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Deliverable 3.1
ICT architecture and tools - first release
WP3 ICT architecture and tools
T3.1 ICT architecture and tools – first release

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Public

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Abstract: The present deliverable documents the first iteration of the ICT architecture of inGOV. A set of EIRA compliant zero level architecture diagrams, one for each pilot, were produced following IPS holistic framework guidelines. The status of the mock-up of the tools, is also reported in the present deliverable.

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Executive Summary

The present deliverable documents the level zero of the ICT architecture of inGOV, together with the first release of the wireframe mockups of the tools. By consolidating the outcomes of the needs' elicitation, as carried out in T1.2: "Needs elicitation" and following the co-creation approach, as this was codified in the Agile Roadmap of the IPS holistic framework documented in D2.1: "IPS Holistic Framework", a set of level zero architecture diagrams were produced, one for each pilot. The architecture diagrams make use of the high-level viewpoint of the European Interoperability Reference Architecture (EIRA) by aligning the high-level descriptions of the solution blocks, that will facilitate each pilot, with architecture blocks of EIRA. In parallel, as requirements are iteratively consolidated, a set of wireframe mockups was implemented, which is currently under validation by the pilots. Also, in parallel, a set of re-usable building blocks consisting both of Connecting Europe Facility (CEF) blocks and Core Vocabularies for representing data have been identified to fulfil aspects of functionality requirements of the inGOV use cases. These lower-level building blocks are expected to merge with the solution blocks of the architecture, as this is designed in levels one and two. The outputs of the present report are expected to lead the second iteration of co-creation workshops, which will result in high-fidelity functional mockups both at the component and at the data level.

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v 0.3	9/12/2021	Draft	Elena Politi	Methodology
v 0.4	10/12/2021	Draft	Elena Politi, Dimitris Ntalaperas	Framework
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Acronyms and Abbreviations

Acronym/Abbreviation	Description
ABB	Architecture Building Block
AI	Artificial Intelligence
CEF	Connecting Europe Facility
CPSV-AP	Core Public Service Vocabulary – Application Profile
EBSI	European Blockchain Services Infrastructure
eIDAS	electronic IDentification, Authentication and trust Services
EIF	European Interoperability Framework
EIRA	European Interoperability Reference Architecture
FOAF	Friend Of A Friend
ICT	Information and Communication Technologies
IPS	Integrated Public Services
ISA	Interoperability Solutions and common frameworks for European public Administrations, businesses and citizens
PA	Public Authority
RDF	Resource Description Framework
SBB	Solution Building Block
TOGAF	The Open Group Architecture Framework

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Partners List Abbreviations

Acronym/Abbreviation	Description
UNIS GR	UNI SYSTEMS SYSTIMATA PLIROFORIKIS MONOPROSOPI ANONYMI EMPORIKI ETAIRIA
Deloitte	DELOITTE CONSULTING SRL
CERTH	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS
UBITECH	UBITECH LIMITED
RIDE	RIDE TECHNOLOGIES DOO
KUL	KATHOLIEKE UNIVERSITEIT LEUVEN
DUK	DANUBE UNIVERSITY KREMS
UoM	UNIVERSITY OF MACEDONIA
MITA	MALTA INFORMATION TECHNOLOGY AGENCY
LAND NÖ	AMT DER NIEDEROSTERREICHISCHEN LANDESREGIERUNG
THESSALY	PERIFERIA THESSALIAS
BJELOVAR	GRAD BJELOVAR

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1. Introduction

Public authorities (PAs) throughout the EU are requested to provide better public services (PS) with fewer resources. As citizens demand personalized electronic public services that match their exact needs and circumstances, PS need to be widely accessible anywhere, anytime particularly from disadvantaged social groups. Integrated Public Services (IPS) in particular, constitute the holy grail of electronic public service delivery and are a prerequisite to achieve significant strategic goals, such as one-stop government, joined-up government, single window, offerings around life and business events, and the once-only principle [1].

The vision of the inGOV project is to provide innovative ICT-supported governance models as well as mobile apps including chatbots, which will enable stakeholders' collaboration in co-producing inclusive and accessible IPS thus increasing trust and satisfaction. For that purpose, multidisciplinary scientific methods will be used including design science, multiple case study and variants of the technology acceptance model. In this context, Work Package (WP) 3 will focus on the definition of the inGOV ICT architecture and related tools that will support IPS co-creation and governance models and is based on emerging IT paradigms for accessible mobile and apps and visual assistants' development. The inGOV ICT architecture and tools will consist of three releases. Task 3.1 will be the first release and it will be based on four pillars, as these are described in the DoA, namely:

a) the Internal Information Sources and Services pillar that will exploit knowledge graphs, PS-related vocabularies, semantics, and Linked Data technologies

(b) the IPS Coordination pillar that will exploit suitable technologies to accommodate the agreements needed between stakeholders in various organizational structures

(c) the IPS platform and apps development: Novel mobile apps and chatbots development that will comprise the majority of the work carried out in the project. This layer will include the platform for mobile apps developments and the chatbot engine

(d) The fourth pillar is based on acquiring experience from existing best practices and also develop and deploy new IPS in diverse areas including IPS for social benefits in Malta, for tourism tax in Austria, for disabled in Greece and for informing the general population in Croatia

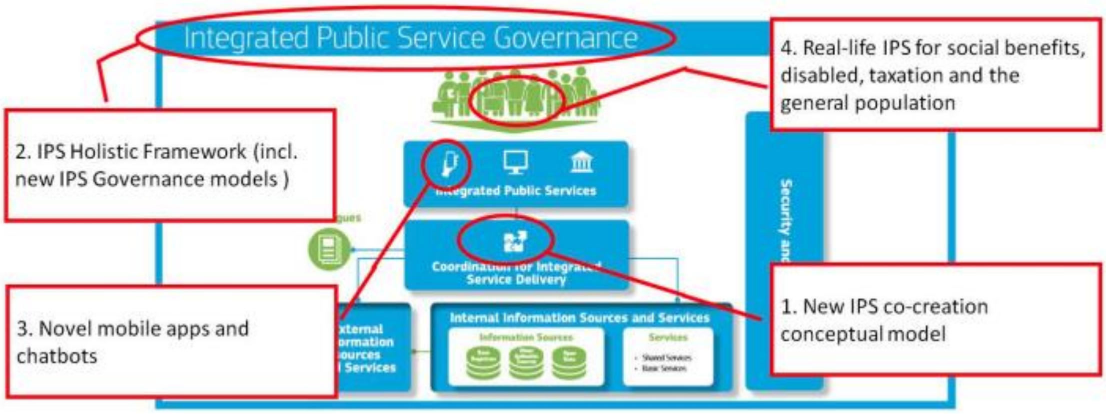

Figure 1: inGOV Pillars

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1.1 Document Scope

The present deliverable is the first release of the Reference Architecture and inGOV ICT tools that will be developed upon the first release of the IPS holistic framework (T2.1). The purpose of this document is to present the architectures and ICT platforms and tools that will support IPS co-creation and governance models. Work in this area will mainly include an IPS reference architecture and platform for mobile applications development e.g., including native mobile apps for visual assistants. In addition, knowledge graphs and Linked Data will be exploited as emerging technologies for open data storage and access that can facilitate the provision of personalized information to citizens, businesses, and other end users.

1.2 Document Structure

The document is organized as follows. Section 1 defines the scope of the document as well as the relation with other deliverables. In section 2 the state of the art of existing methodologies and frameworks for the delivery of public services is presented. Section 3 describes the proposed methodology that was followed for the first release of the inGOV ICT Architecture. Section 4 presents the conceptual design of the technical architecture for each pilot of the inGOV project, while section 5 documents the wireframe mockups of the tools together with the reusable components that are to be incorporated in the inGOV solutions, namely the various CEF building blocks and the semantic models for representing data. Finally in sections 6 and 7 we present the conclusions and future roadmap for WP3.

1.3 Relation with other Deliverables

The work in the present deliverable is based on the results of both D1.1 "IPS Enhanced models and needs elicitation" which was delivered on M6 and D2.1 "IPS holistic framework" which was delivered on M9 of the project in the context of WP2.

2. Background

As citizens of the EU are nowadays able to work and relocate, and businesses are free to trade within the Member States, the need for designing and delivering seamless European PS to other public administrations has evolved. The digitalization of existing PS, as well as the opportunity for the creation of new ones through the exploitation of modern ICT tools, has created new opportunities for governments to serve and inform stakeholders with improved quality and accountability. In this section the existing EU policies, frameworks, software building blocks, and standards as well as state-of-the-art methodologies and examples of integrated public services will be presented.

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Increasing demands of citizens of the EU for responsiveness, participation, and inclusion in the delivery of public services have turned e-government services to an explicit component of the public sector. The purpose of e-government services is to exploit ICT channels and powerful technologies in order to deliver public services and address stakeholders' needs in an efficient manner. The European public service provision often requires different public administrations to collaborate to meet end users' needs and provide public services in an integrated way. In such context, the term IPS refers to the orchestration of different public administrations into one integrated public service where the stakeholder's needs are identified while appropriate services are provided in a more effective manner and with the integral participation of the citizens [2]. Apart from a better quality of public services this approach also can offer reduced development costs, improved software quality, increased users' experience, and improved interoperability [3].

The value of increased transparency and open data in existing e-government implementations have been identified as powerful tools for supporting access to information, transaction services and citizen participation in public services [4]. Moreover, the use of various ICT technologies and tools, such as mobile technology has been proposed for improving the quality of public services [5]. Existing frameworks have also explored the vast advantages of Blockchain and other distributed ledger technologies (DLT). Such infrastructures can solve trust issues raised when dealing with stored data, transactions validity, service, and systems' conformity of intergovernmental services. The main advantage of blockchain technologies is that they are secure by design and offer a powerful framework for decentralized data processing and sharing [6]. Recent advances in Artificial Intelligence (AI) and deep learning techniques have also opened the way for new capabilities in e-government systems and services. Artificial Intelligence (AI) technologies can provide unprecedented opportunities for governments to improve public services and strengthen their interactions with citizens with the use of intelligent features, such as face recognition, machine learning, or recommender systems[7].

2.1 Frameworks

The creation and delivery of public services of high value is dependent upon the ability of the diverse organizations to work together towards mutually beneficial goals, involving the sharing of information and knowledge among them, through appropriate ICT systems [1]. Interoperability frameworks are agreed approaches among such organizations towards the delivery of high-quality public services. To address interoperability challenges of public administrations, the European Union (EU) launched the ISA² program in 2016. The program supports the development of digital solutions that enable public administrations, businesses, and citizens in Europe to benefit from interoperable cross-border and cross-sector public services.

Moreover, the new European Interoperability Framework (new EIF) was adopted in 2017, in the context of the digital single market strategy in Europe, to support interoperability within the public sector. EIF offers recommendations, models, and guidance to public administrations on how to improve governance of their interoperability activities, establish cross-organizational relationships, support end-to-end digital services, and ensure that existing and new legislation do not compromise interoperability efforts [2]. The implementation of the EIF recommendations aims to support the establishment of European public services but also cultivate a European ecosystem where stakeholders are familiar with interoperability, organizations are prompt to collaborate, and common frameworks facilitate the establishment of European public services.

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2.2 Methodologies

2.2.1 Co-Creation

Digital tools and technologies can enhance citizen participation and transform the ways in which public sector organizations produce and deliver services. In such context, the term co-creation refers to the active collaboration between government and citizens on specific policy issues. Co-creation processes may be government-led or may result from bottom-up initiatives. They also require a considerable amount of time and particular digital skills on behalf of the citizens [8]. An overview of roadmaps as identified with focus on the public sector, and how they are used for public service design can be found in D2.1 “IPS holistic framework”.

Designing public services with co-creation capabilities can address economic problems resulting from austerity measures and provide solutions to the problem of democratic deficit. Moreover, co-creation leads to the improvement of the effectiveness and quality of public services while lowering costs and ensures higher satisfaction with public services, general improvement of the wellbeing of citizens, and fulfilment of their needs [9].

3. Project Methodology

3.1 Challenges

Interoperability is a perquisite for enabling information sharing among public administrations. However there exist several challenges that may lead to a failure in the successful delivery of public services, such as integration of services and data at the local level, legacy systems, changing technology, and lack of interest of stakeholders to work towards common approaches [10].

From a technical point of view, the availability of high-quality internet services, such as the internet bandwidth capacity or the quality of mobile services provided, can undermine the quality of the provided services for modern cross-organizational information systems. Another major concern over the e-government implementations is the security and privacy of the e-government services and data sharing applications that may compromise the transparency of such systems [11].

Moreover, one should note that the architectural design of the inGOV project is highly dependent upon the legal and ethical challenges, considering the sensitive nature of the data being handled. These may include the legislation that deals with information, data, services or content, such as freedom of information, intellectual property rights or the protection of personal data. Though it is obvious that the architecture should be GDPR compliant, this compliance should be evident at all stages of development to all involved stakeholders (public servants and citizen end users), especially since co-creation is used as the main interaction method for designing and evaluating the delivered services. Societal, organizational and political challenges should be also considered, for example user acceptance of the proposed technology tools. Individuals may often be discouraged by the extra work and effort required in learning new technology software or a whole new operating system.

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3.2 The approach of inGOV

The main goal of inGOV is to design and implement services that fulfill end-user needs, by using a process that leverages both co-creation techniques as well as best practices for IPS design, as these are defined in various EU guidelines and crystalized in the inGOV framework (see also D2.1: "IPS Holistic Framework"). In order to achieve this, an agile approach is followed with each cycle of design implementation and evaluation, leading to incremental improvements both in system definitions (as this is represented in the running version of the architecture) and to the functionalities of the tools after each release. Co-creation is used in each one of these cycles especially during the design and evaluation.

To involve stakeholders more efficiently, a hybrid approach, incorporating elements of both top-down and bottom-up design, is followed. The rationale behind this decision is that pure top-down approaches, in which the system is first designed and then implemented, may miss crucial feedback from end-users and stakeholders that will become apparent during the late stage of prototype testing. Bottom-up approaches on the other hand, may become too focused on design and functionality details, such that important interoperability and framework elements are only later discovered during system design by the IT experts; ideally, we would like such elements to emerge during interactions with the end users. The hybrid approach that will be followed in inGOV therefore combines these two approaches. At each iteration step:

1. User needs and input is gathered
2. The input is mapped into the architecture
3. A new version of the software (design, functional mockups, or prototype according to the stage of development) is released.
4. User input is gathered for both the architecture and the tools' functionality. User satisfaction is rated according to KPIs and, more importantly, goals for the next release are set.

