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EXPLORING EUROPEAN INTEROPERABILITY REFERENCE ARCHITECTURE (EIRA)

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Abstract
EIRA stands for European Interoperability Reference Architecture and represents a European Union Commission initiative concerning public services integration. In fact, the European Commission (DG Informatics) started the ISA² Programme (Interoperability Solutions for Public Administrations, Businesses, and Citizens). In this context, the new European Interoperability Framework was first elaborated and stated several directing principles or recommendations. There are twelve underlying principles of the EIF such as subsidiarity and proportionality, openness, transparency, reusability, technological neutrality and data portability, user-centricity, inclusion and accessibility, security and privacy, multilingualism, administrative simplification, preservation of information, and assessment of effectiveness and efficiency.
Subsequently, EIF was implemented by the EIRA. This reference architecture represents a metamodel defining the architectural building blocks (ABBs) to build interoperable e-Government systems. EIRA is aligned with the principles of TOGAF (The Open Group Architecture Framework) and follows a technology and product-neutral, and service-oriented architecture (SOA) style.
Consequently, to implement public and government services, the EU offers a computing-oriented definition of such an architecture as an extension of the open-sourced ArchiMate® model. The specific viewpoints formalized by ArchiMate model refer for example to the Interoperability Privacy viewpoint, Interoperability Governance viewpoint, Interoperable European Solution viewpoint, and Interoperability Security viewpoint.
EIRA should support the following activities: (1) designing, (2) assessing, (3) communicating and sharing, and (4) discovering and reusing of eGovernment solutions. The specialists targeted are Enterprise Architects as well as Solution Architects, Business Analysts, and Portfolio Managers.
Keywords: *EIRA; Public Services; eGovernment; Software Interoperability; Application Integration; SOA.*
JEL Classification: L86, C88, M15.

1. INTRODUCTION: EUROPEAN INTEROPERABILITY REFERENCE ARCHITECTURE [EIRA] CONTEXT

Our objective in this paper is to elaborate an opinion based on an initial exploratory analysis of the EU initiatives concerning integration in a common digital space, especially from a technical perspective.

We found EIRA as the most relevant and supported initiative in this direction, so our effort took into consideration some research questions targeting problems like:

- If EIRA has a sounding and solid conceptual basis.
- If there is a certain potential and a certain perspective for adopting EIRA.

1.1 European Commission (DG Informatics) - ISA² Programme

ISA² was a funding programme of the European Union that supported the development of digital solutions for public administrations, businesses, and citizens (European Union, 2017a). ISA² represented the commitment of the EU Commission to develop a Digital Europe that is "inclusive, transparent, fair, and accountable" (European Union, 2017b). There were two European initiatives that preceded and founded this programme:

- Tallinn declaration of the E-Government states principles for digital government policy and interoperability policy (European Union, 2017c).
- Berlin Declaration on Digital Society and Value-Based Digital Government stands for ensuring high quality, user-centric, and seamless cross-border digital public services for citizens and businesses and developing a future-oriented European single market (European Union, 2020).

These declarations prove the real and supportive interest of the EU Commission in this domain of digital interoperability. ISA² has evolved into Interoperable Europe - the initiative of the European Commission for a reinforced interoperability policy.

1.2 EIF: European Interoperability Framework

The European Interoperability Framework (EIF) is one of the most important results of the ISA² Programme - continued by the Interoperable Europe initiative is EIF - the European Interoperability Framework.

