

Developing Cross-border E-governance: Exploring Interoperability and Cross-border Integration

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Abstract. The recent policy and regulatory initiatives of the EU, such as Digital Single Market Strategy, Single Digital Gateway, European Interoperability Framework and eIDAS, identify the need for digital cross-border integration in the EU. The achievement of the digital single market within the EU is challenging governments at all levels to transform or update their governance systems in order to establish the cross-border e-governance. The existing stage models in the e-Government literature, do not address the cross-border integration in the evolution phase of the e-Government. The heterogeneity and the legacy systems of the cross-border data exchange infrastructures hinders the process of seamless cross-border data exchange. This heterogeneity of cross-border data exchange infrastructures and complexity of the cross-border integration in the EU requires high level of interoperability in the legal, organisational, technical and semantic environment. Therefore, we explore the cross-border data infrastructures and its state of play in the EU by following the predominant framework that ensures the interoperability of the digital public services, EIF. We found that the most successful approach for cross-border e-governance and the cross-border integration might be the federated approach.

Keywords: cross-border integration, data-exchange solutions, EIF, Single Digital Gateway, eIDAS, OOP.

1 Introduction

One of the main initiatives of the EU in the field of digital transformation is the achievement of the Digital Single Market. In the Digital Single Market, individuals and businesses are able to seamlessly exercise and access online activities across borders without any discrimination and under a high level of personal data protection. The Digital

Single Market was already part of the strategy of the European Commission 2014 - 2019 and the work is continued as part of the EC priorities for 2019 - 2024. One of these priorities is to make Europe fit for the digital age and one of the pillars of the Digital Single Market strategy is to create a better access for consumers and businesses to digital goods and services across Europe. e-Government, smart government and smart governance, as corner stones of the activities in Europe can provide a wide variety of benefits including more efficiency and savings for governments and businesses, increased transparency, and greater participation of citizens, e.g. in political life and cross border services. Therefore, we have analysed “what are the different approaches for cross-border e-governance and the cross-border integration in the wider area of eGovernment?” We have recognised that an overview in this field is missing. The goal of this paper is to report and summarize the state of play and highlight weaknesses and good practices along the line of the European Interoperability Framework (EIF).

1.1 Methodological Approach

In order to identify drivers, barriers and opportunities for cross-border e-Government we made a literature review, analysed several e-Government initiatives and examined the related legal- and organisational framework.

In e-Government literature, so called stage or maturity models have played an important role to describe current ongoing and planned or expected future development in the digital transformation of public administration. Stage models take either an evaluatory, normative, or positive approach, which were identified in the seminal study by Meyerhoff Nielsen [1] where he reviewed 42 different stage models. In this study, one of the identified foci is dedicated to integration and transformation dimension. Here the most widely cited paper by Layne and Lee stands out, which is identifying a vertical and horizontal integration within a given context [2]. Andersen and Henriksen included Layne and Lee model and additionally identified full transformation by emphasising the user-centricity [3]. However, none of the identified models, look at the cross-border integration, however the recent developments by the European Commission and the Member States clearly identified this policy goal.

Consequently, we are exploring the topic of cross-border data exchange infrastructure and its state of the play in the EU. First, we conduct a preliminary literature analysis on the drivers, barriers and benefits to cross-border data exchange. Second, we follow the predominant framework that ensures the interoperability with other digital public services, the EIF and its layers: 1) Legal, 2) Organisational and 3) Technical and Semantic Interoperability. The EIF is developed by the EC to give specific guidance on how to set up interoperable digital public service and to improve the quality of European public services [5]. The EIF criteria and a mapping against them, allows us to explore the topic comprehensively. Last, we compare existing approaches to cross-border data exchange and provide a first evaluation for this break-through development finally enabling the Digital Single Market (DSM). At the end we provide an overview of the findings and recommendations based on the descriptions, analysis and evaluation in the respective parts of this paper.