3.2.1 Co-creation

As already noted above (Section 3.2) co-creation is an integral part of design and implementation for inGOV's Architecture and Tools. One important aspect of co-creation is that it attempts to bridge the knowledge and communication gap between the various teams participating in the development of the solutions (e.g., stakeholders like citizens and public servants, system engineers, software development etc.). IT experts tend to make assumptions concerning usability and system behaviour that might not be justified by the real end-user needs; end users on the other hand may benefit from existing systems and solutions that fulfil their needs in a much more concrete way than what they may have envisaged.

Based on the above considerations, it becomes clear that co-creation is the central driving force between iterations and not a supporting tool to aid design. It is used at each stage to minimize the risk of diverging from user needs and expectations.

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3.2.2 The framework

The inGOV IPS holistic framework (documented in D2.1 IPS Holistic Framework) defines a set of recommendations for design, delivery and evaluation as well as the Agile Roadmap for IPS Co-Creation. The recommendations and roadmap will provide a detailed guideline for designing the architecture and implementing the inGOV tools. One of the secondary tasks of WP3: "ICT architecture and tools" will also be that of the validation of the recommendations and roadmap steps, at least those that involve technical aspects. In essence, instead of passively following the guidelines, an effort to demonstrate that they can emerge naturally, if end-users are actively engaged in the creation of IPS, is made. The results of these effort will be a secondary output of WP3 that can be used in the 2nd iteration of D2.1.

Table 1, Table 2 and Table 3 summarize the framework's design, delivery, and evaluation recommendations respectively. Evaluation recommendations correspond to the evaluation of pilots' activities, which take place in WP4: "Pilots planning and evaluation" and are listed here for completeness.

Concerning the design recommendations, at least for those that are more relevant to the technical aspects, stakeholders were engaged from the earliest time possible with the twofold goal of a) conceptualizing the solution and produce concept diagrams and mockups and b) making both the stakeholders and the technical team members familiar with the scope of the needs and the project objectives. This process corresponds to the fulfilment of recommendations 2-4, with recommendation 1 being fulfilled mainly in the phase of needs elicitation during T1.2 Needs' elicitation activities. Concerning the organizational aspect, a number of meetings were organised, and sub-objectives were iteratively defined and presented to stakeholders (recommendations 5 and 6). Though recommendations 5-8 are not technical, efforts during WP3 were carried out with the aim of being compliant with legal aspects. For example, GDPR compliance is constant requirement throughout the whole design and implementation phase. In the technical and semantic aspect finally, recommendation 10 is followed by making an effort to reuse existing components and solutions, especially the ones adopted by the EU in the context of Connecting Europe Facility (see also Section 5.4).

Table 1: Summary of recommendations for the Design Phase

Design Phase Recommendation	
Needs identification	1. Use a research approach for scanning the issues perceived by the community.
Role of Stakeholders	2. Engage holders of data, service owners and service users (frontline staff, citizens) from the earliest stages.
Stakeholder engagement	3. Contact, inform and provide an opportunity to contribute to every identified stakeholder early on.
	4. Formalise exchanges with stakeholders.
Organisational/managerial aspects	5. Structure the project across successive phases and aiming at reasonable deadlines.
	6. Plan regular information meetings, or of a specific supervisory board.
Legal/normative aspects	7. Inscribe the project's design within existing legal frameworks.
	8. Ensure the legal framework is complemented by formal agreements signed between the parties involved.

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Design Phase Recommendation	
Political aspects	9. Secure political commitment by engaging policy makers from the start of the project.
Technical/semantic aspects	10. Use pre-existing technical solutions that can facilitate the integration of public services.

For the delivery phase, as the first functional mockups are being delivered, a series of workshops and training sessions is planned in order to make the stakeholders aware, both of the features and aspects of the solution delivered and of the details that are relevant to their overall satisfaction. For example, when a service is delivered stakeholders will not only be trained to use the service, but also to understand how the underlying technology ensures their privacy and data safety.

Table 2: Summary of recommendations at the Delivery Phase

Delivery Phase Recommendation	
Role of Stakeholders	11. Keep stakeholders constantly informed throughout the project lifecycle to maintain their interest and support for the project.
Stakeholder engagement	12. Devise ways to develop digital competences and train service users.
	13. Provide relevant opportunities for service users and other stakeholders to bring them into the delivery of service.
Organisation/managerial aspects	14. Have a unified and consequential management for the project team.
Legal/normative aspects	15. In the case of cross-border projects, ensure that political decisions between governments are grounded in a written agreement, possibly laying down an explicit roadmap.
Political aspects	16. Seek political support when it is instrumental for civic support or solving roadblocks.
Technical/semantic aspects	17. Consider devising ways of bridging the gap that can exist between the technical skill and equipment of each partaking authority.

Evaluation recommendations, as already mentioned, correspond to WP4 activities and are listed here for completeness.

Table 3: Summary of recommendations at the Evaluation Phase

Evaluation Phase Recommendation	
Role of Stakeholders	18. Establish the stakeholders who will provide feedback and the role of service users as co-evaluators.
Stakeholder engagement	19. Adopt specific qualitative indicators for users to help identify service weaknesses.
Organisation/managerial aspects	20. Establish a clear repartition of roles within the project team.
Legal/normative aspects	21. Suggest relevant legislative changes to decision-makers.
Technical/semantic aspects	22. Devise a set of relevant quantitative KPIs for evaluation.

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The above recommendations can be incorporated to the Agile Roadmap for IPS Co-Creation, as this is documented in D2.1: "IPS Holistic Framework" and depicted in Figure 2. The Agile Roadmap is holistic, and it covers all aspects of inGOV, from co-creation processes to implementation guidelines. As mentioned, T3.1 activities are consistent with the recommendations, and therefore also this roadmap. As we are now in the phase of delivery of wireframe mockups and business diagrams, the agile roadmap was mostly validated for the design phase. Moreover, while entering the first iteration of delivery and evaluation that will lead to high fidelity mockups and services (expected to be concluded by M15), recommendations relevant to delivery and evaluation will also be followed. Experience and lessons learned that are relevant to the adoption of the roadmap will be a secondary output of WP3, which can be used to further enhance the IPS holistic framework in the context of WP2 activities.

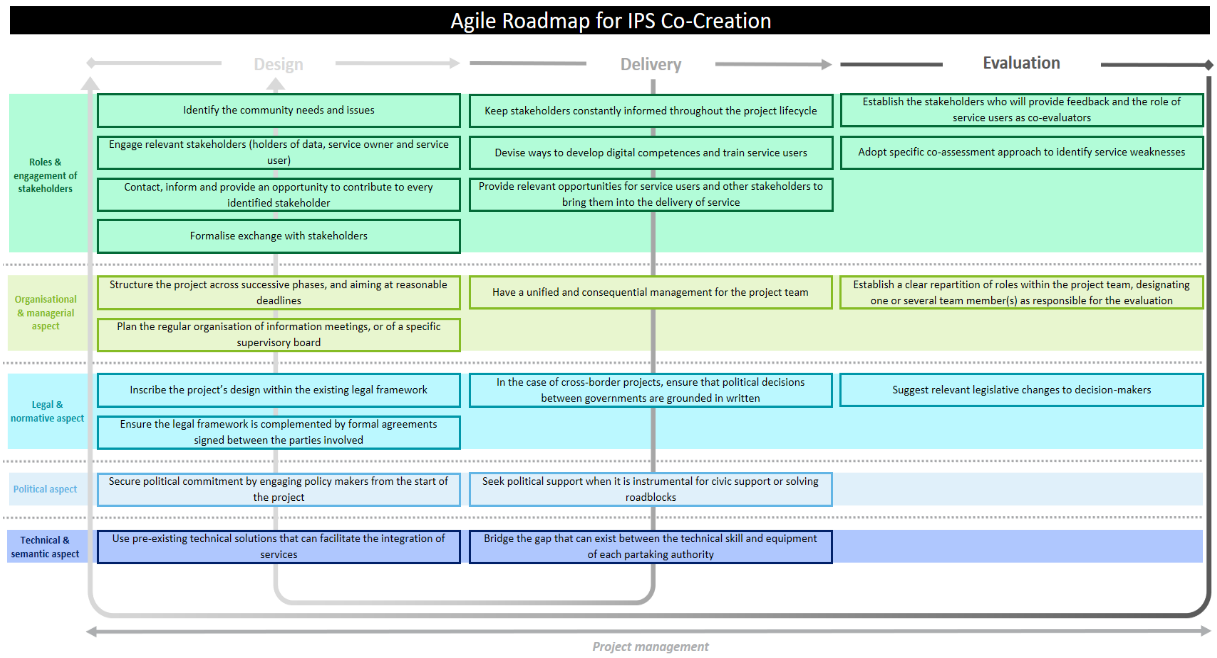

Figure 2: Agile Roadmap for IPS Co-Creation

3.2.3 Architecture design

As the architecture is a basic component of defining a system and reasoning about its functionalities it is essential that the same general requirements that hold for the system development, should also be applicable for the architecture. More specifically, the architecture should:

- Be the result of a co-creation process. At each stage, architecture and/or solution blocks together with their relations, should emerge from needs and input gathered with stakeholders.
- Be verifiable by stakeholders. Although not all stakeholders are expected to be technically capable of interpreting or evaluating an architecture, the architecture should still be transparent, in the sense that is represented in a standard format and is sufficiently documented.

- Offer reusability features. Parts of the solution that can be reused, instantiated, or specialized in other solutions or in different level of the same solution, should be easily identified and exported as a separate block. Standard terminology is also an enabler for reusability since it allows easy cross-domain and cross-border adoption of existing artefacts.

To facilitate all the above, it is useful to adopt a standard way of representing and designing the architecture. The most natural choice is basing the architecture on European Interoperability Reference Architecture (EIRA).

3.2.3.1 EIRA Model

EIRA[1] is an output of the ISA² Action 2016.32 that addresses the need of public administrators to design and coordinate cross-border IPS. Quoting from the official documentation page of EIRA, the main four characteristics of EIRA are:

- *Common terminology to achieve a minimum level of coordination: It provides a set of well-defined ABBs that provide a minimal common understanding of the most important building blocks needed to build interoperable public services.*
- *Reference architecture for delivering digital public services: It offers a framework to categorise (re)usable solution building blocks (SBBs) of an e-Government solution. It allows portfolio managers to rationalise, manage and document their portfolio of solutions.*
- *Technology- and product-neutral and a service-oriented architecture (SOA) style: The EIRA© adopts a service-oriented architecture style and promotes ArchiMate® as a modelling notation. In fact, the EIRA© ABBs can be seen as an extension of the model concepts in ArchiMate®.*
- *Alignment with EIF and TOGAF®: The EIRA© is aligned with the European Interoperability Framework (EIF) and complies with the context given in the European Interoperability Framework - Implementation Strategy (EIF-IS). The views of the EIRA© correspond to the interoperability levels in the EIF: legal, organisational, semantic and technical interoperability. Within TOGAF® and the Enterprise Architecture Continuum, EIRA© focuses on the architecture continuum. It re-uses terminology and paradigms from TOGAF® such as architecture patterns, building blocks and views.*

As already mentioned, the architecture of inGOV will be based on EIRA. More specifically, for each one of the pilots, EIRA will be extended and adopted to the pilot's needs. Although EIRA was not designed with the main assumption that inGOV has, namely that co-creation should be the main driving force of system design, this is not expected to have a significant impact. Indeed, the co-creation process is expected to influence the definition of the architecture/solution blocks and their relations. These blocks and relations will correspond to IPS concepts that EIRA, by its very definition, covers. In other words, the semantics of the process by which we reach the architecture definition is not relevant to the expressive power of EIRA concepts, which is agnostic to the design method of the architecture. If, however, at a later point we discover that co-creation does indeed impose a limitation or justifies an expansion of the main representations, this should be noted and documented

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

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as an output. In any case, the process itself of using co-creation to design an architecture will have a representation of its own in a new "Design View" that will be an extension of the "Architecture Principle View" of EIRA; this will be documented in the final iteration of D3.1.

3.2.3.2 Modelling in Archimate

One of the main advantages of EIRA, is that it is already modelled in Archimate[2], a widely used design tool. As such, solutions that are based on EIRA components, can be easily distributed, reused, and edited. Apart for the main functionalities of Archimate, EIRA comes along with an extra set of high-level support features in the form of Cartography Tool (CarTool). CarTool is an extra plugin for Archimate that offers extra editing features, modelling functionalities using EIRA as well as modular definitions of new architectural or solutions blocks that can then easily be inserted in solutions.

Archimate and CarTool will be the main design tool for modelling the architecture during the lifetime of the project.

4. Architecture

As mentioned in the previous section, the Architecture of inGOV will consist of four architectural diagrams, one for each pilot. The four diagrams will be created in Archimate using the EIRA model as basis and the CarTool to model and define the various blocks of each solution. In the first iteration, we will focus on the main entities and blocks that consist each solution; as such the first iteration will contain only the high-level viewpoint of EIRA, as this is specialized for each one of the pilots.

As inGOV follows a hybrid of top-down and bottom-up approach, some of the core tools and technologies that are going to be implemented have already been defined, especially during the phase of needs elicitation, as this process is documented in D1.1: "PS Enhanced Models and Needs Elicitation". The set of core technologies and tools that emerged for the needs' elicitation process is depicted in Table 4. 'YES' indicate a required component, 'NO' indicates an irrelevant for this pilot component, while 'GOOD' indicates a "nice to have" component (a component that, though not strictly necessary, is expected to provide useful supporting functionality). Some of these tools (e.g., chatbots) will require to have detailed technical views which are to be designed in the next iteration. As such, they will be represented only as part of the relevant architecture blocks in the corresponding views.