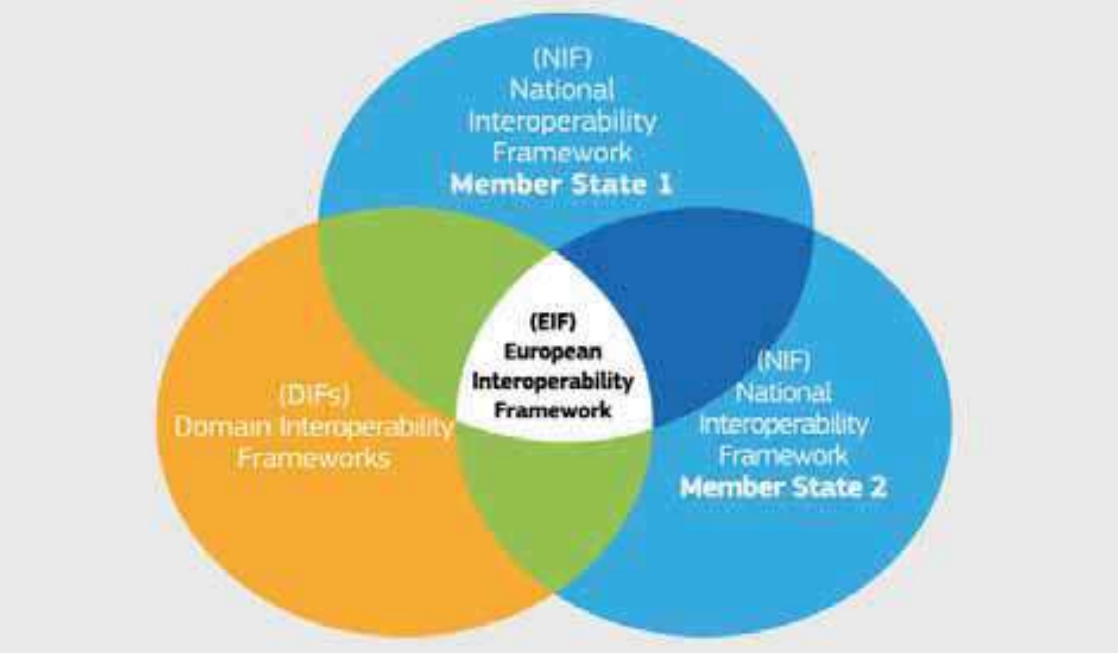
EIF represents a European initiative to promote "seamless services and data flows for European public administrations". EIF states the underlying principles of European public services:

1. Subsidiarity and proportionality
2. Openness
3. Transparency
4. Reusability
5. Technological neutrality and data portability

6. User-centricity
7. Inclusion and accessibility
8. Security and privacy
9. Multilingualism
10. Administrative simplification
11. Preservation of information
12. Assessment of Effectiveness and Efficiency

These principles are grouped into four categories (European Union (a), 2017): 1. The principle setting the context for EU actions on interoperability (1); 2. Core interoperability principles (2 to 5); 3. Principles related to generic user needs and expectations (6 to 9); 4. Foundation principles for cooperation among public administrations (10 to 12).

Also, EIF defines and takes into consideration the following interoperability frameworks: the National Interoperability Frameworks specific to each member state, and various Domain Interoperability Frameworks which are functional-oriented. The relationship between these frameworks is illustrated in Figure1.



Source: European Union (2017a)

Figure 1. Relationship between EIF, NIFs, and DIFs

2. FROM EIF TO EIRA: EUROPEAN INTEROPERABILITY REFERENCE ARCHITECTURE

EIRA is an architecture content metamodel "defining the most salient architectural building blocks (ABBs) needed to build interoperable e-Government systems" (European Union, 2023). EIRA provides a common language to be used

in the development lifecycles of the interoperable e-Government systems, extends the ArchiMate language as a modeling notation and uses SOA architectural style, is meant to implement European Interoperability Framework (EIF).

The main characteristics of the European Interoperability Reference Architecture could be synthesized as:

1. Common terminology to achieve coordination.
2. Reference architecture for delivering digital public services.
3. Technology-and-product-neutral and a service-oriented architecture (SOA) style.
4. Alignment with EIF and TOGAF.

