy at the highest possible level to avoid fragmentation and duplication. Management of metadata, master data and reference data should be prioritised."

Metadata Management Service. Shares the functionalities for the i) creation, ii) storage, iii) categorisation and iv) retrieval of metadata.

Network. Transmission systems and, where applicable, switching or routing equipment and other resources which permit the conveyance of signals by wire, by radio, by optical or by other electromagnetic means, including satellite networks, fixed (circuit- and packet-switched, including Internet) and mobile terrestrial networks, electricity cable systems, to the extent that they are used for the purpose of transmitting signals, networks used for radio and television broadcasting, and cable television networks, irrespective of the type of information conveyed. The Network ABB is salient for technical interoperability because it provides the network where can operate interoperable solutions (both public and private network).

Networking Service. Shares the functionalities provided by a network provider which is the combination of transmission systems and, where applicable, switching or routing equipment and other resources which permit the conveyance of signals by wire, by radio, by optical or by other electromagnetic means, including satellite networks, fixed (circuit- and packet-switched, including Internet) and mobile terrestrial networks, electricity cable systems, to the extent that they are used for the purpose of transmitting signals, networks used for radio and television broadcasting, and cable television networks, irrespective of the type of information conveyed.

Non-Binding Instrument. Legal means, involving no obligation, which are available to the ADM to carry out their tasks, like recommendations and opinions.

The Non-binding Instrument ABB is a key interoperability enabler as a specialisation of the Legal Act.

Ontology. An Ontology is a formal description of knowledge as a set of concepts within a domain and the axioms connecting concepts and allowing for logic inferences. When speaking

about an ontology, we do not refer only to the terminology (or T-Box) but also to all the "assertions" about the concepts and roles (the A-Box), i.e., all the individuals or instances of concepts and roles of the terminology and as important, the rules for logic inference: the semantics "part".

The Ontologies ABB is salient for semantic interoperability because it is defined as a simplified, reusable, and extensible data model that captures the fundamental characteristics of a data entity in a context-neutral and syntax-neutral fashion.

Ontologies Catalogue. Indexed inventory of ontologies with comprehensiveness and trustiness value. This ABB is a key interoperability enabler (*) for sharing/PROVISIONING and reusing/CONSUMING Data. The Ontologies catalogue ABB is a key interoperability enabler because it supports to achieve semantic structural interoperability by ensuring the provision/consumption of ontologies by digital public services.

Open Data Policy. The rules and practice of publishing (raw) data in a way that is accessible, reusable, machine readable and licensed permissively. It can be generated by a wide range of parties, including public authorities, the semi-public sector, businesses and the public. In the case of MDA, making their data available for public reuse supports economic development, openness, and transparency.

The Open Data Policy ABB is salient for semantic interoperability because Open Data is a part of the basic components of the e-GIF conceptual model for integrated public services.

Orchestration Component. Implements the functionality of defining the sequence and conditions in which one service invokes other services to realise some useful function. The Orchestration Component ABB is salient for technical interoperability because it provides a set of various methods to manage existing business processes or define and establish new ones. BPM components also execute business process documented through accepted modelling techniques.

Orchestration Service. Shares the functionality of defining the sequence and conditions in which one service invokes other services in order to realize some useful function. The Orchestration Service ABB is salient for technical interoperability because it provides the functionality of "automated" business processes coordination. The e-GIF Conceptual model for integrated public services foresees the concept a Coordination for Integrated Service Delivery. The Model comprises an "integrated service delivery" is based on a "coordination function", which is related to SOA principles such as choreography and orchestration, to manage internal business processes in order to remove complexity for the end-user. This function should select the appropriate sources and services and integrate them. Coordination can be automated or manual.

Organisation. An Organisation is a principal that provides and/or consumes Public Services.

The Organisation ABB is salient for organisation interoperability because organisations can play the role both of providers of Public Services (mainly ADMs) and consumers of Public Services (ADM or businesses).

Organisational Interoperability Agreement. Organisational Agreement means any agreement to which the Company or any Restricted Subsidiary is a party pursuant to which, among other things, fees are paid to the Company or a Restricted Subsidiary in exchange for organisational, consulting or similar services.

Organisational Interoperability Requirement. An organisational interoperability requirement is an interoperability requirement that must be met to help achieve organisational interoperability.

Point of single contact. Point of Single Contact (PSCs) is e-government portal that allow service providers to get the information they need and complete administrative procedures online. The Ugandan PCS is a one-stop online centre for Government online services. Its main objective is to enhance Government service delivery to citizens, non-citizens, businesses and to Government Ministries, Departments and Agencies (MDAs). The benefits include making Government services more accessible, reducing access cost and queuing at Government offices, transparency, timeliness and increasing convenience of transaction with the Government of Uganda ANYTIME and from ANYWHERE.