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

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Table 4: Core technologies identified for each pilot

	Functionality				
Pilot	Semantic Alignment	Mobile App	Chatbot	Knowledge Graph	Blockchain
Austria	YES	NO	NO	GOOD	GOOD
Croatia	YES	YES	YES	GOOD	NO
Greece	YES	YES	GOOD	GOOD	NO
Malta	YES	NO	NO	YES	NO

Another point worth noting is that all pilots require authentication and authorization of users, at least for part of their needs. Though no pilot currently uses eIDAS, it is nonetheless considered for use as it performs the required functionality on top of also providing a cross-border and decentralized way of obtaining self-sovereign identification (SSI). An SSI allows users to present evidence in a decentralized way without the need of constantly signing on to different agencies to verify their claims. A student for example, that wishes to apply for a post grad position, can have her/his credentials signed by an issuer that is part of EU trust service providers. This can be verified by the university accepting the application to ensure that the user's titles are correct. This is a good example of the point raised in Section 3.2 concerning the bridging of gap between IT and stakeholders: though most pilots did not use or did not know about eIDAS, its relevancy and the pilots' willingness to adopt it became apparent during the first iteration of the co-design phase, currently under way. Other CEF blocks are also considered as they map naturally to existing user needs (see also Section 5.4).

As mentioned, the high-level viewpoint of the architecture for each one of the pilots will be based on the high-level viewpoint of EIRA, depicted in Figure 3. The architecture principle view is naturally aligned with EIF and TOGAF. If during inGOV the need to extend the view to accommodate with the co-creation process, or to explicitly represent processes of the inGOV holistic IPS framework emerge, the corresponding view will be updated in future iterations of D3.1.

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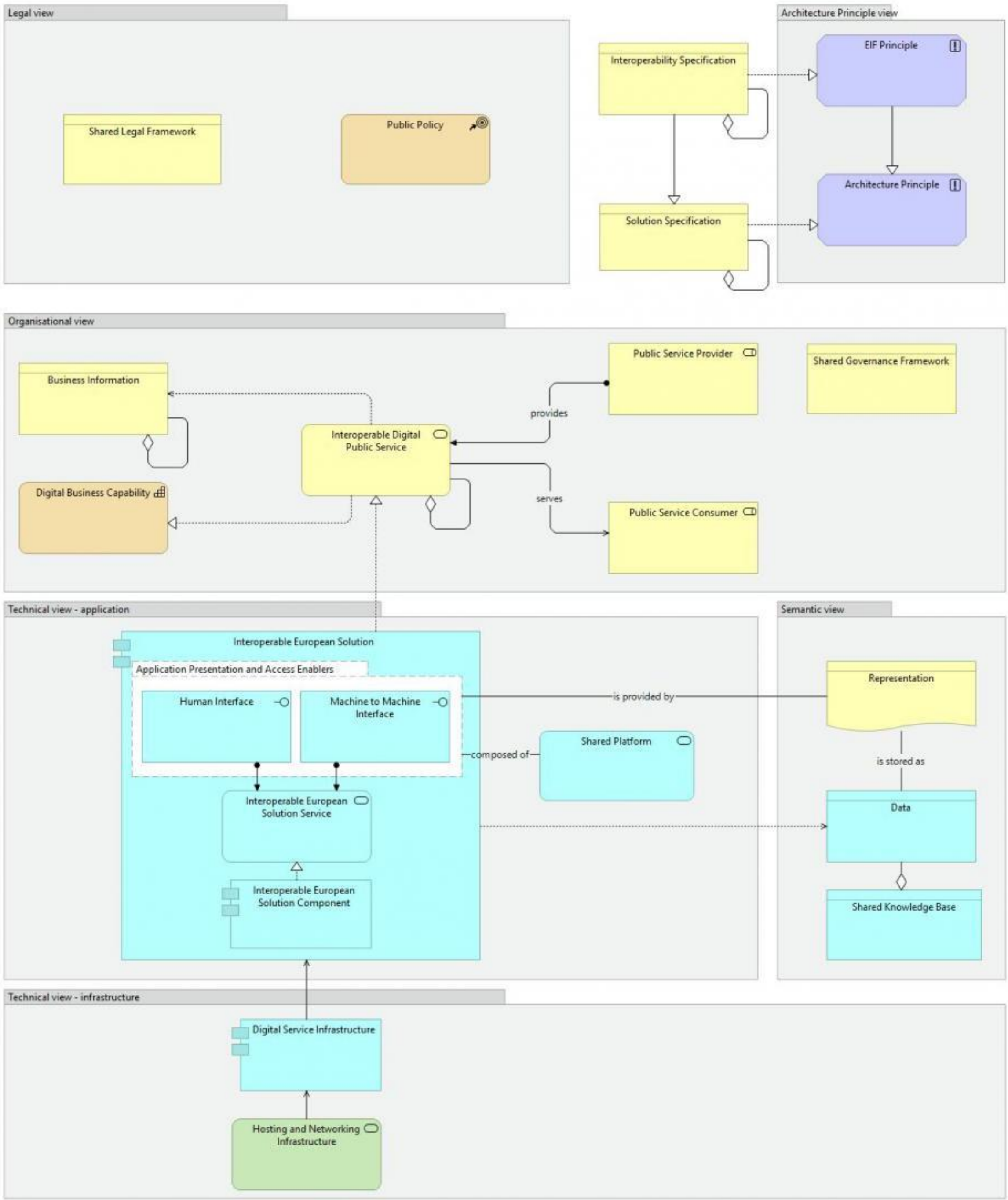

Figure 3: EIRA high-level overview

For the other views of the high-level architecture, the model of each pilot will instantiate each block either as an architecture or as solution building block. The difference between these two categories is that architecture building blocks (ABBs) correspond to abstract functionality that the solution must implement, while solution budling blocks (SBBs) denote a specific solution that is required to be part of an implementation.

Consider for example the need to protect sensitive data: An ABB denoted as "Data privacy policy", would denote that the solution that is based on this architecture should implement a policy for data

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privacy. The exact policy to be adopted is either unclear at this point, or the decision is left intentionally for the adopter to decide which policy to adopt or implement. If, on the other hand, the need to adopt a specific data privacy policy, such as GDPR, is required from every adopter of the architecture, this is represented as a SBB that is constructed from the relevant ABB. In our case, an SBB with a name denoting this relationship, such as “<<arch:Data Privacy Policy>> GDPR”, would be present in the architecture. For a more detailed description of these concepts, please refer to Section 4.1.

Since this deliverable D3.1 is mainly concerning ICT architecture, the views that will be elaborated are those that are relevant with the technical implementation (Technical view – application, technical view - infrastructure and semantic view). For reference, the diagrams for each one of the views of interest are depicted in Figure 4 (Technical View – application), Figure 5 (Technical View – infrastructure), and Figure 6 (Semantic View). The descriptions of each one of the ABBs according to the official EIRA documentation are likewise depicted in Table 5 (Technical View – application) Table 6 (Technical View – infrastructure) and Table 7 (Semantic View).

Table 5: ABBs for Technical View - application

Architecture building block	Description
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. Source: ISA^2 - EIA Action (*) DECISION (EU) 2015/2240 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2015 establishing a programme on interoperability solutions and common frameworks for European public administrations, businesses and citizens (ISA^2 programme) as a means for modernising the public sector.
Machine to machine interface	A boundary set of means enabling the exchange of data between a service and other services. This ABB is a key interoperability enabler (*) for assessing compatible interfaces. Source: ISA^2 - EIA Action (*) DECISION (EU) 2015/2240 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2015 establishing a programme on interoperability solutions and common frameworks for European public administrations, businesses and citizens (ISA^2 programme) as a means for modernising the public sector.

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Architecture building block	Description
Interoperable European Solution Service	Represents an explicitly defined shared application behavior of an Interoperable European Solution. Based on ArchiMate® v3 http://pubs.opengroup.org/architecture/archimate3-doc/chap09.html
Interoperable European Solution Component	Interoperable European Solution Component represents the encapsulation of a functionality provided by an Interoperable European Solution. Based on ArchiMate® v3 http://pubs.opengroup.org/architecture/archimate3-doc/chap09.html
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 a public administration (central, regional, local) towards the achievement of the public policy goals, enabling: i) 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 public administrations and cross borders); ii) 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 public administrations and cross borders); and iii) Governance of 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 public administrations and cross borders).

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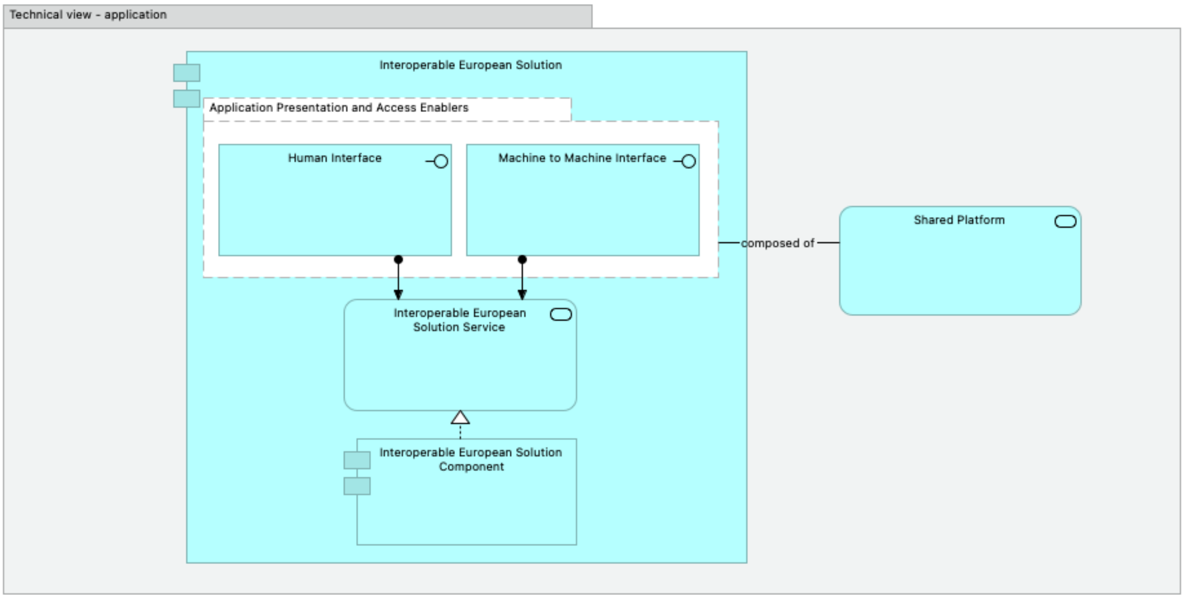

Figure 4: EIRA high-level viewpoint: Technical View - application

Table 6: ABBs for Technical View - Infrastructure

Architecture Building Block	Description
Digital Service Infrastructure	Infrastructure which enables networked services to be delivered electronically, typically over the internet, providing trans-European interoperable services of common interest for citizens, businesses and/or public authorities, and which are composed of core service platforms and generic services Source: Regulation (EU) No 283/2014 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0283&from=EN
Hosting and Networking Infrastructure	Shares the functionalities for i) hosting Interoperable European Solutions and ii) providing the necessary networks for operating these solutions. Source: ISA^2 - EIA Action

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Figure 5: EIRA high-level viewpoint: Technical View - infrastructure

Table 7: ABBs for Semantic View

Architecture Building Block	Description
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.). Source: ArchiMate® v3 http://pubs.opengroup.org/architecture/archimate3-doc/chap08.html
Data	Data are symbols obtained through an encoding process of business information or a legal act. Source: ISO-IEC-2382-1 1993 https://www.iso.org/obp/ui/#iso:std:iso-iec:2382:ed-1:v1:en
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 public administration (central, regional, local) towards the achievement of the public policy goals, enabling: i) 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 public administrations and cross borders); ii) 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 public administrations and cross borders); and iii) governance interoperability by semantic resources supporting the collaboration with internal/external peers exchanging data, information

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Architecture Building Block	Description
	or knowledge (i.e., Sematic Interoperability Agreements on interpretations enabling sharing, reuse and exchange of data/information/knowledge cross public administrations and cross borders).

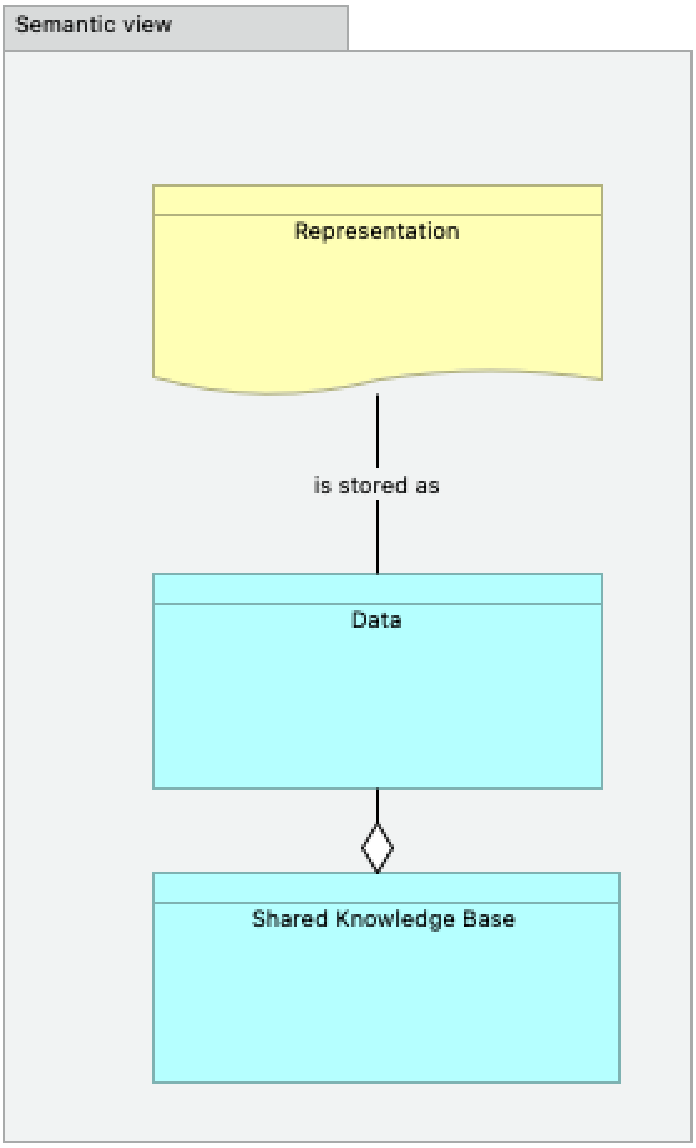

Figure 6: EIRA high-level viewpoint: Semantic View

For each one of the pilots, we will document the relevant SBBs that are instantiated from each ABB, as these are retrieved from the initial phase of the needs elicitation. The procedure followed was the

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same for each pilot. Deriving output from T1.2 "Needs elicitation", a concept diagram was created for each pilot; each pilot validated the diagram. Based on this, and on the technical refinements that took place for each place in the context of pilot planning in T4.1[3], the hybrid approach was followed:

- From the top-down perspective, the definition of SBBs that instantiate EIRA ABBs has started. This is an ongoing work and is currently completed only for the high-level viewpoint. Future iterations will provide concrete SBB definitions for the level 1 views of the architecture.
- From the bottom-up perspective, the definition and the design of mockup interfaces of the tools that are deemed necessary for each pilot has started and is expected to be validated by the pilots following co-creation principles.