2.1 The Open Group Architecture Framework: TOGAF Foundation For EIRA

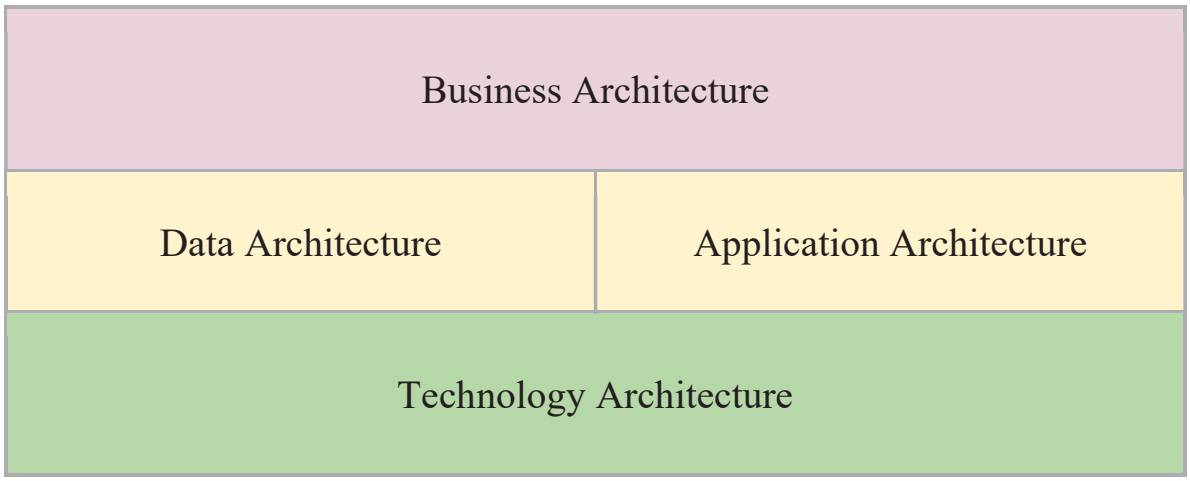
TOGAF is a methodology to design and develop Enterprise IT Architectures: "TOGAF takes a high-level approach to the framework that an enterprise uses to plan, design, implement, and manage its Enterprise Architecture" (Priyadharshini, 2023). The Enterprise Architecture of TOGAF is decomposed into 4 domains (see Figure 2):

- Business Architecture
- Data Architecture
- Application Architecture
- Technology Architecture.

The EIRA conceptual foundation is inspired from the TOGAF's architectural principles like (TOGAF, 2023):

(Business Principles)

- Principle 1: Primacy of Principles
- Principle 2: Maximize Benefit to the Enterprise
- Principle 3: Information Management is Everybody's Business
- Principle 4: Business Continuity
- Principle 5: Common Use Applications
- Principle 6: Service Orientation
- Principle 7: Compliance with Law
- Principle 8: IT Responsibility
- Principle 9: Protection of Intellectual Property



Source: TOGAF (2023)

Figure 2. EA domains conform to TOGAF

(Data Principles)

- Principle 10: Data is an Asset
- Principle 11: Data is Shared
- Principle 12: Data is Accessible
- Principle 13: Data Trustee
- Principle 14: Common Vocabulary and Data Definitions
- Principle 15: Data Security

(Application Principles)

- Principle 16: Technology Independence
- Principle 17: Ease-of-Use

(Technology Principles)

- Principle 18: Requirements-Based Change
- Principle 19: Responsive Change Management
- Principle 20: Control Technical Diversity
- Principle 21: Interoperability

In conclusion, one could say that the EIRA foundation is based on one of the most solid frameworks targeting Enterprise Architectures. The role of the EIRA consists of translating this foundation into the domain of public services in the EU common space.