Ugandan PCS: https://ecitizen.go.ug/content/ecitizen-portal

Privacy Component. Privacy Component implements the functionalities of storing, securing, anonymising, pseudonymising, rectifying and erasing personal data.

The Privacy Service ABB is salient for interoperability because "security and privacy are primary concerns in the provision of public services" and, as stated in e-GIF: "Define a common security and privacy framework and establish processes for public services to ensure secure and trustworthy data exchange between public administrations and in interactions with citizens and businesses."

Privacy Service. Privacy Service shares the functionalities of storing, securing, anonymising, pseudonymising, rectifying and erasing personal data.

Privacy Framework. Agreed governance approach focusing on confidentiality aspects on data, information and knowledge assets and organisational resources handling them.

Privacy Policy. A privacy policy is a document that explains how an organisation handles any customer, client or employee information gathered in its operations.

The Data Policy ABB is salient for semantic interoperability because it provides a guiding framework to ensure the privacy of data and information according to e-GIF interoperability principles.

Private Hosting Facility. A Hosting Facility, meaning the equipment supporting the hosting of Interoperable Solutions and their components, usually embodied in a build-in, which is owned by or dedicated to one organisation (e.g. data centre or private cloud). The Private Hosting Facility ABB is salient for technical interoperability because it provides all the equipment, dedicated to one organisation, supporting the hosting of interoperable solutions and their components.

Private Network. A network that is used for the only purpose of realising the physical communication among GOU, and cannot be accessed by the public. The Private Network ABB is salient for technical interoperability because it provides the private network where can operate interoperable solutions.

EXAMPLE: Any private network

Hosts within enterprises that use IP can be partitioned into two categories:

Category 1: hosts that do not require access to hosts in other enterprises or the Internet at large; hosts within this category may use IP addresses that are unambiguous within an enterprise, but may be ambiguous between enterprises.

Category 2: hosts that need access to a limited set of outside services (e.g., E-mail, FTP, netnews, remote login) which can be handled by mediating gateways (e.g., application layer gateways). For any hosts in this category an unrestricted external access (provided via IP connectivity) may be unnecessary and even undesirable for privacy/security reasons. Just like hosts within the first category, such hosts may use IP addresses that are unambiguous within

an enterprise, but may be ambiguous between enterprises.

A third category is what is called a 'public network' and consist of the following:

Category 3: hosts that need network layer access outside the enterprise (provided via IP connectivity); hosts in the last category require IP addresses that are globally unambiguous.

Public Hosting Facility. The equipment supporting the hosting of Interoperable Solutions and their components, usually embodied in a building, which is owned by a third party and shared between organisations (e.g., cloud services). The Public Hosting Facility ABB is salient for technical interoperability because it provides all the equipment, shared between organizations, supporting the hosting of interoperable solutions and their components.

Public Network. A network that can be accessed by the public (public administrations, businesses, and citizens) without specific authorisations. Interoperable Solutions can rely on Public Networks (e.g., the Internet) to realise the physical communication between nodes.

The Public Network ABB is salient for technical interoperability because it provides the public network where interoperable solutions can operate.

Public Policy. Set of principles followed by the authorities of Uganda.

Public Policy Cycle. The series of public policy phases that are regularly repeated in order to manage all aspects of a public policy.

The Public Policy Cycle ABB is salient for legal interoperability because it impacts the design and formulation of public policies, which are implemented through legal acts. Interoperability principles need to be taken into account during the whole public policy cycle.

Public Service Agent. An agent that consumes or delivers a public service on behalf of a principal. The Public Service Agent is salient for organisational interoperability because it acts on behalf of a Public Service Consumer Agent to consume a Public Service and Public Service Provider Agent to deliver a Public Service.

Public Service Catalogue. A catalogue of public services is a collection of descriptions of active public services that are provided by public administrations at any administrative level (i.e., local, regional, national). All public service descriptions published in a catalogue of public services conform to a common data model for representing public services. The Public Service Catalogue ABB is a key interoperability enabler because it supports to achieve organisational structural interoperability by ensuring the provision/consumption of front-office digital public services.

Public Service Consumer. A person, institution, or machine (on behalf of somebody) consuming public services.

Public Service Provider. A person, institution, or machine (on behalf of somebody) delivering public services.

Reference Data Policy. A Data Policy applying to data used to organise or categorise other data, or for relating data to information both within and beyond the boundaries of the enterprise. Usually, it mandates the use of codes and descriptions, or definitions.

Reference data consists typically of a small, discrete set of values that are not updated as part of business transactions but are usually used to impose consistent classification. Reference data normally has a low update frequency. Reference data is relevant across more than one business systems belonging to different organisations and sectors

The Reference Data Policy ABB is salient for semantic interoperability because Reference Data can be shared and reused (e.g., in the form of taxonomies or controlled vocabularies) between

organisations to agree on some basic information.