As explained in the methodology section, the main aim is that the two approaches converge. Co-creation is the main driving force behind this effort; if at any time there is a discrepancy, this will be resolved only with collaboration with the stakeholders following the recommendations of the IPS holistic framework.

One artifact of the hybrid approach is that some SBBs may not be depicted in the current version of the architecture, despite the fact that their definition may have reached a certain level of maturity. For example, eIDAS for identity management and blockchain technology for traceability in transactions for the Austrian pilot, and a solution based on knowledge graphs for the representation of data for the Malta pilot have been identified as useful inGOV components by the end-users. However, since they correspond to a lower-level of description, they have not yet merged with the higher-level description that is followed by the top-down approach. As the architecture is defined at lower levels, it is expected that these SBBs will naturally fill ABBs for the corresponding pilots.

4.1 Architecture Building Blocks and Solution Building Blocks

According to the TOGAF[4] standard, a proven Enterprise Architecture and framework developed by The Open Group, an enterprise architecture can be described by three continuums:

- The Enterprise Continuum is the outermost continuum and classifies assets related to the context of the overall enterprise architecture. The Enterprise Continuum classes of assets may influence architectures but are not directly used during the ADM[5] architecture development. The Enterprise Continuum classifies contextual assets used to develop architectures, such as policies, standards, strategic initiatives, organizational structures, and enterprise-level capabilities. The Enterprise Continuum can also classify solutions (as opposed to descriptions or specifications of solutions). Finally, the Enterprise Continuum contains two specializations, namely the Architecture and Solutions Continua.

[3] See Section 2 of D4.1: "Pilots and Evaluation plan - Version a"

[4] https://www.opengroup.org/togaf

[5] The Architecture Development Method (ADM) is the TOGAF method for developing an IT architecture. Please see: http://www.opengroup.org/public/arch/p2/p2_intro.htm#:~:text=The%20TOGAF%20Architecture%20Development%20Method,assets%20available%20to%20the%20organization

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- The Architecture continuum offers a consistent way to define and understand the generic rules, representations, and relationships in an architecture, including traceability and derivation relationships (e.g., to show that an Organization-Specific Architecture is based on an industry or generic standard). The Architecture Continuum represents a structuring of ABBs which are re-usable architecture assets. ABBs evolve through their development lifecycle from abstract and generic entities to fully expressed Organization-Specific Architecture assets. The Architecture Continuum assets will be used to guide and select the elements in the Solutions Continuum (see below). The Architecture Continuum shows the relationships among foundational frameworks (such as TOGAF), common system architectures (such as the III-RM[6]), industry architectures, and enterprise architectures. The Architecture Continuum is a useful tool to discover commonality and eliminate unnecessary redundancy.
- The Solutions Continuum provides a consistent way to describe and understand the implementation of the assets defined in the Architecture Continuum. The Solutions Continuum defines what is available in the organizational environment as re-usable Solution Building Blocks (SBBs). The solutions are the results of agreements between customers and business partners that implement the rules and relationships defined in the architecture space. The Solutions Continuum addresses the commonalities and differences among the products, systems, and services of implemented systems.

The continuums and their relations are depicted in Figure 7. As the architecture evolves, ABBs and SBBs are specialized to meet customer needs, while, on the other hand, generic ABBs and SBBs may be identified as reusable and documented accordingly. As the architecture is defined at even greater granularity, it is to be expected that features and definitions of ABBs and SBBs belonging to different levels may have some overlap. However, the distinction should be very clear for a specific level and for a specific pilot.

In inGOV, we expect that for the architecture continuum EIRA will be sufficient for all levels with any modification or extension needed appropriately documented. The extent to which the architecture continuum is similar for all pilots is one of the major outcomes of T3.1. Although we anticipate that the Architecture Continuum will be the same for all pilots (at least for the higher levels of the architecture), thereby justifying a common schema for all IPS based on co-creation, this has to be justified by co-creation activities with the pilots during the project's period. For Solution Continuum the above point is not expected as the solutions adopted will of course vary between pilots. We expect however to have a good deal of reusability for some core SBBs.

[6] https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap22.html

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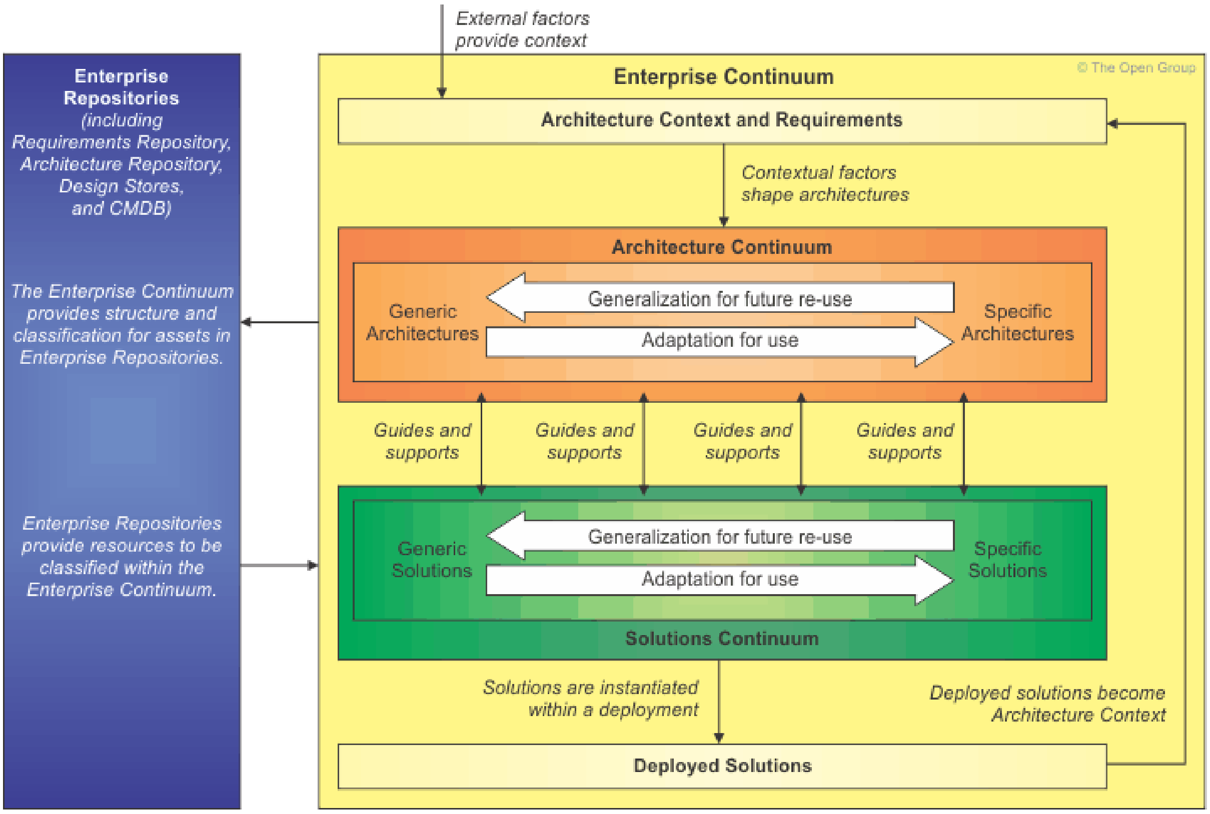

Figure 7: Enterprise continuum according to TOGAF

4.2 Pilot Models

During the pilots needs elicitation phase, a set of interviews and workshops were conducted with the aim of defining the needs of any stakeholder categories, with the results of this process being documented in D1.1: "IPS Enhanced models and needs elicitation". This output was then encoded into concepts diagrams, one for each pilot, which were then validated by the pilots during a series of technical workshops. This step 0 iteration provided a staging point from which initial mockups could be designed and from which the upper layers of the technical architecture for each pilot could be conceptually designed. In accordance with the hybrid approach some low-level solution blocks have also been verified, but these are not covered by the current version of the deliverable, as we expect these to naturally merge with the higher levels as the architecture is iteratively expanded.

In the following sections, these concept diagrams will be briefly presented and the corresponding instantiation of the relevant ABBs to pilot specific SBBs will be provided. It is to be noted that, at this stage, aspects of SBBs are also abstract; these are expected to be more concrete technology blocks when the level 1 diagrams (which correspond to each one of the EIRA views separately) are produced. Furthermore, the infrastructure view is still not instantiated as an SBB. Various infrastructure solutions, that are geared towards re-using European and government standards and infrastructure (e.g., EBSI, eIDAS and other CEFs listed in Section 5.4) are considered. These are expected to be finalized in the next round of co-creation workshops.

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4.2.1 Austrian Pilot

Figure 8 depicts the concept diagram for the Austria pilot. Local councils, that have gathered tax data from hotels, aggregate these data and forward them to the Federal Government. This data is uplifted using a common model and is represented in a standard way. The standard representation facilitates easy data organization, retrieval and automatic tax calculation. Although not depicted in the diagram, the need to track all transaction using blockchain was also hinted by the Austrian stakeholders as a good to have feature.

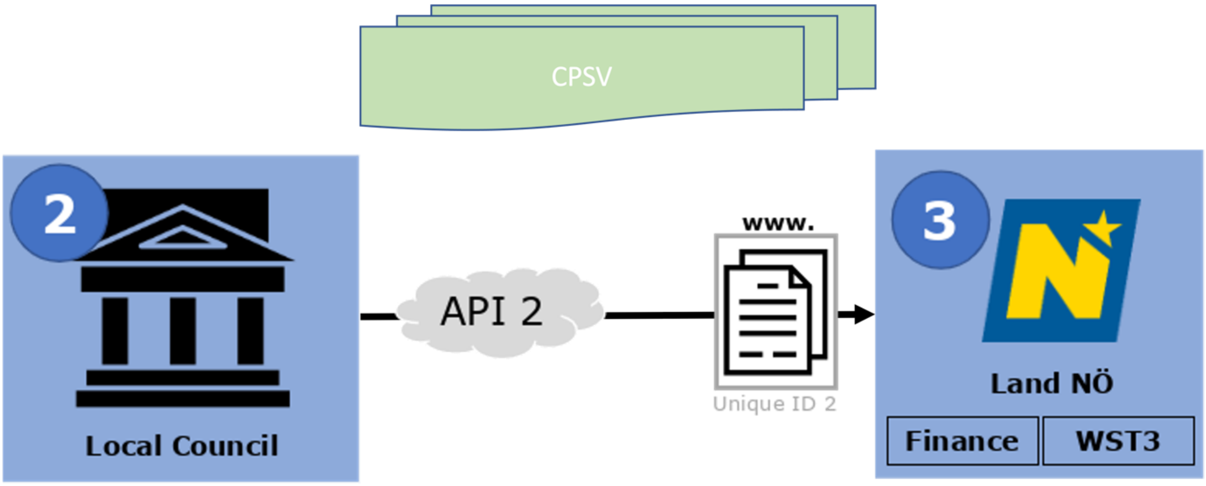

Figure 8: Concept diagram for the Austria pilot

Table 8 depicts the high level technical SBBs for the Austria pilot. The core of the solution is the usage of standard vocabulary to represent information in unified way. CPSV will be adopted, but extra vocabularies and ontologies are also being investigated, such as the Person Core Vocabulary, the Core Criterion and Core Evidence Vocabulary (CCCEV), and the Location Core Vocabulary (see pilot architecture descriptions in Section 4.2 and the summary of models in Section 5.2.1 for a short description of CPSV and the other ontologies). Concerning infrastructure, apart from hosting needs that are still being investigated, the need to authorize/authenticate users and the need to host a blockchain infrastructure has been identified, with eIDAS and European Blockchain Services Infrastructure (EBSI[7]) being possible candidates for the solution (see Section 5.4 for a brief description of these two CEF blocks).

Table 8: SBBs for the Austria pilot

SBB	ABB	View	Description
Local Tax collection and calculation Solution	Interoperable European Solution	Technical – application	The solution that is to be implemented for facilitating alignment of data form tax forms collected form councils.

[7] https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/EBSI

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SBB	ABB	View	Description
Local Tax collection GUI	Human Interface	Technical – application	The component that will provide visual output of the tax calculation to end users. The high-level description of this component is still in progress.
Local Tax collection interface	Machine to machine interface	Technical – application	The interfaces used to communicate information. REST is considered for communicating data between local councils and Land NO, and Hyperledger fabric for storing transaction data.
Local Tax calculation service	Interoperable European Solution Service	Technical – application	The block represents the abstract service that allows Land NO to retrieve and align tax data, as well as to compute taxes using a common representation model.
Local Tax calculation component	Interoperable European Solution Component	Technical – application	This block is a realization of the "Local Tax calculation service" SBB.
Local Tax Collection Integrated platform	Shared Platform	Technical – application	The totality of interoperable visual and interfacing components implementing all the required functionality will compose the integrated platform
N/A	Digital Service Infrastructure	Technical – Infrastructure	Same as corresponding ABB
N/A	Hosting and Networking Infrastructure	Technical – application	Same as corresponding ABB
Local Tax Data Representation	Representation	Semantic	The specification of the format according to which tax data are going to be represented. RDF is the most likely candidate since standard ontology models are expected to be adopted for knowledge representation.
Tax Form Data	Data	Semantic	The data as it is uplifted and aggregated by local councils. Secondary data points will consist of transaction data documenting transactions
Local Tax Model	Shared Knowledge Base	Semantic	The model which will encapsulate all relevant information of the underlying tax forms. CPSV will be used; adoption of other ontologies (Core Person, Core location, CCCEV) is still considered with the aim being to have most data mapped to European standard vocabularies.