2.2 Archimate: A Tool For Modeling The Enterprise Architecture

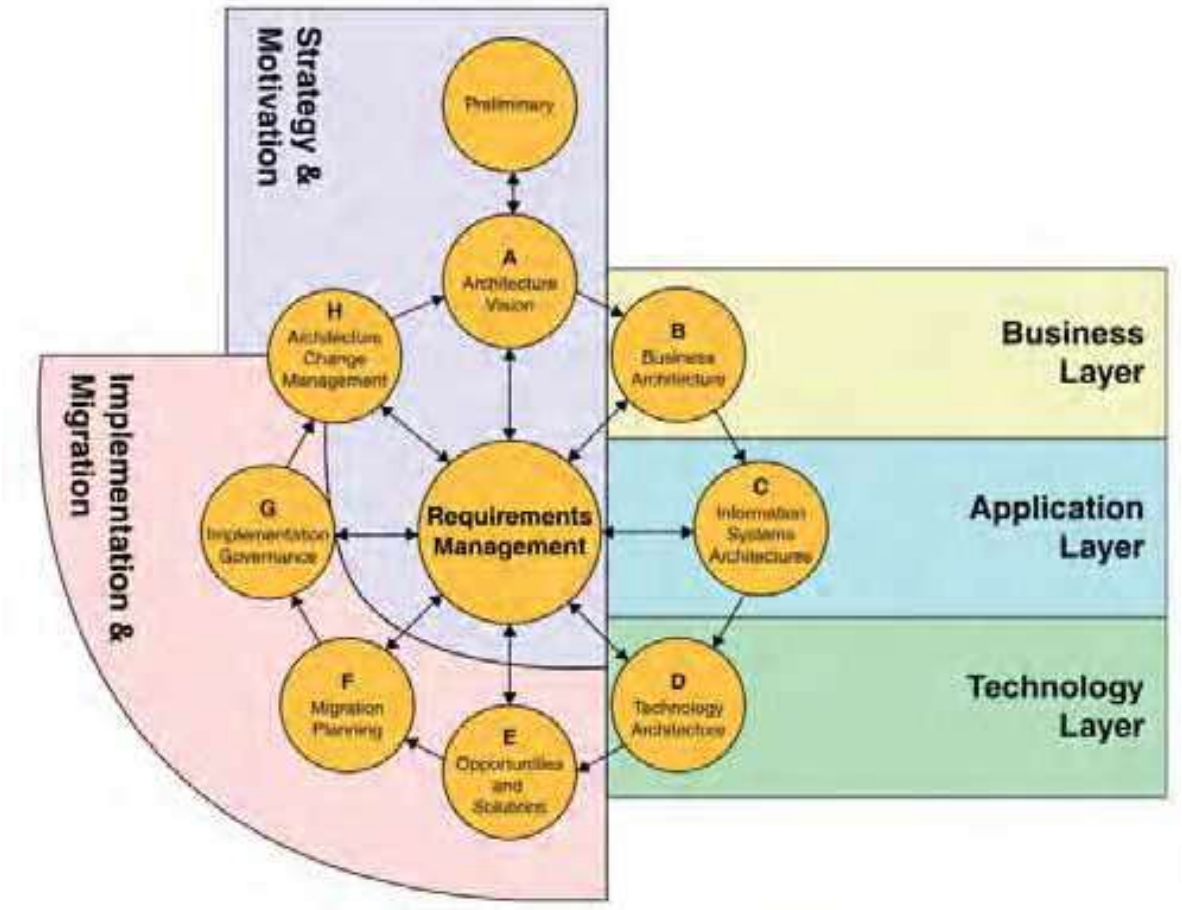
ArchiMate is an open and independent modeling language for Enterprise Architecture. The ArchiMate modeling language "provides a uniform representation for diagrams that describe Enterprise Architectures and offers an integrated approach to describe and visualize the different architecture domains together with their underlying relations and dependencies".

The ArchiMate is a complex and complete tool for EA and the underlying standards that support it are:

- TOGAF (The Open Group Architecture Framework)
- BPMN (Business Processing Modelling Notation)
- UML (Unified Modelling Language)
- BIZBOK Guide (Business Architecture Body of Knowledge Guide)
- BMM (Business Motivation Model)

Consequently, the meta-model (conceptual model) that ArchiMate proposes is aligned with TOGAF principles (see Figure 3).

To formalize the EIRA architectural principles, the Archimate tool could provide the platform to build a specific extension.