Registered Electronic Delivery Service. Shares the functionalities that: (1) makes it possible to transmit data between third parties by electronic means and (2) provides evidence relating to the handling of the transmitted data, including proof of sending and receiving the data, (3) and that protects transmitted data against the risk of loss, theft, damage, or any unauthorised alterations. These functionalities SHALL cover UgHUb solution.

Representation. The description of the perceptible configuration of business information or a Legal act. Representations can be classified in various ways; for example, in terms of medium (e.g., electronic or paper documents, audio, etc.) or format (HTML, ASCII, PDF, RTF, etc.).

Security Framework. Agreed governance approach focusing on protection aspects on data, information and knowledge assets and organisational resources handling them.

Security Policy. A privacy or security policy is a statement or a legal document (in privacy law) that discloses some or all the ways a party gathers, uses, discloses, and manages a customer or client's data.

The Data Policy ABB is salient for semantic interoperability because it provides a guiding framework to ensure the security of data and information according to e-GIF interoperability principles

Semantic Agreement. An agreement from a peer to the common ontology is the result of a matching or mapping process that is used to resolve their semantic discrepancies. The combination matching process consists of linguistic base, internal and external structure comparison. Result of a matching combination will be used to develop an agreement unit as a component of agreement. There are some assumptions for the agreement, such as using the same language for representation of schema/ontology, labels represent the meaning of concept, and there is no individual at the common ontology.

Semantic Interoperability Agreement. A Semantic interoperability agreement is a semantic resource formalising governance rules enabling collaboration between digital public services with ontological value.

The Semantic Interoperability Agreement ABB is a key interoperability enabler because it supports semantic governance interoperability by enabling collaboration between digital public services.

Semantic Interoperability Requirement. A semantical interoperability requirement is an interoperability requirement that must be met to help achieve semantic interoperability.

Semantic Interoperability Specification. Semantic interoperability enables organisations to process information from external sources in a meaningful manner. It ensures that the precise meaning of exchanged information is understood and preserved throughout exchanges between parties. In the context of the GOU e-GIF, semantic interoperability encompasses the following aspects:

- Semantic interoperability is about the meaning of data elements and the relationship between them. It includes developing vocabulary to describe data exchanges, and ensures that data elements are understood in the same way by communicating parties.
- Syntactic interoperability is about describing the exact format of the information to be exchanged in terms of grammar, format, and schemas.

Semantic interoperability specifications support semantic interoperability by addressing the core semantic interoperability background for solutions.

The Semantic Interoperability Specification ABB is salient for semantic interoperability because it enables organisations to process information from external sources in a meaningful manner and ensuring that the precise meaning of exchanged information is understood and preserved throughout exchanges between parties.

Service Delivery Model. The way of delivering to public service consumers, or otherwise interacting with them, for the purpose of supplying specific public services with accessibility value. This involves a number of management practices to ensure that the public services are provided as agreed between the public service provider and the consumer.

Service Discovery Service. Shares the functionality of locating a machine-processable description of a service-related resource that may have been previously unknown and that meets certain functional criteria. It involves matching a set of functional and other criteria with a set of resource descriptions. The goal is to find an appropriate service-related resource. The Service Discovery Service ABB is salient for technical interoperability because it allows to discover service available for reuses.

Service Discovery Component. Implements the functionality of locating a machine-processable description of a service-related resource that may have been previously unknown and that meets certain functional criteria. It involves matching a set of functional and other criteria with a set of resource descriptions. The goal is to find an appropriate service-related resource. The Service Discovery Component ABB is salient for technical interoperability because it allows to implement the functionality of sharing services available for reuse.

Service Registration Service. Implements the functionality of registering the system service within a catalogue to be discovered by other services. This ABB is a key interoperability enabler for sharing/PROVISIONING and reusing/CONSUMING back-office services. The Service Registration Component ABB is a key interoperability enabler because it supports to achieve technical interoperability by provisioning and consuming back-office services as stated in the e-GIF recommendation: "Put in place catalogues of public services, public data, and interoperability solutions and use common models for describing them."

Service Registry Component. Shares the functionality of registering the system service within a catalogue to be discovered by other services. The Service Registration Service ABB is a key interoperability enabler because it supports to achieve technical structural interoperability by ensuring the provision/consumption of back-office digital public services.

Shared Governance Framework. A shared legal framework is formed by [re]usable legal resources, with convergence power, in relation to public policy goals attainment, given by their functioning impact via communication and harmonisation, across the levels of a public administration (central, regional, local) towards the achievement of the public policy goals.