The instantiation of the above SBBs is represented in the high-level viewpoint of EIRA and can be seen in Figure 9.

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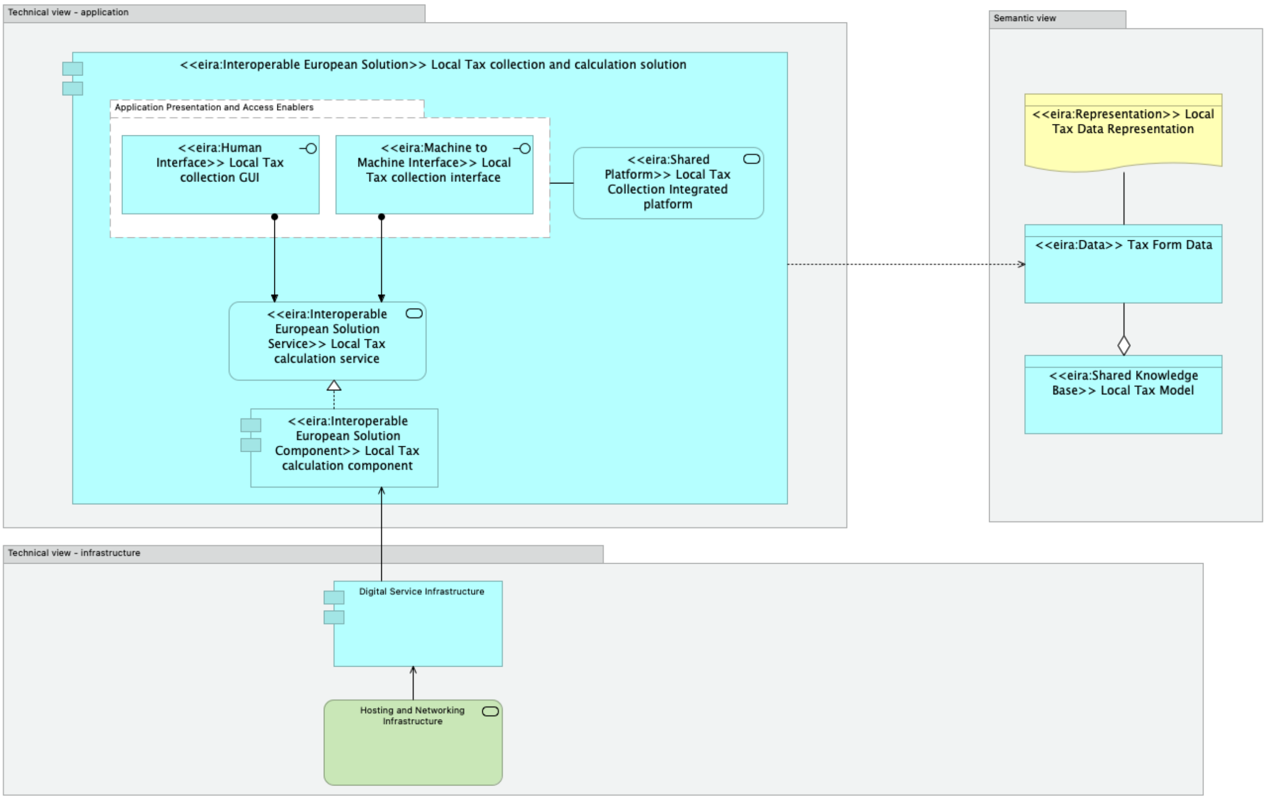

Figure 9: Level 0 ICT Architecture for the Austria Pilot

4.2.2 Croatian Pilot

Figure 10 depicts the concept diagram for the Croatia pilot. From the user perspective, the pilot aims to offer a Virtual Assistant that will help users navigate through the services offered by the City of Bjelovar. Services, that are either public or demand identification and authentication via NIAS[8], are represented by a common model, that is to be designed and implemented during inGOV. Using this model, the end user can navigate between the model's entities and discover services and relevant information according to her/his needs. A model enabled chatbot may help the user to navigate through the services.

[8] https://nias.gov.hr/en

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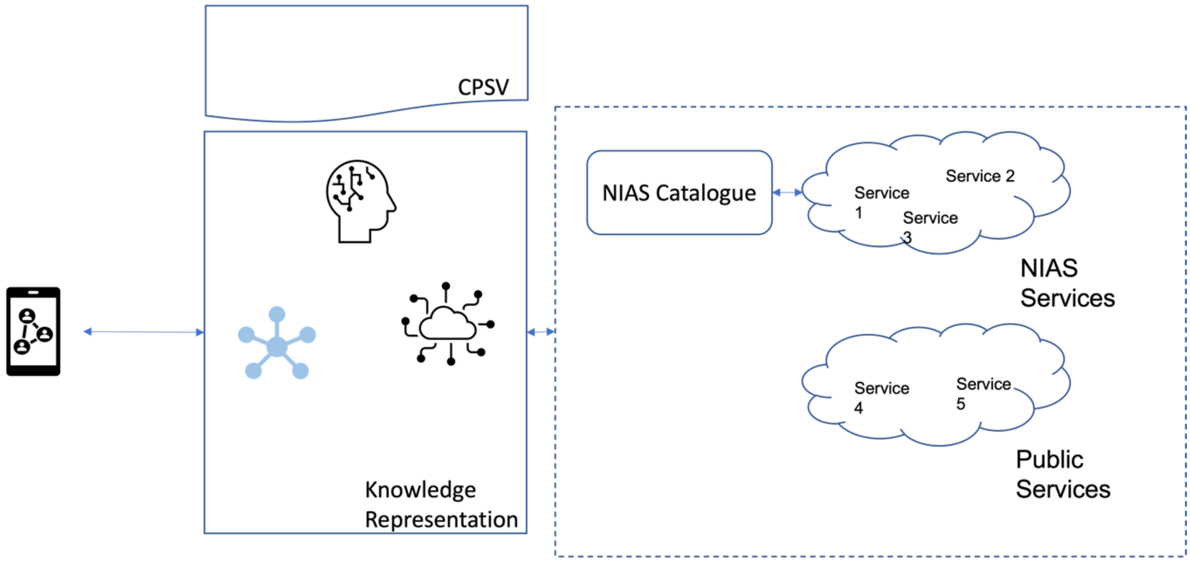

Figure 10: Concept diagram for the Croatia pilot

Table 9 depicts the solution blocks for the Croatia pilot. Knowledge graphs and chatbots are the main components that enable the pilot. It is crucial that these components are based on a common model to accommodate the very diverse semantics inherent in each one of the services (public or NIAS). CPSV is identified as a necessary prerequisite, with extra taxonomies being currently investigated. For a brief summary regarding the CPSV model, please refer to Section 5.2.1.

Table 9: SBBs for the Croatia pilot

SBB	ABB	View	Description
Virtual Assistant solution	Interoperable European Solution	Technical - application	The solution that is to be implemented discovering and navigating through the multitude of public and NIAS based services of Bjelovar.
Virtual Assistant GUI	Human Interface	Technical - application	The component that will provide visual output to end users. A mobile app together with a chatbot that can be integrated in social media platforms (Facebook).
Virtual Assistant interface	Machine to machine interface	Technical - application	The REST interfaces used to communicate information.
Virtual Assistant service	Interoperable European Solution Service	Technical - application	The block represents the abstract service that allows end users to use the solution.

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SBB	ABB	View	Description
Virtual Assistant component	Interoperable European Solution Component	Technical - application	This block is a realization of the "Virtual Assistant" SBB.
Virtual Assistant Integrated platform	Shared Platform	Technical - application	The Virtual Assistant integrated platform.
N/A	Digital Service Infrastructure	Technical - Infrastructure	Same as corresponding ABB.
N/A	Hosting and Networking Infrastructure	Technical - application	Same as corresponding ABB.
Virtual Assistant representation	Representation	Semantic	The specification of the format according to which service and personal meta data are going to be represented. For CPSV enabled chatbots and catalogues, this will be RDF.
Virtual Assistant data points	Data	Semantic	Public service metadata as these are used for cataloguing and discovery.
Virtual Assistant Data Model	Shared Knowledge Base	Semantic	The model which will encapsulate all relevant information of the service catalogues. CPSV or enhanced CPSV will be used, however the adoption of other ontologies is still considered with the aim of having most data attributes mapped to European standard vocabularies.

The instantiation of the above SBBs is represented in the high-level Viewpoint of EIRA and can be seen in Figure 11.

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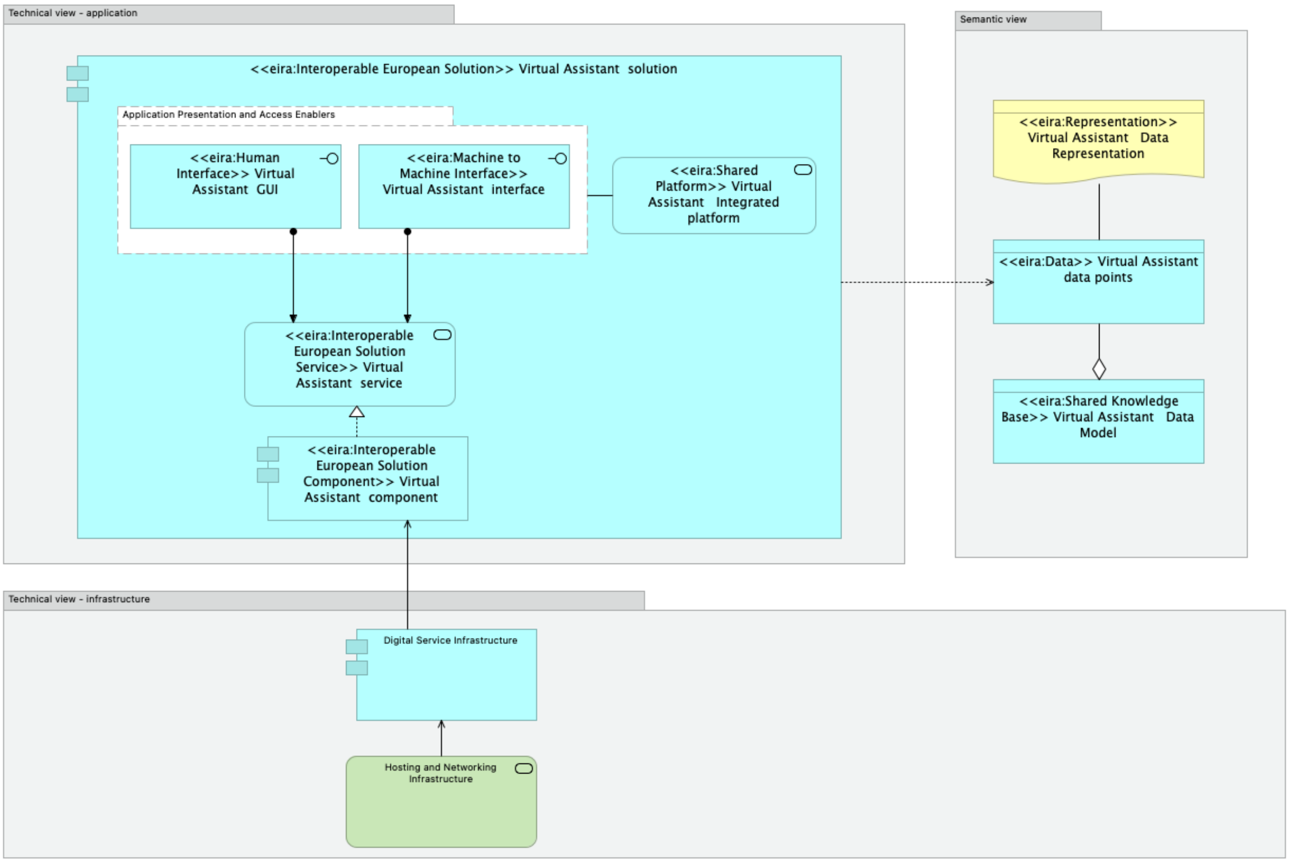

Figure 11: Level 0 ICT Architecture for the Croatia Pilot

4.2.3 Greek Pilot

Figure 12 depicts the concept diagram for the Greek pilot. Users upload the required documents (either through web services provided by the Greek Interoperability Centre, or, when not available, by manual uploading) via a mobile app and these are forwarded to the Region of Thessaly. If valid, the Region responds with confirmation that the disability card has been issued. From the part of the Region of Thessaly, a desktop application is used to monitor applications from end users and check the validity of the evidence submitted, either through direct document inspection or, where applicable, through acquisition of the required evidence from the web services that are provided through the Greek Interoperability Centre. If requirements are met, the card is renewed, and the user is notified.

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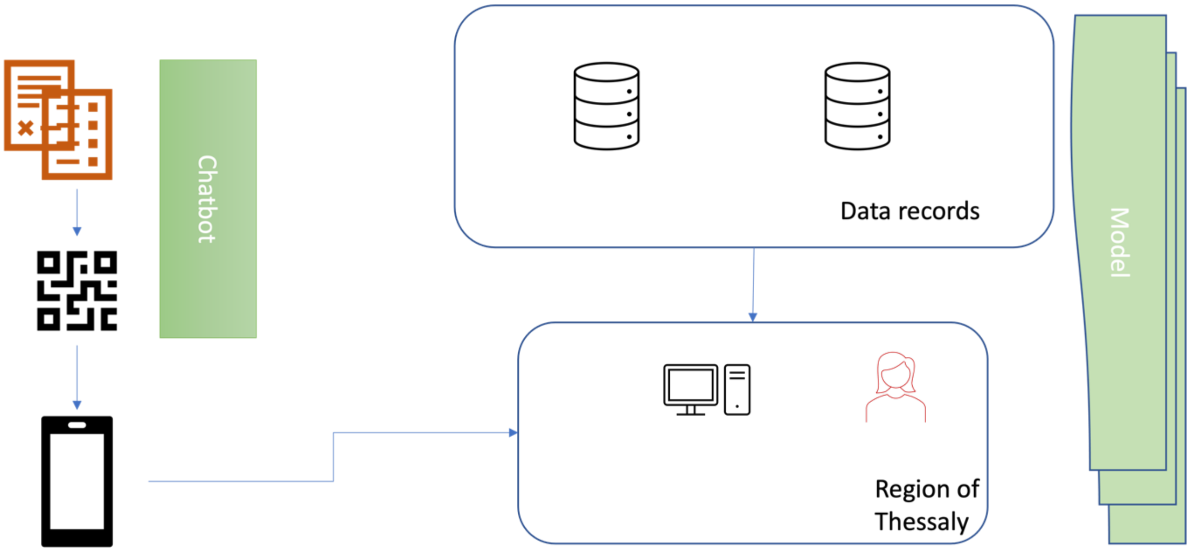

Figure 12: Concept diagram for the Greek pilot

Table 10 depicts the SBBs for the Greek pilot. Apart from the core mobile app, a chatbot will help end users to navigate through the guidelines and prerequisites to obtain a disability card. Though the data are homogenous (as only data from the mobile app is retrieved), the data has still to be validated against other government data. Consequently, other e-gov services may need to process this data. Therefore, a common representation using ontologies will also be sought after for the Greek pilot.