Source: ArchiMate 3.1 Specification (Josey, 2019)

Figure 3. ArchiMate alignment with TOGAF

2.3 EIRA Extension Of The Archimate: Key Concepts

The Key Concepts to leverage Archimate for EIRA-specific principles are the following (European Union, 2023):

- *EIF interoperability level* which is "a set of guidelines for developing public services".
- *EIF principles* which are underlying principles of European public services (see 1.2 section).
- *EIRA view* which consists of a graphical notation of the EIRA ontology for each EIF principle.
- *EIRA viewpoint* which "provides a perspective with specific stakeholders' concern in mind".
- *Architecture Building Block (ABB)* is defined as an " abstract component that captures architecture requirements and that directs and guides the development of Solution Building Blocks".
- *Solution Building Block (SBB)* which "is a concrete element that defines the implementation and fulfills the required business requirements".
- *Solution Architecture Template (SAT)* is a concrete specification including a sub-set of Architecture Building Blocks.
- *Reference Architecture* ensembles the components, principles, and guidelines that define an architectural solution (an EA solution).
- *Solution Architecture* is defined as a definition of Reference Architecture using ABBs.
- *Solution* as an implementation of a Solution Architecture using SBBs

The most relevant EIRA architectural models/views are the *Legal view*, the *Organisational view*, the *Semantic view*, the *Technical view* (composed of an application and infrastructure part), and the European Interoperability Framework *Underlying Principles view*.

Consequently, the most relevant viewpoints are defined as:

- *Conceptual Model for Integrated Public Service Provisioning* viewpoint
- *EIRA Ontology* viewpoint
- *High-level* viewpoint
- *Interoperability Governance* viewpoint
- *Interoperability Privacy* viewpoint
- *Interoperability Security* viewpoint
- *Key Interoperability Enablers* viewpoint
- *API* viewpoint
- *Interoperable European Solution* viewpoint.

2.4 EIRA Building Blocks

The EIRA Building Blocks formalized as Archimate constructs are defined for each of the aforementioned EIRA views: legal, organizational, semantic, and technical. Some of the Legal, Organisational, and Semantic view ABBs are resumed in Table 1.

Table 1. Legal, Organisational, and Semantic ABBs of EIRA

The Legal view	The Organisational view	The Semantic view
Legal Agreement	Organisational Agreement	Semantic Interoperability Agreement
Legal Interoperability Agreement	Organisational Interoperability Agreement	Master Data Policy
Public Policy Cycle	Interoperability Strategy	Open Data Policy
Shared Legal Framework	Interoperability Framework	Data Portability Policy
Architecture Principle	Security Framework	Data Mapping
Detail-Level Architecture Requirement	Detail-Level Architecture Requirement	Distributed Ledger
	Solution Specification	Ontologies Catalogue
	Digital Public Service	Ontology
	Digital Public Service Delivery Model	Data Set Catalogue
	Digital Public Service Delivery Machine Agent	Data Set
	Digital Public Service Delivery Human Agent	Data Model
	Digital Public Service Delivery Consumer	Data Syntax

Source: EIRA 6.0.0 Specifications (European Union, 2023)

Also, Some of the ABBs to define a technical solution from the technical view are presented in Table 2.