2 Background

Achieving the Once-only principle (OOP) is one of the priorities of the EU. Understanding of the OOP varies, in some countries it means store data only once and link to this single source, while in others, it means that citizens and business need to provide personal data only once, thus copies can exist [4].

In this section we describe the relevant policy initiatives and legislation's background addressing the interoperability policy and cross-border data exchange on the EU level. Since interoperability is a necessary condition for reliable and trustworthy cross-border access to procedures and cross-border data exchange, this section is inspired by the European Interoperability Framework interoperability model; more specifically, it includes interoperability governance and integrated public service governance layers.

2.1 Interoperability Governance

As defined in the EIF, interoperability governance, among other things, can be understood as all decisions on interoperability, policies and institutional agreements that enable interoperability at the national and EU level [5]. In this subsection we describe the policies and initiatives on the EU level in ensuring the digital government transformation.

European Commission (EC) adopted the Digital Single Market Strategy communication (2015) to harmonise the initiatives and incentivise the development of digital transformation in the EU. A Digital Single Market can be understood as an ecosystem in which the citizens and businesses can assess the online services under fair competition conditions and personal data protection, irrespective of their nationality or place of residence. One of the barriers that are hindering the development of the Digital Single Market is the lack of open and interoperable systems and services, and the lack of common data portability infrastructures [6]. To overcome these barriers for cross-border data exchange, suggested solution is to reuse the existing building blocks of the Connecting Europe Facility programme, with further integrating the existing platforms, portals, networks and systems into the one Single Digital Gateway [6].

The EU has adopted the e-Government Action plan 2016 - 2020 to set up conditions and define actions to achieve the Digital Single Market's strategic objectives, such as modernising public administrations, achieving cross-border interoperability and enabling easy interactions with the citizens. Main objective of this plan is to enable citizens and businesses to fully benefit from the interoperable digital public services and enable access to cross-border digital public services. To achieve these objectives public administrations should enable the access to digital public services for cross-border users and to prevent further fragmentation in the digital environment [7].

The latest policy initiative by the EU is the Digital Europe Programme (DEP) for 2021 – 2026. The DEP aims to reinforce the impact of the Digital Single Market's policy achievements. The DEP's primary objective is to create investment opportunities within the EU, national, regional and local level in the critical technological industries [8]. This investment programme is the key programme in the next following years to

achieve seamless cross-border public services and citizen-centric public service in the EU. To achieve these objectives EC agreed on three key actions; first is the creation of the digital transformation platform, second the rollout of the OOP, and third the implementation of the interoperability incubator. The EC committed to support the full integration of the CEF Telecom building blocks, ISA² actions and the European Data portal into one ecosystem Digital Transformation Portal [8]. This will provide the basis especially for the implementation of the OOP in the cross-border settings under the Single Digital Gateway. Proposed actions in the DEP could further enable interoperability among the public administrations at all administration levels and achieve seamless cross-border digital public services.

To achieve the Digital Single Market, ministers of the EU Member States signed the Tallinn Declaration on e-Government, adopted in 2017. In this declaration, ministers of the EU Member States agreed on the shared vision and actions to enable and provide borderless and interoperable digital public services to all citizens and business [9]. Among the common principles for digital public services, Tallin Declaration also addressed specific actions that the Member States will work on to achieve the objectives. In particular, they agreed to collaborate to implement the OOP for the key public services and also to adhere to EIF for the cross-border digital public services to achieve the principle of interoperability-by-default [9].

Recognizing the importance of the united support and political commitment towards the digital transformation of the public services and the importance of the goals addressed in the Tallinn Declaration, ministers of the Member States agreed to continue and further support the development of the digital public services ecosystem in the EU. The Berlin Declaration [10] has been adopted with the objective to achieve value-based digital transformation by supporting and strengthening digital participation and inclusion in the EU. They agreed to continue coordination to achieve cross-border interoperability and also to strengthen the EIF. In particular, one of the priorities is to strengthen Europe's digital sovereignty and interoperability. To achieve this priority, Member States will collaborate to reduce the administrative burdens on European citizens and businesses and promote the cross-border implementation of the OOP by supporting interoperability by design policies and solutions [10].