Table 10: SBBs for the Greek pilot

SBB	ABB	View	Description
Online Disability Card solution	Interoperable European Solution	Technical - application	The solution that is to be implemented that allows end users to [re]issue a disability card online.
Online Disability Card GUI	Human Interface	Technical - application	The component that will provide visual output to end users and public servants: • A mobile app together with a chatbot that can be integrated in social media platforms (Facebook). • A desktop application for public servants to monitor requests.
Online Disability Card interface	Machine to machine interface	Technical - application	The REST interfaces used to communicate information between.
Online Disability Card service	Interoperable European Solution	Technical - application	The block represents the abstract service that allows end users to use the solution.

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SBB	ABB	View	Description
	Service		
Online Disability Card Component	Interoperable European Solution Component	Technical - application	This block is a realization of the “discount transport Card for disabled online service” SBB.
Online Disability Card Integrated platform	Shared Platform	Technical - application	The “discount transport Card for disabled online service” platform.
N/A	Digital Service Infrastructure	Technical - Infrastructure	Same as corresponding ABB.
N/A	Hosting and Networking Infrastructure	Technical - application	Same as corresponding ABB.
Online Disability Card Data Representation	Representation	Semantic	The specification of the format according to which disability card data are going to be represented. For CPSV aligned data, this will be RDF.
Online Disability Card Data	Data	Semantic	Online requests and public service data points.
Online Disability Card Data Model	Shared Knowledge Base	Semantic	The model which will encapsulate all relevant information of the requests and issued cards. CPSV or Enhanced CPSV will be used, however the adoption of other ontologies is still considered with the aim of having most data attributes mapped to European standard vocabularies.

The instantiation of the above SBBs is represented in the high-level Viewpoint of EIRA and can be seen in Figure 11.

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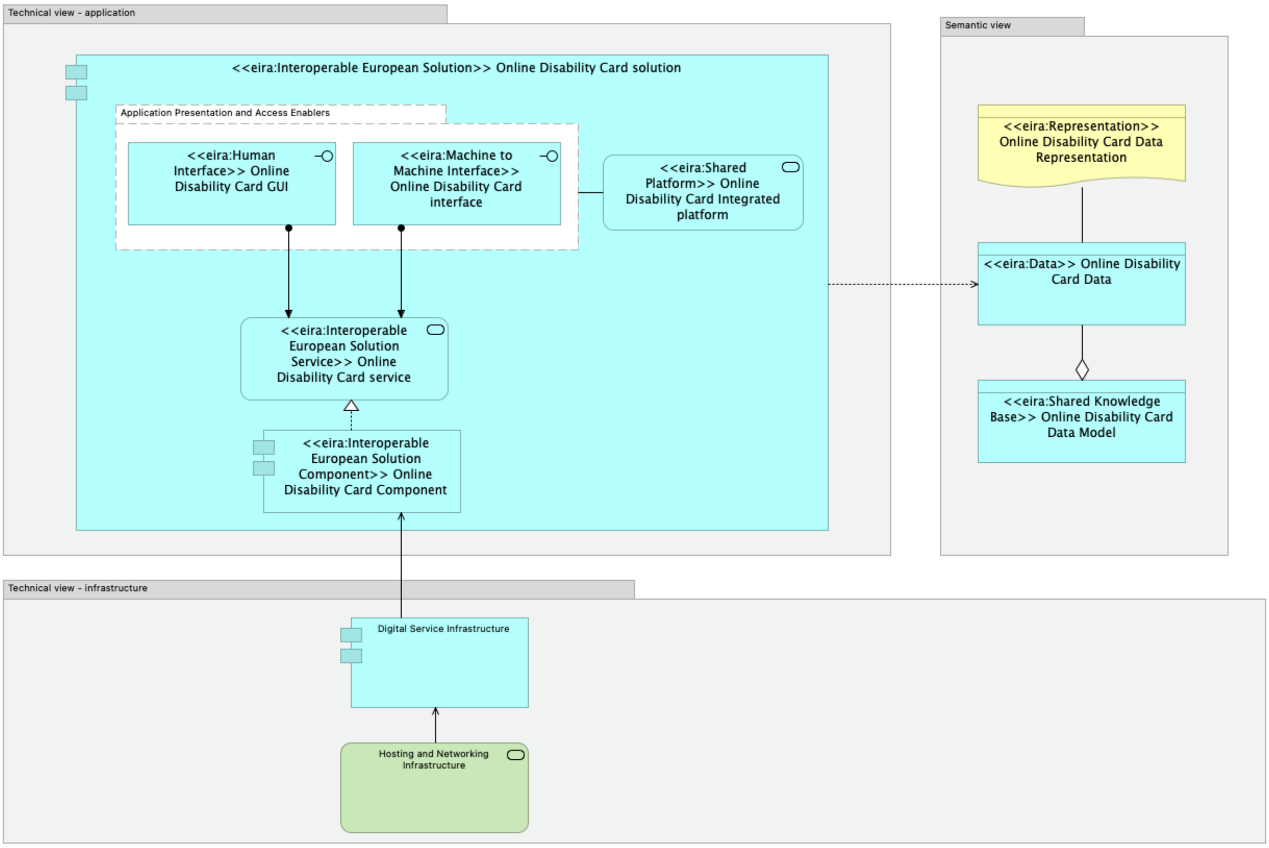

Figure 13: Level 0 ICT Architecture for the Greek Pilot

4.2.4 Malta Pilot

Figure 14 depicts a concept diagram based on an example use case that demonstrates, from the end-user perspective, how social security allowances are calculated and differentiated according to each household category. The data that is needed to identify households is distributed over a large set of data sources corresponding to various domains (e.g., tax data, citizen identity data, etc.). Hence, the main objective of the pilot is to aggregate this heterogenous data to a single household unit registry. This integration will not only provide an efficient means to calculate social security allowances in a timely manner but will also offer a way to implement proactive actions and improve upon other initiatives involving households.

As household and citizen data are retrieved from a multitude of government data sources, the main challenge of this pilot is, as mentioned, that this data is aligned, processed, and uplifted using a common data model. Processing this data will allow the calculation of social allowances for each case. As the data for the Malta pilot is vast, appropriately designed knowledge graphs will be implemented to help public entities navigate through the household unit data points.

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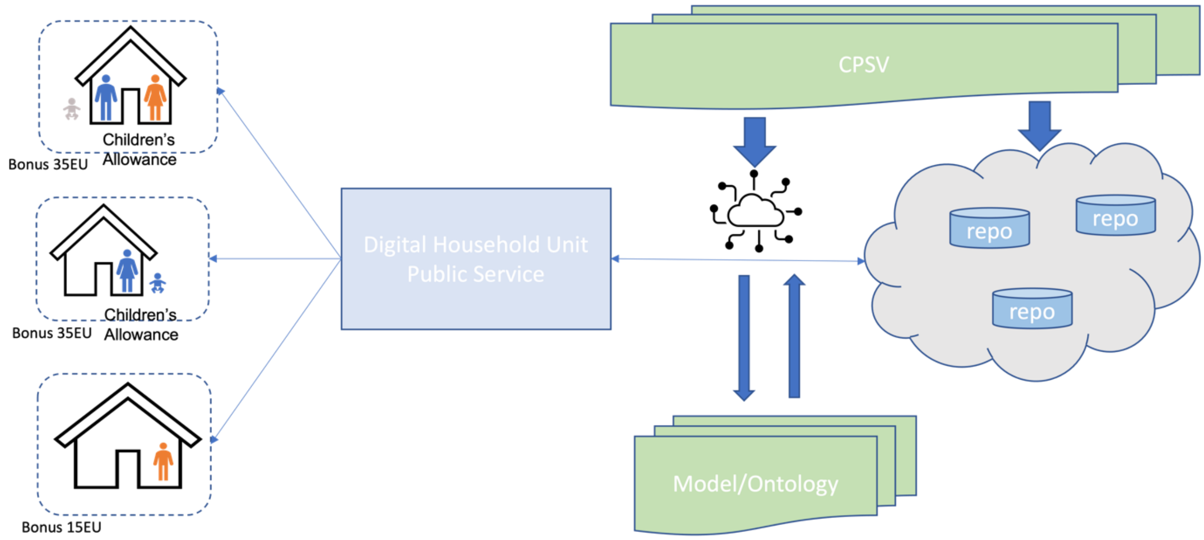

Figure 14: Concept diagram for the Malta pilot

Table 11 depicts the SBBs for the Malta pilot. Knowledge graphs and common data models are the core components. The data models initially considered are the Core Public Service Vocabulary Application Profile (CPSV-AP)[9] and the Ontology on People and Households (CPV_AP IT)[10], with investigation of other models also being underway. These two data models offer semantics to model public services and households respectively. The ISA[2] vocabularies of Person and Location are to be used since the concepts that they model are very relevant to the information that the unified household unit registry will represent. A brief analysis of these models can be found in Section 5.2.1. Infrastructure wise, there is a need to host a large amount of data, however this infrastructure is already provided by Maltese Government via the Government of Malta Hybrid Cloud Platform[11].

Table 11: SBBs for the Malta pilot

SBB	ABB	View	Description
Household monitoring solution	Interoperable European Solution	Technical - application	The solution that is to be implemented that allows public servants to aggregate and monitor household related data in a semantically unified way.
Household monitoring GUI	Human Interface	Technical - application	Visualisation of knowledge graphs that will depict the household unit information together with querying interfaces.
Household monitoring	Machine to machine	Technical -	The REST interfaces used to communicate

[9] https://ec.europa.eu/isa2/solutions/core-public-service-vocabulary-application-profile-cpsv-ap_en
[10] https://www.istat.it/en/archivio/217549
[11] https://mita.gov.mt/portfolio/data-center-ict-services/hybrid-cloud-platform/%20Hybrid%20Cloud%20Platform

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SBB	ABB	View	Description
interfaces	interface	application	information between systems.
Household monitoring service	Interoperable European Solution Service	Technical - application	The block represents the abstract service that allows end users to use the solution.
Household monitoring component	Interoperable European Solution Component	Technical - application	This block is a realization of the "Household monitoring service" SBB.
Household monitoring integrated platform	Shared Platform	Technical - application	Household monitoring integrated platform (GUI together with backend data processing and uplifting modules).
N/A	Digital Service Infrastructure	Technical - Infrastructure	Same as corresponding ABB.
N/A	Hosting and Networking Infrastructure	Technical - application	Same as corresponding ABB.
Household monitoring data representation	Representation	Semantic	The specification of the format in which the household unit data is going to be represented. For ontology aligned data, this will be RDF.
Household monitoring data	Data	Semantic	Household unit data points.
Household monitoring data model	Shared Knowledge Base	Semantic	The data model which will encapsulate all relevant information of households. Person and Location data models will be adopted for usage, however the adoption of other ontologies is still considered with the aim of mapping the attributes to European standard vocabularies, like CPSV, and CPV-AP_IT.

The instantiation of the above SBBs is represented in the high-level Viewpoint of EIRA and can be seen in Figure 15.

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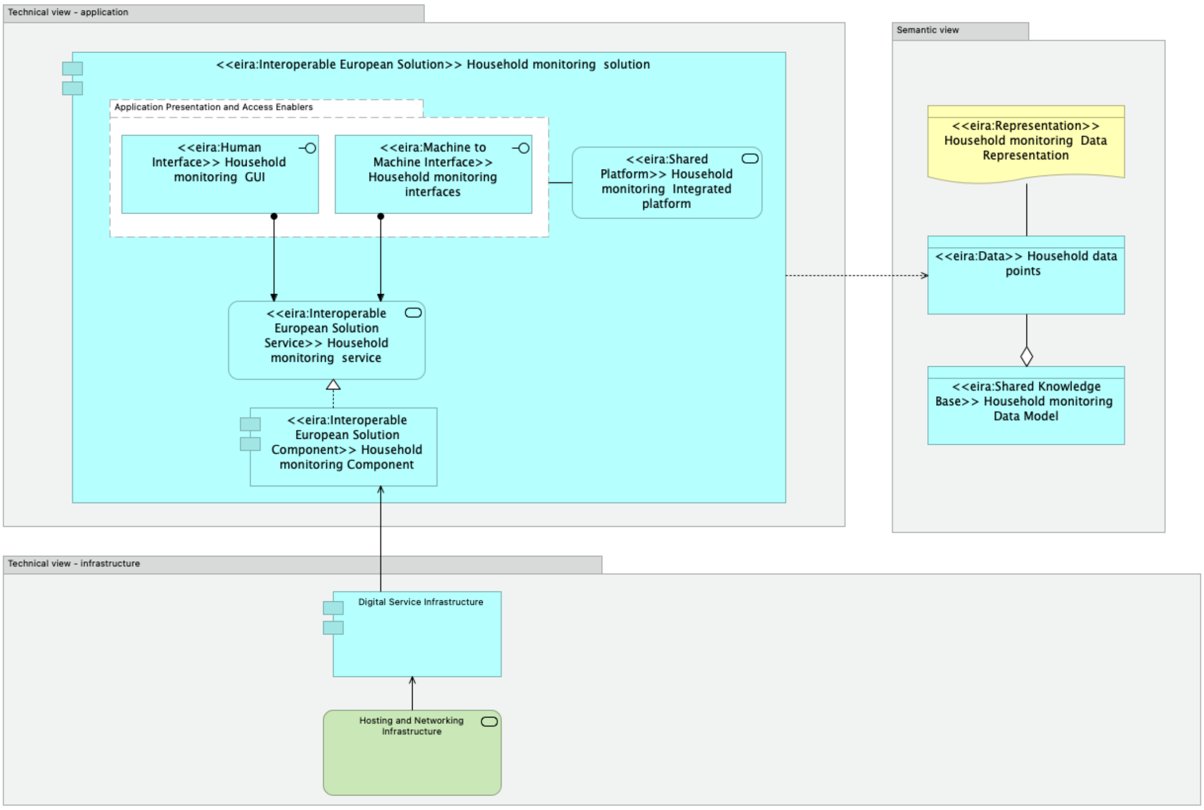

Figure 15: Level 0 ICT Architecture for the Malta Pilot

5. Tools and Technologies

From the analysis of needs elicitation, a set of tools and technologies have been identified. These tools and technologies, together with integration of existing IPS, will form the backbone for the realization of each use case. Using co-creation, the operational details of each tool and implementation details of each technology will be iteratively refined to match the need of each use case, in consistence with the iterative process of TOGAF for refining architecture and solution blocks. Behavior that is common across modules will be factored out; ideally each component, if possible, will be reusable, in a way that only configuration parameters and input vocabularies will be needed to specialize its functionality. When possible, existing CEFs will also be used. These will be denoted in a separate sub-section.