Shared Knowledge Base. A shared Knowledge Base is formed by usable data, information, and knowledge resources, with convergence power, in relation to public policy goals attainment, given by their impact in the enactment of common understanding from the existing organisational information, across the levels of a MDAs towards the achievement of the public policy goals.

Shared Legal Framework. A shared legal framework is formed by [re]usable legal resources, with convergence power, in relation to public policy goals attainment, given by their legally binding nature, across the levels of MDAs towards the achievement of the public policy goals.

Shared Platform. A shared platform is formed by [re]usable ICT resources (i.e., the platform), with convergence power, in relation to public policy goals attainment, given by the impact of the availability of common problem-solving instruments, across the levels of MDAs towards the achievement of the public policy goals.

Solution. A solution consists of one or more Solution Building Blocks to meet a certain stakeholder need. Within the context of the GIRA, a solution is usually an Interoperable GOU Solution that facilitates the delivery of electronic Public Services between ADMs or Citizens.

Solution Building Block (SBB) is a candidate solution which conforms to the specification of an Architecture Building Block (ABB). Source TOGAF® : https://pubs.opengroup.org/architecture/togaf9-doc/arch/chap03.html#tag_03_70

Solution specification. An Architecture Specification is a document of the highest possible level of granularity on a Solution Building Block, formulated as an agreed normative statement.

Technical Agreement. These agreements constitute a framework and a privileged forum to identify common interests, priorities, policy dialogue, and the necessary tools for Strategic & Technological collaboration.

Technical Interoperability Agreement. Technical Interoperability Agreement is the means through which Technical Authorities mandate specific Technical Interoperability Specifications, ensuring organisations (operating under different technical frameworks, policies, and strategies) are able to work together.

The Technical Interoperability Agreement ABB is a key interoperability enabler because it supports technical governance interoperability by enabling collaboration between digital public services.

Technical Interoperability Requirement. A technical interoperability requirement is an interoperability requirement that must be met to help achieve technical interoperability.

Technical Interoperability Specification. A specification contained in a document which lays down the characteristics required of a product such as levels of quality, performance, safety, or dimensions, including the requirements applicable to the product as regards the name under which the product is sold, terminology, symbols, testing and test methods, packaging, marking or labelling and conformity assessment procedures. The Technical Interoperability Specification ABB is salient for technical interoperability because it assesses the characteristics required of a product to support interoperability solutions.

Technical Specification. A document that prescribes technical requirements to be fulfilled by a product, process, or service.

- Note 1 to entry: A technical specification should indicate, whenever appropriate, the procedure(s) by means of which it may be determined whether the requirements given are

fulfilled.

- Note 2 to entry: A technical specification may be a standard, a part of a standard or independent of a standard.

The Technical Specification ABB is salient for technical interoperability because it assesses the characteristics required of a product to support technical solutions.

Trust Registry Component. Implements the functionality of the discovery of essential information about e.g., supervised/accredited trust service providers issuing certificates for electronic signatures, for electronic seals or for website authentication; supervised/accredited trust services for eSignature, eSeal or TimeStamp creation and validation; supervised/accredited trust services for eSignature or eSeal preservation; supervised/accredited trust services for electronic registered delivery.

Trust Registry Service. Shares the functionality of the discovery of essential information about e.g., supervised/accredited trust service providers issuing certificates for electronic signatures, for electronic seals or for website authentication; supervised/accredited trust services for eSignature, eSeal or TimeStamp creation and validation; supervised/accredited trust services for eSignature or eSeal preservation; supervised/accredited trust services for electronic registered delivery.

Trust Service Provisioning Component. Implements the functionalities encapsulating the trust services functionalities. A **'trust service'** means an electronic service normally provided for remuneration which consists of these functionalities:

i) the creation, verification, and validation of electronic signatures, electronic seals or electronic time stamps, electronic registered delivery services and certificates related to those services, or

ii) the creation, verification and validation of certificates for website authentication; or

iii) the preservation of electronic signatures, seals or certificates related to those services.

10. Abbreviations

Abbreviation	Meaning
ABB	Architecture Building Block
ADM	The Architecture Development Method
AI	The Artificial Intelligence
Archi	The modelling toolkit for creating ArchiMate models and sketches,
ArchiMate	The Enterprise Architecture Modelling Language
DUV	The Digital Uganda Vision
e-GIF	e-Government Interoperability Framework
EIRA	The European Interoperability Reference Architecture
GEA	e-Government Enterprise Architecture
GIRA	The e-Government Interoperability Framework Reference Architecture
GOU	Government of Uganda
ICT	Information and communication technology
MDA/LG	Ministries Departments, Agencies and Local governments
PCS	Point of single contact
SOA	Service Oriented Architecture
SA	Security Architecture
TOGAF	The Open Group Architecture Framework
WASA	Web Application Security Architecture Framework