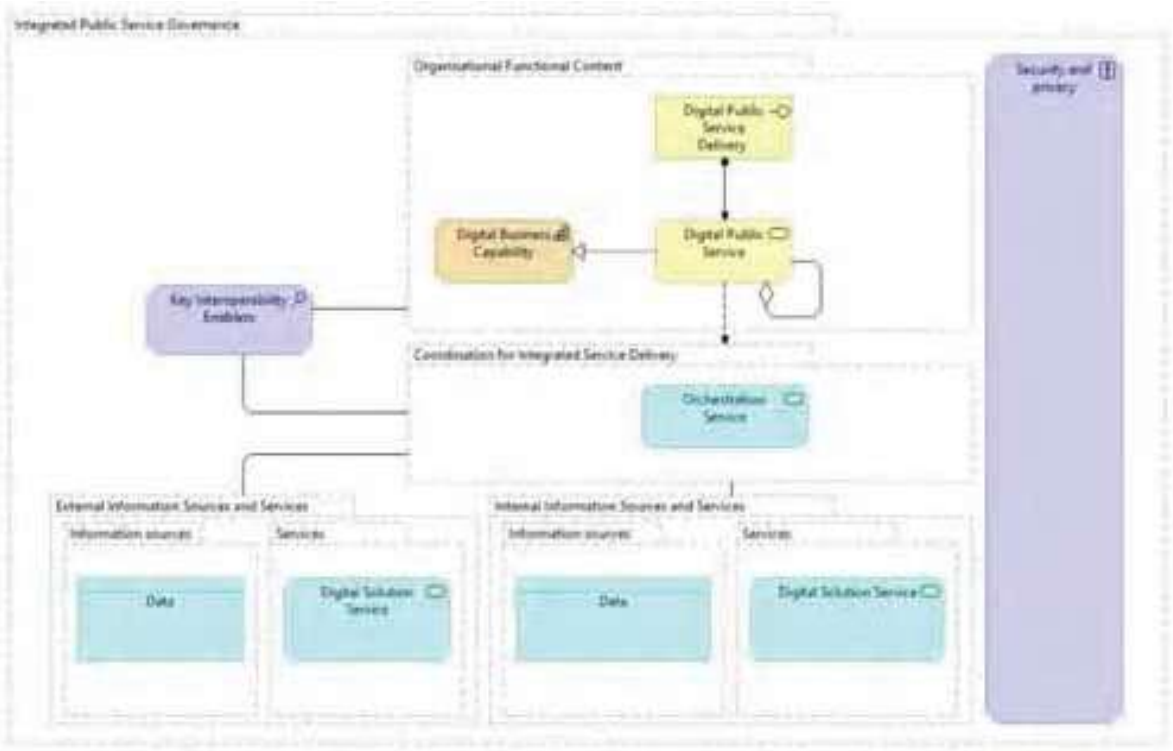
Table2. Technical ABBs of EIRA

The Technical view - Application	The Technical view - Infrastructure
Technical Interoperability Agreement	Solution Specification
Saas, PaaS, IaaS	Outsourcing
Interoperable Digital Solution	Saas
Machine to Machine Interface	PaaS

The Technical view - Application	The Technical view - Infrastructure
Human Interface	IaaS
Digital Solution Service	Computing Hosting, Networking, and Data Hosting Infrastructure
Digital Solution Component	Application Service
Shared Platform	Data Access Service
API Discovery and Catalogue Service	Intranet Service
API Catalogue	Remote Desktop Service
API	VPN Service
Service Registry	Web Service
Service Discovery and Registry Service	On Premise Facility
Software Component Discovery and Catalogue Service	Application Interface
Software Components Catalogue	Data Interface
API Catalogue Component	Intranetwork Service
Web Service	Data Virtualization
Service Registry Component	Data Warehouse
Software Component Catalogue Component	Data Server Software Environment
Orchestration Service	Data Lake
Orchestration Component	Data Hub

Source: EIRA 6.0.0 Specifications (European Union, 2023)

Figure 4 pictures an example of a ABBs composition to describe a Solution Architecture using EIRA ArchiMate extension.



Source: EIRA 6.0.0 Specifications (European Union, 2023)

Figure 4. ABBs composition of an EIRA Solution

One could see clearly that the EIRA is elaborated/positioned not only as a *standard* to specify interoperability European solutions but also offers the necessary *tools* to design and document these solutions.

3. CONCLUSIONS

From the beginning, the EIRA initiative objective was very ambitious: to define a powerful tool to design public/eGovernment services that could easily interoperate within national and EU space. The EIRA Specification is now at the sixth iteration, so one could say that this standard has reached a stable maturity level. There is no doubt that EIRA formal and technical foundations are sound, due to the underlying standards that support it, but, in our opinion, there are several questions that need further investigation:

- The formal specification needs a Reference Architecture Implementation POC (Proof of Concept) to validate it.
- An extensive study across the EU members is needed in order to build a solid evaluation of the adoption of the proposed architectural approach.
- The EIRA specification needs more elaborated principles, views, and building blocks for Cloud-based architectures, in the context of the large spreading of eGovernement-Cloud-based platforms.

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