5.1 Mobile App

Mobile applications are needed for the case of Greece and Croatia pilots. By their nature, mobile apps offer specialized functionality and are therefore not reusable. However, there are many eGov components that may be used to impose a similar behaviour in all applications, thereby flattening the learning curve for new users. For example, for the Greek pilot, where the design phase is in progress, the layout of gov.gr is going to be used for all the screens.

In this phase, a first mockup for the Greek pilot has been produced; this mockup is intended to be used and validated by end users so that the final design can be consolidated after the finalization of this co-creation process. For the Croatia pilot, the design phase has just started, as this pilot is currently focusing mostly in the chatbot component, which provides the core functionality of its needs.

For prototyping and providing easy access to mockups, the Figma[12] tool was used. Figure 16 depicts some sample screenshots of the mockups for the Greek pilot. For these, the icons8 library[13] was used for icons; these will be removed in the high-fidelity version after the sequence is verified by the pilots, so that the gov.gr template can be applied. Person pictures are AI generated[14] and do not correspond to any real person. The prototype for the Greek pilot can be accessed at: https://www.figma.com/proto/USTWlLMrEynsrLQ3fMjqv7/App?node-id=152%3A1004

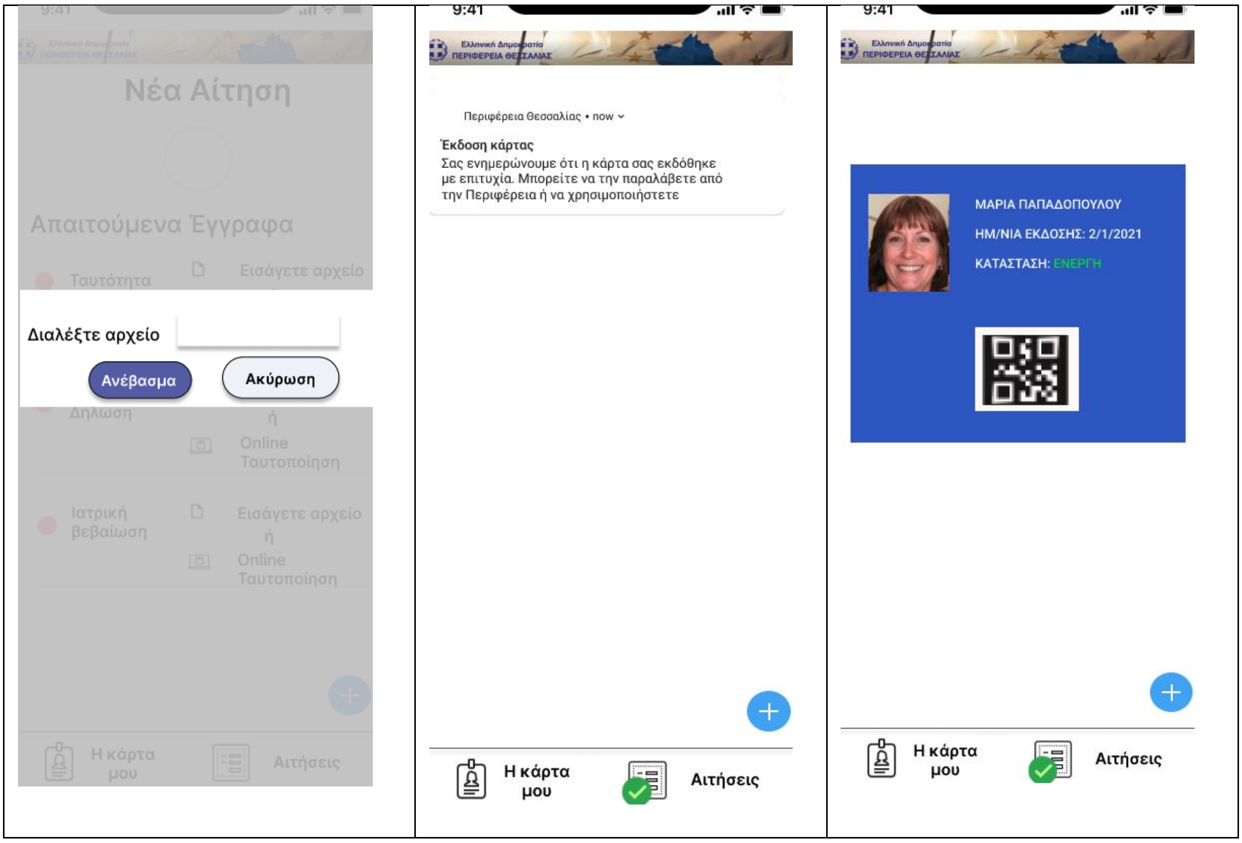

Figure 16: Low fidelity mockups for the Greek pilot.

[12] https://www.figma.com/
[13] https://icons8.com/
[14] https://thispersondoesnotexist.com/

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5.2 Semantic Mapper

Semantic alignment is crucial when heterogenous data needs to be collected, processed, and represented visually. Identification of common concepts and formats, together with realization of common representation schemas has been one of the main objectives of the Semantic Web to accommodate for this diversity. It is this diversity of old and new data sources that make the problem of Semantic Alignment unsolvable in the most generic case.

Despite the above, there now exist many data models and ontologies that are widely used and can be used for common representation of the most frequently occurring concepts. Although there may still be gaps in the representation, the most important properties of a data set can be mapped to a standard and, after uplifting, queried in a unified way.

It is clear from the above considerations, that the key component of a useful semantic alignment is the identification of the correct data models to represent the information. Good data models should:

- Have adequate expression power, so that the main concepts of the data are correctly mapped with common labels.
- Correspond to standards or so that they are used by the majority of stakeholders that share data with similar semantics. A good model that is not widely adopted, has limited use since it cannot be exploited to link entities semantically with other sources, at least not without the need of an extra meta-model to link them.

Addressing the above issues, there are now a wealth of commonly used ontologies that are used at a global or at a European level. FOAF[15] for example is a globally used ontology for describing persons and their relations, while CPSV is a solution adopted by EU for describing the semantics of public services.

For inGOV, the need for CPSV-AP has been identified by all pilots to address exactly the need to model the services; this will facilitate functionality such as service discovery and modelling. In some cases, more especially in the Croatia and Greek pilots, CPSV is further needed to identify functionalities for external services that are needed for the correct behavior of the relevant applications. The Greek pilot, for example, requires connection with other eGov services to retrieve documents, while the Croatia pilot demands the semantics of services to construct the relevant knowledge graph and a chatbot that will guide users to navigate through the service catalogue.

Other ontologies, especially for the Malta and Austria pilots, will be needed to model their data. These are still under investigation; synthetic data that is currently provided by the pilots is used to identify these ontologies.

In the context of wireframe mockups that implement the basic functionality of semantic uplifting and identify the best candidates of existing models of adoption, a Semantic Mapping tool was implemented to test the efficiency of parsing and uplifting data, as well as representation

[15] http://xmlns.com/foaf/spec/

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mechanisms that help to navigate through the uplifted data and the major concepts of the underlying models. Figure 17 depicts an example for the household unit case from the Malta Pilot. Synthetic data was produced and aligned to the Person and Location Core Vocabularies. The relations of a household unit with regard to its location and person description nodes are depicted for a two-person household case. The example is depicted using the Neo4j[16] graph database management system. In the following sub-section, we describe the main models and ontologies that are currently considered for inGOV.

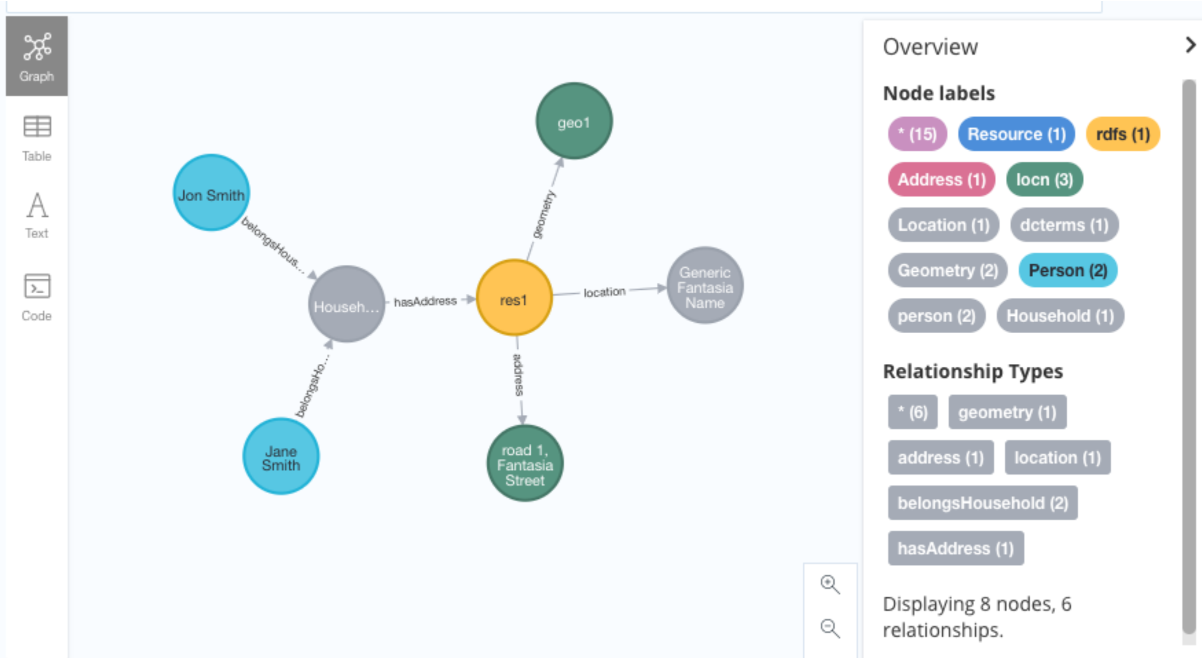

Figure 17: Example representation of synthetic data corresponding to a household unit

5.2.1 Models and Ontologies

A semantic model is a high-level representation of concepts and data. Typically implemented in high-level descriptive languages (e.g., OWL), semantic models aim to offer unified schemas of representing data and mechanisms of reasoning and inferring new relations based on the existing schema and data points. While traditional data schemas make a distinction between schema description and data instances, semantic models can represent both the schema and the data instances using the same descriptive language; this allows for complex reasoning and easy extension of existing models. When a semantic model encompasses all the aspects of representation, naming, data, and relationships between both entities and data, it is commonly called an Ontology.

As Ontologies offer a cross-application way of representing data with similar semantics, they are core components of any solution that aims for data interoperability. Standard ontologies are widely in use that can be re-used and extended; the ISA[2] Programme in particular, recommends the usage of the so

[16] https://neo4j.com/

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called ISA^2 core vocabularies with the aim of facilitating interoperable cross-border and cross-sector public services.

In this section, we give a brief description of all ontologies that were identified as potential candidates of data models, during the needs' elicitation and the 1st design phase. It is to be noted that this list may be not exhaustive, as the workshops that are planned to design the high-fidelity mockups may identify other schemas for adoption. For a more detailed overview of all the Core Vocabularies, the reader may consult Core Vocabularies Handbook[17].

5.2.1.1 ISA^2 Core Person Vocabulary

The Person Vocabulary provides a minimal, yet conclusive, set of classes and relations for describing persons. As it is integrated with the Location and Business Core Vocabularies, two vocabularies that also cover semantic aspects of inGOV pilots, it is a very strong candidate for modelling personal attributes. The Person Core vocabulary is considered for the Austria and Malta pilots, as the synthetic data that was produced for those pilots contain semantics that are described by the vocabulary.

5.2.1.2 FOAF

The FOAF (Friend Of A Friend) Ontology was implemented by the FOAF project and was initially designed with the aim of encapsulating personal information in the context of social web and media. FOAF has been adopted by a number of websites, to model profile data, and is also used by search engines, which can search over user profiles encoded in FOAF. Although not an ISA^2 vocabulary, FOAF still has the advantage that it has already been applied to a number of datasets and semantic web browser plugins. For the purposes of inGOV, FOAF is mainly considered for compatibility purposes. That is, persons will be represented by using the Person Core Vocabulary, with a number of core properties and relations be extended to cover FOAF, so that they can also be indexed and queried by modules and plugins implementing FOAF.

5.2.1.3 ISA^2 Core Location Vocabulary

The ISA^2 Programme Location Core Vocabulary provides a minimum set of classes and properties for describing any places, points of interest, and geometry. It is integrated with the Person Core Vocabulary and is expected to play a central part in the representation of data of the Austria and Malta pilots.

5.2.1.4 Core Criterion and Core Evidence Vocabulary

The Core Criterion and Core Evidence Vocabulary (CCCEV) encodes the cross-organizational exchange of information in terms of evidence. As such, it can be used to model information that is shared by different organizations, yet corresponds to the same semantic entities. Tax data submitted by hotels for example, as is the case for the Austria pilot, is a typical example where CCCEV can be of benefit.