2.2 Integrated public service governance at the EU level

In this subsection we describe relevant policies and initiatives that ensure integrated public service governance at the EU level. Digital public services in the EU are achieved by many interconnections and collaboration of multiple organisations to provide digital public services, which requires coordination and governance on the EU level. Thus, in the cross-border data exchange, the EU programmes that enable the coordination and governance of the EU, digital public services are described.

EC created "Interoperability solutions for public administrations, businesses and citizens – ISA²" and the "Connecting Europe Facility – CEF" funding programmes to support and enable the governance of the interoperable cross-border digital public services. These programmes aim to facilitate and enable the cross-border digital public

services between the public administrations at the cross-border, national, regional and local level [11, p. 5].

The ISA² programme was running from 2016 until 2020, aiming to support the development of cross-border digital interoperable solutions. The interim evaluation of the ISA² shows that in the absence of ISA², the overall objectives for cross-border interoperable public services would not be achieved by only national or subnational interventions [12]. Also, the ISA² has contributed to improving the cross-border interoperability in the EU, by raising awareness on the topic of interoperability and by facilitating the exchanges between Member States [12].

Similarly, the CEF is a funding programme that supports the development of the infrastructure and technical solutions for digital public services, facilitating cross-border interactions between public administrations, citizens and businesses [13]. CEF supports cross-border interactions by deploying key building blocks, Digital Service Infrastructures (DSIs), to create an interoperable European digital ecosystem for public administrations [14]. The value of these building blocks is the reusability and extensibility. They can also be integrated into other IT projects and combined with each other [14]. Building blocks that CEF has been developed, inter alia, are eID, eSignature, eInvoicing, eDelivery, Automated Translation and EBSI.

Alongside the EC funding programmes, EC has also addressed the interoperability of public services in the EU level by adopting the revised EIF in 2017. The EIF provides guidance and recommendations to public administrations on developing and achieving interoperable digital public services. In the EIF, interoperability is defined as "the ability of organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems." [5, pp. 4-5]. The purpose of this framework is to inspire public administrations to develop and deliver interoperable digital public services to other public administrations, business and citizens; to provide guidance to public administrations on how to design their own national interoperability framework; and lastly but not least, to contribute to the establishment of the Digital Single Market by creating and supporting cross-border interoperable European public services [5]. Three main elements of the EIF, are the core interoperability principles, interoperability layers (Legal, Organisational, Semantic and Technical) and integrated public services model. Legal interoperability layer as described in the EIF, ensures that the public administrations are able to interconnect and work together under different legal frameworks, policies and strategies [5]. Organisational interoperability is described as "documenting and integrating or aligning business processes, and relevant information exchanged" [5, p. 24]. Semantic interoperability is more focused on the data and therefore "ensures that the precise format and meaning of exchanged data and information is preserved and understood throughout exchanges between parties" [5, p. 25]. Technical interoperability ensures the communication between different technical infrastructures linking systems and services [5].

One of the recommendations, inter alia, within the EIF is addressing the functioning of the Digital Single Market and the data exchange systems, in which is recommended that the designers of public services should address the data portability infrastructures in order to avoid lock-in and to support the free movement of data [5].

As previously mentioned, the structure of this article is inspired by the EIF interoperability layers, in order to present the state of play of the cross-border data exchange systems in the EU.

3 Drivers and Barriers to Cross-border Data Exchange

This section describes the drivers, barriers and benefits to cross-border exchange.