[17] https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/solution/e-government-core-vocabularies/release/201

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5.2.1.5 Core Public Service Vocabulary – Application Profile

Core Public Service Vocabulary – Application Profile (CPSV-AP) is an ISA[2] common data model for describing public services. It aims to offer a standard for providing information in a user-centric way and map under a single description multiple existing related data models. CPSV-AP has already been adopted by various EU countries and stakeholders; this experience has led to refinements and active maintenance of the model. Apart from the model itself, a set of tools has also been released that make its adoption and usage simpler. Such tools consist of the Public Service Description Creator for creating CPSV-AP compliant forms, the Public Service Description Editor for exposing public service descriptions in machine readable form, the Mapping Editor for mapping existing models currently in use to CPSV-AP, and much more.

As CPSV-AP is core to all interoperable public services, it is expected to play a core role to all pilots, both to expose the metadata of the services implemented, and to annotate and query existing services (e.g., discoverable services for the Virtual Assistant for the Croatia pilot, or evidence issuing services for collection of required documents for the Greek pilot).

5.2.1.5.1 Enhanced Core Public Service Vocabulary – Application Profile

Although CPSV-AP is a promising standard, recent research has shown that further enhancement is needed in order to be able to support personalisation in complex PS provision and co-creation activities. [3], [12], [13]. In WP1 the enhanced CPSV-AP has been derived as the integration of a set of EC ISA[2] Core Vocabularies, namely CPSV-AP, Core Criterion and Core Evidence Vocabulary (CCCEV), Core Person Vocabulary (CPV) and Core Business Vocabulary (CBV), and additional one more class, namely the Feedback class, that has been found in a literature review of PS models [3]. During the course of inGOV, new versions of the enhanced CPSV-AP model will be produced following the publication of new versions the aforementioned EC ISA[2] Core Vocabularies.

The Enhanced CPSV-AP is documented in Section 6 of D1.1 and is considered for adoption for both the Greek and the Croatian pilot. It will provide the conceptual basis for pilot implementations employing various technologies, as for example linked data, knowledge graphs, chatbots and mobile applications.

5.2.1.6 Core Person Vocabulary – Application Profile - Italy

CPV_AP-IT is a household ontology developed by Istituto Nazionale di Statistica[18]. It describes People, their place of residence, their place of birth and households, and is considered for adoption for the Malta pilot. It is, in a sense, the application of the Person Vocabulary on People in Italy. As such, it is not generic enough to cover all aspects needed for the pilot, while it also has significant overlap with the Person vocabulary. In this sense, it will not be adopted as is, but only a lightweight extension of it compliant with the concepts of the Core Vocabularies and the needs of the Malta pilot.

[18] https://www.istat.it/en/archivio/217549

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5.3 Chatbots

Chatbots are needed for the Croatia pilot for navigating through the service catalogue (indeed they are the core component for this pilot), and for the Greek pilot as a supporting functionality to help the citizen navigate through the required steps for renewing her/his card. A prototype of a CPSV enabled chatbot that was already implemented by the University of Macedonia and validated by the Belgian Federal Public Service for policy and support (BOSA) and the region of Epirus (Greece) was used as a reusable component[19]; this of course is configured and aligned for the needs of the inGOV pilots. The component is implemented in Rasa and, as already mentioned, uses CPSV to map entities and the internal knowledge representation.

The current status of the Croatia and Greek prototypes are depicted in Figure 18 and Figure 19 respectively. The Croatia chatbot is fully integrated with CPSV and has local language support. The Greek chatbot is integrated in Facebook; it does not yet have full local language support. Both chatbots are to be validated by end users following the co-creation procedure; this will lead to their first prototype next release, planned to be documented in the second iteration of tools that will be documented in D3.2: “ICT architecture and tools – second release”.

[19] https://github.com/catalogue-of-services-isa/cpsv-ap_xborderChatbotPilot_EpirusBelgium

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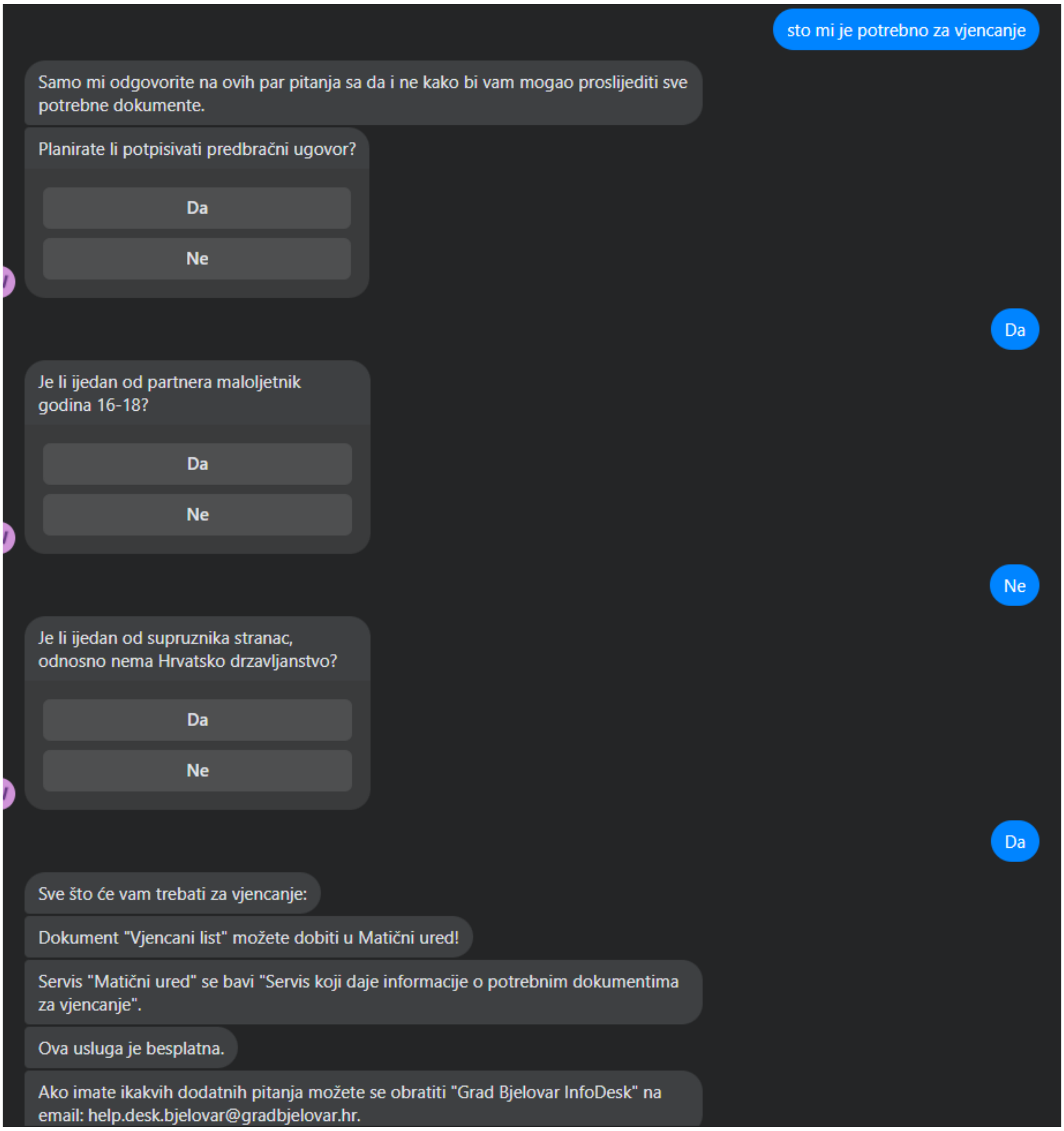

Figure 18: Chatbot instance for the Croatia pilot

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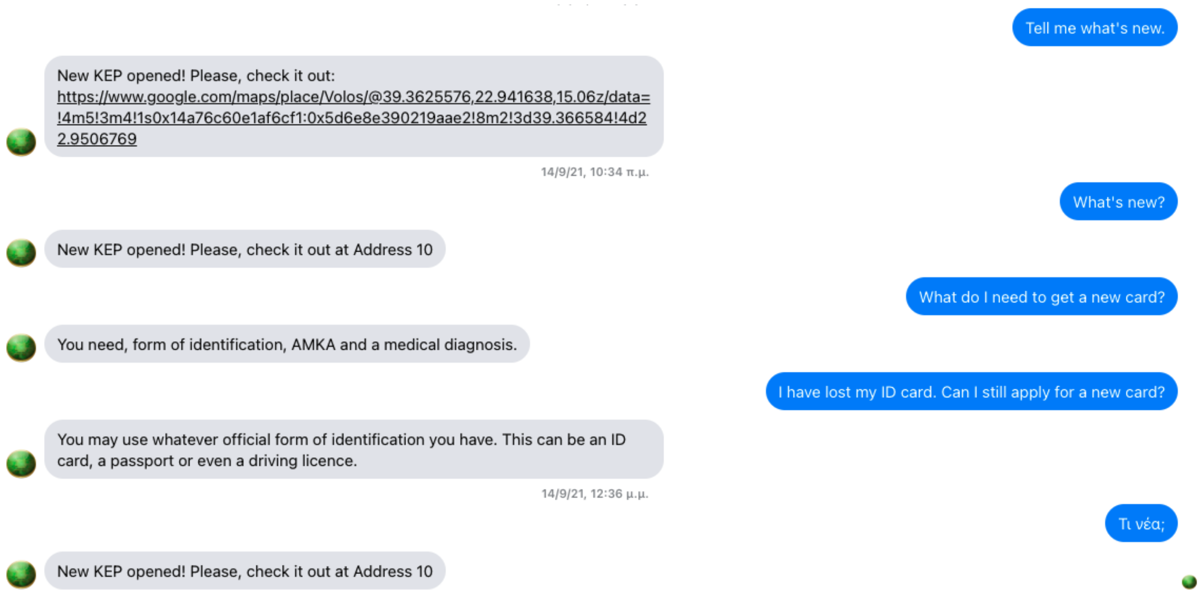

Figure 19: Chatbot instance for the Greek pilot

5.4 CEF Services

The CEF offers a set of free services that enhance the concept of reusability and provide a common cross-border functionality for all EU members. InGOV will therefore try to adopt them as needed. The following sub-sections describe the main CEFs that have been identified and considered for adoption.

5.4.1 eDelivery

This CEF helps public administrations to exchange electronic data and documents with other public administrations, businesses and citizens, in an interoperable, secure, reliable and trusted way. It is expected to be used in any case where document exchange is needed (e.g., the electronic discount transport card for disabled for the Greek pilot).

5.4.2 eID

This CEF helps public administrations and private online service providers to easily extend the use of their online services to citizens from other EU Member States. It allows cross-border authentication, in a secure, reliable, and trusted way by making use of existing national electronic identification systems, using a single eID. The electronic Identification, Authentication and trust Services (eIDAS) regulation was implemented to facilitate the usage of single eIDs, by requiring from Member States to recognize any electronic signature that conforms to the eIDAS standards. For the purposes of inGOV, a node has already been initialized for the purposes of inGOV and we will investigate the extent to which all pilots can use this for identification.

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5.4.3 eTranslation

The main goal of eTranslation is to help European and national public administrations exchange information across language barriers in the EU, by providing machine translation capabilities that will enable all Digital Service Infrastructures (DSIs) to be multilingual. This CEF is expected to be used for all pilots to translate to the local language, both in the context of data processing and in the context of presentation. Chatbots developed for Greek and Croatia pilot already have translation capabilities; these will be fully aligned with eTranslation to allow for maximum reusability.

5.4.4 EBSI

EBSI provides for a common blockchain infrastructure to all EU member states. EBSI is considered for the deployment of the blockchain infrastructure that will be used to track transaction of the Austria pilot. After the specification of its functionality, if EBSI meets these needs, inGOV will file for the early adopters' program of EBSI.

6. Conclusions

This work in this deliverable has presented the first release of the Reference Architecture and inGOV ICT tools that will be developed upon the first release of the IPS holistic framework (T2.1). In this regard, the document presents the architectures and ICT platforms and tools that aim to enable stakeholders' collaboration in co-producing inclusive and accessible Integrated Public Services (IPS), thus increasing trust and satisfaction. Specifically, based on the Archimate and CarTool modelling tools, we designed the inGOV architecture which comprises four architectural diagrams that correspond to each pilot of the project. Moreover, the appropriate technologies and tools, such as mobile applications, semantic alignment, and chatbots that will consist the backbone for the realization of each use case were introduced with respect to co-creation processes. Finally, future enhancements of the inGOV Reference Architecture were discussed.

7. Future Roadmap

The next important milestone is the realization of the high-fidelity mockups, which are a prerequisite for the 2nd release of architecture and tools. The high-fidelity mockups will cover:

- At the component level, a faithful representation of the end user experience. In contrast with the wireframe mockups currently available, which focus more on the business diagram aspect, the high-fidelity mockups will produce screens and flows that will correspond exactly to the look and feel of the final applications. Standard eGov templates will be applied to all elements, and the layout will be consistent with the output of co-creation workshops that will be organized in the context of WP4 and WP3 activities. Although further iterations may lead

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to alterations of the final application behaviour, these are expected to correspond to visual enchantments and refinements rather than drastic redesign.

- At the data level, high-fidelity mockups will consist of synthetic data that are representative of the real use case. Where data are aligned to ontologies and vocabularies, high-fidelity mockup data will have the semantically uplifted representation, exhibiting the possibility to use the data in an interoperable way. Again, refinements are expected in future iterations, but these are expected to cover minor deviations and additions, such the representation of extra relations or the extension of the models to cover more concepts rather than a drastic re-design of the underlying data models.
- At the integration level, high-fidelity mockups will consist of messages containing the synthetic data that is exchanged between applications and systems in a typical use case scenario. In case of integration points that are implemented between applications implemented by inGOV, these messages will correspond to the format of the underlying interfaces, as these are defined by the Solution Building Block(s) implementing the "Machine to Machine Interface" Architecture Building Block of the architecture. For integration points with existing egov applications, the developer endpoints of these applications will be used; if not available, the data will be simulated according to the specifications of the API.

After the validation of the high-fidelity mockups, these will be deployed on the infrastructure of each pilot and subsequent releases will incrementally add real data functionality. As mentioned, high-fidelity mockups are expected to be designed during a series of workshops with the pilots and external stakeholders that will take place during the following months, until M16.

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