The reason why the OOP is accepted as a priority in the EU policies on digital government transformation lies in the promise that it will reduce the burden on citizens, businesses, and public administrations when it comes to provision and collection of data [15–18]. Mainly, several authors are agreeing on that implementing OOP will bring various benefits for public administrations, business and citizens [4, 15, 18–20]. The benefits for public administration can be time savings, costs savings, higher administrative gains, increased efficiency and effectiveness, proactive public services, and the creation of better public services [15, 21]. Also, the OOP might lead to the process optimisation and no duplication of tasks [21]. Similarly, implementation of OOP in the government brings positive outcomes also to the citizens and business, mainly in time savings, reduced administrative burden, less cumbersome and more convenient procedures, increased transparency of the use of resources by the state [18, p. 3]. Finally, it is estimated that the implementation of the OOP in cross-border settings can increase cost savings up to 5 million euros [17]. However, although OOP brings various benefits to stakeholders in the public services creation, it is still poorly understood, as Krimmer *et al.* [19] state, most likely due to the novelty of the concept and lack of cross border OOP initiatives (pp. 7).

The drivers for the implementation of OOP are mostly generated by the external triggers, such as in the demand of the citizens and business for reduced administrative burden, in the legal obligation (e.g. SDGR), or in improved service quality and better governance [16, 19, 22]. Moreover, Krimmer *et al.* [19] note that the participation in cross-organisational and cross-border knowledge transfer with strong leadership by the managers can be seen as a driver at the organisational level for the implementation of the OOP. Also, it is found that the maturity of the technical infrastructure and the existence of the OOP in the country can be seen as a driver for the implementation at the cross-border level [16]. This shows that the difference in the maturity levels of the e-Government and heterogeneity of data exchange infrastructures within the Member States might have hindering effects on the adoption of the Single Digital Gateway.

Besides these drivers, there are several factors hindering the process of OOP implementation on cross-border level. Mainly, research has shown that the Member States are mostly concerned about the privacy and data protection issues, the legality of the data sharing across-borders, procedural differences, lack of political and managerial support and lack of financial support [19, pp. 4-5]. Furthermore, the existing governmental silos and lack of organisational interoperability, hinders the process of the OOP implementation in the cross-border setting [19, p. 3].

Technological heterogeneity and maturity of the e-Government systems are perceived by many authors and Member States as the main barrier for the cross-border

implementation of the OOP [16–19, 21]. Moreover, Mamrot and Rzyszczak [23] state that the fragmentation of the data exchange infrastructures in the Member States has a negative impact on extending EU-wide OOP. Similarly, Cave *et al.* [17] stated that the local solutions that are implemented in national borders are not designed for the cross-border data exchange while at the same time they so embedded, and the changes will be resisted. This has been proven by the research of Krimmer *et al.* [19], in which is found that the Member States are not willing to undertake major changes to their legacy systems for cross-border reasons. The lack of technical interoperability can be seen in, inter alia, in the heterogeneity of the data exchange infrastructure systems, different approaches to handling data, access to distributed data sources. More specifically, due to the heterogeneity of the data-exchange infrastructures in the EU, it is difficult to achieve cross-border interconnection between local databases, and the solution needs to ensure a high degree of compatibility with the existing technological systems [21]. In addition, one of the major challenges in the implementation of the OOP at the cross-border level is the mutual trust between the public administration on the cross-border level [24]. Similarly, citizens in the DACH region are also concerned about the seamless data exchange across borders, where two-thirds of respondents are having a negative impression of the cross-border OOP implementation [25].

4 Legal Interoperability

Following the overarching political initiatives in the field of e-Government and also the funding programmes and frameworks in the field of interoperability, in this section, the main focus will be on the legal interoperability and the regulations adopted by the EU that addresses the cross-border data exchange ecosystem. The following regulations enable mainly the legal and technical interoperability among the Member States by requiring them to collaborate and enable interoperability at all levels.

One of the milestones for achieving interoperable cross-border digital public services is the adoption of the eIDAS Regulation in 2014 [26]. In cross-border data exchange systems, one of the key building blocks is electronic identification and authentication. One of the main objectives of the eIDAS is to improve trust among the stakeholders and remove barriers in the cross-border use of national electronic identification by providing a framework for interoperable recognition of the national identifications in cross-border settings [26]. eIDAS also sets up the framework for electronic registered delivery service (ERDS), which is essentially the data exchange IT system that enables the transfer of data and provides proof of evidence that data is transmitted [26]. Recognition of the legal validity for the data sent through ERDS is also provided in eIDAS. However, there is no implementing act for ERDS adopted yet, which means that standards for ERDS are still unclear [27]. The recognition of eID and electronic delivery services are one of the reasons why the eIDAS Regulation is of huge importance for successful cross-border data exchange among public administrations in the EU.

Following the achievements of eIDAS regulation, the EU has adopted the resolution on Single Digital Gateway in 2018 [28]. The SDG regulation aims to create one single

gateway in which the citizens and business would be able to get information, give feedback and to access online public procedures. The Single Digital Gateway will be implemented into the EU portal Your Europe which will act as a single access point to existing national portals [25]. The SDG regulation requires all Member States to enable access to 21 digital public procedures¹ also for the cross-border users. One of the important goals of SDG regulation, inter alia, is to enable the access to these online procedures by implementing the OOP through safe and secure technical system [28].

5 Organisational Interoperability

The main focus in this section is on organisational interoperability through which will be explained the data exchange ecosystem in the EU.

As already explained, the lack of organisational interoperability and the heterogeneity of the data-exchange infrastructure are considered a major barrier to the development of the Single Digital Gateway. In this section we explore the national solutions that Member States are using for the data exchange purposes. The focus in this section is on the Member States that mostly participated in the large-scale projects in the EU such as STORK², TOOP³, DE4A⁴.

One of the pioneers in the digital transformation in government is Estonia, also considered as the leading country in the digitalisation of public services. This high development in digital transformation can be prescribed to their data exchange system X-Road. This secure exchange internet-based communication protocol is considered as a backbone of the OOP in Estonia because it enables the connection between multiple databases and enables data sharing among them [23]. During the phase of the creation of the system, the aim of this data-exchange system was not to replicate existing data in database systems but rather to re-use and connect different database systems to communicate and to enable the secure sharing of data [22]. The main characteristics of the X-Road, inter alia, are that it is open-source, autonomous, confidential, interoperable and secure [20]. Next to the X-Road system, it is important mentioning that Estonia has a mature and high degree of uses of its eID solution, which enables the implementation of the OOP. Also, other countries are using the X-Road solution, such as Finland, which uses the X-Road solution for their data-exchange purposes. Consequently, Estonia and Finland are also the pioneers in the cross-border implementation of OOP. With the bilateral agreement and connection of the Finland databases in the central server of X-Road, data stored in databases in both countries are shared by utilising the X-Road system [25]. It is very important to mention that X-Road is centrally governed and that it is used by all public administrations for all kinds of data exchanges, while it also allows uses by private parties [29].

¹ These procedures are related to seven life events: “Birth”; “Residence”; “Working”; “Studying”; “Moving”; “Retiring”; “Starting, running and closing the business”.

² Secure Identity Across Borders Linked (STORK); <https://ec.europa.eu/digital-single-market/en/content/stork-take-your-e-identity-you-everywhere-eu>

³ The Once-Only Principle Project (TOOP); <https://www.toop.eu/>

⁴ Digital Europe for All (DE4A); <https://www.de4a.eu/>

The Netherlands, however, is using multiple data exchange systems to enable the implementation of the OOP. This is the reason because the institutional structure requires a demarcation between private and public infrastructures [29, p. 41]. These systems are Digikoppeling, Digilevering, Digimelding, and Stelselcatalogus, and they are employed in order to enable seamless data exchange between public administrations. The Netherlands also has a system of agreements for data exchange systems, Diginetwerk, which includes multiple networks and databases by employing the above-mentioned systems.

In Austria, the implementation of the OOP is enabled by its data exchange system Register and System Network (RSV) [24]. This data exchange system interconnects 130 databases of the various public administrations, and it acts as an interconnector between the databases and front-end solutions [24]. RSV is considered a prerequisite for OOP implementation by the Austrian authorities because it facilitates the exchange of data in a transparent and secure environment [24].

Slovenia, instead, similarly to the Netherlands, use different systems to implement OOP. Three main building blocks for data-exchange are Tray, IO module and Asynchronous Module. These building blocks were developed primarily for the e-social security data exchange, but it is also used for other purposes [30]. Slovenia has developed a central system for electronic delivery, SI-CeV, which enables the secure exchange of documents between public administrations, citizens and businesses [31]. This system can also be used for cross-border connection and implementation of the cross-border OOP [31].

Belgium, as a federal state, uses different exchange systems at the federal and state level. For instance, the Flemish government uses the MAGDA (Maximum Data Sharing between Administration and Agencies) platform to enable data exchange between 190 agencies and 13 departments of the Flemish government and 308 local governments [21]. On the federal level, Belgium utilises Federal Service Bus to enable data exchange between different public administrations and multiple ministries [24]. Federal Service Bus is also used for cross-border purposes and acts as a cross-border connector that allows access to the national registries while taking into consideration security and data protection principles [24].

Finally, these different national solutions for data exchange purposes shows that the development of the solutions was undertaken mostly for national purposes. Further to the technical differences, the additional divergence among these solutions is also based on the governance and control of these solutions. For instance, some countries have centralised data exchange solutions (such as Estonia and Slovenia), while in some countries, there are multiple solutions for the data exchange (such as the Netherlands).

6 Semantic and Technical Interoperability

In this section, we describe the semantic and technical specifications of the cross-border data exchange infrastructure by using the TOOP architecture as an example.

Regarding Data Quality and more specifically the data accuracy, the semantic modules play an important role in the data exchange. The semantic interoperability view

specifies only one process, the semantic mediation and the TOOP project attempted/proposed a loosely coupled semantic architecture, as the monolithic approach is hindering the once-only principle.

The semantic mediation service is necessary on the Data Consumer (DC) side for evidence identification, as well as evidence interpretation and on the Data Provider (DP) for evidence extraction.

As founding aspects of the semantic view, the ontology handling components can be defined as:

- an OOP Semantic Model that describes entities relevant when the Once-Only Principle is applied and are generic. This comprises the reused ISA² core vocabularies concepts, e.g. Natural Person.
- a methodology for modelling Domain Semantic Models based on the methodology proposed by ISA² "e-Government Core Vocabularies handbook".

For this, the domain specific information has to undergo several stages of modelling having transformed into a computable semantic model and representational format (RDF, OWL).

For the generic concepts, the DG GROW eCERTIS component is available for multiple Member States and languages.

A special case comes from the eHealth domain. One of the communication standards, HL7, has been upgraded in the last years with a data model that allows REST operations and semantic interoperability of patient health record by introducing the HL7 Fast Healthcare Interoperable Resources (FHIR) framework. The initiatives and projects where it is employed range from International Patient Summary (IPS), clinical studies data storage and processing to bioresearch apps [32].

Regarding the semantics of the exchanged data, a set of Service-oriented Architecture (SOA) based Common Terminology Services were defined by the HL7 standardization organization [33]. Thus, services like retrieving the appropriate value from the ConceptMap for encoding purposes, validation of used value and display in different languages is possible. The maturity of the FHIR standard has invited the EU eHealth Digital Service Infrastructure (eHDSI or eHealth DSI) to use it when defining the semantic service specification.

In the TOOP project, the extended set of Core Vocabularies are implemented in the semantic data models of the central components like the Data Services Directory (DSD), the Criterion & Evidence Type Rule Base (CERB) (making use of the DG GROW eCERTIS) and the TOOP Exchange Data Model (EDM), with the goal to achieve horizontal, cross-service and cross-actor semantic interoperability. Regarding technical interoperability, both authentication and data exchange levels have evolved in the recent years. The eIDAS network can be employed for user identification.

At the base of the technical interoperability for data exchange lays the CEF eDelivery solution based on a distributed model called the "4-corner model". In this model, the back-end systems of the users don't exchange data directly with each other but do this through Access Points. The data or documents pass through four layers - the backend of the sender (C1), the senders' Access Point (C2), the receiver Access Point (C3) and the backend of the receiver (C4). The communication between these layers is

enabled by the AS4 messaging protocol. These Access Points are the nodes that enable the technical interoperability between the heterogeneous IT systems in the EU.

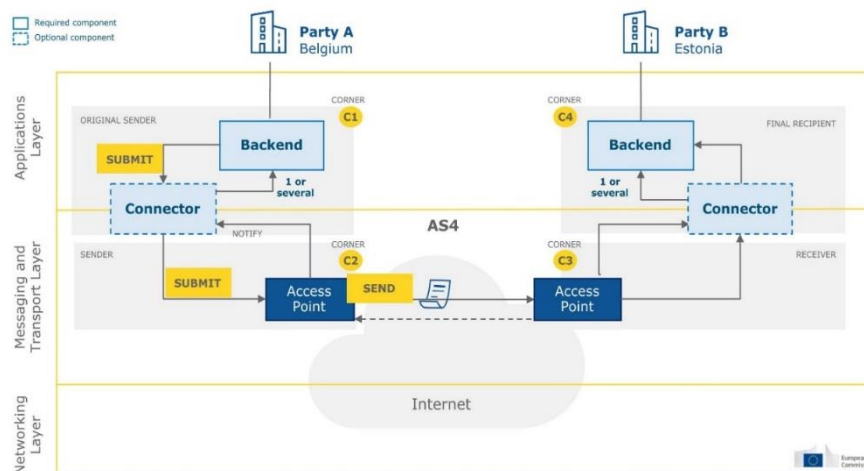


Fig. 1. eDelivery four step model [34]

The Service Metadata Publishing (SMP) [SMP] standard can be used for discovery of communication endpoint (DP or DC) and of the access point for evidence exchange. The list of qualified trust service providers and the provided services are administered by the Member States on trust list servers. Thus, a discoverable service has to perform a SMP endpoint registration to the Service Metadata Location (SML) server. As a remark, OASIS renamed the SML component to Business Document Metadata Service Location (BDXL).

The mGov4EU project is focusing its activity on online services that citizens need to access from a mobile device in a cross-border context due to moving to another Member State or having multiple citizenships (thus having multiple eIDs and residences).

Single Digital Gateway Regulation (SDGR) (EU) 2018/1724 of the European Parliament and of the Council, introducing a single digital gateway aiming at specifying the requirements for evidence exchange for online services in the light of the European Single Digital Market and Services. The “4-corner model” eDelivery can be only regarded as a starting point for the specification and implementation for this regulation, as key components related to the interplay of the eID and the required user explicit request together with the eDelivery concepts and components are still to be designed and validated. Taking into account the implementing act of the SDGR including the refined guidelines, available in a draft format and to be published end of June 2021, well established technologies like Security Assertion Markup Language (SAML), together with the eIDAS Technical Specifications and the OAuth2.0 constitute the anchor points for the design inside the mGov4EU project.

7 Cross-border solutions

Currently, there are several solutions offering options for data exchange on the cross-border level. These solutions are mostly initiated by the European Commission as the leading organisation in enabling cross border interoperability.

7.1 CEF eDelivery

The eDelivery is a building block that enables the secure communication and exchange of data between public administration, business and citizens on the cross-border level [35]. The motivation for the development of this solution is the existing heterogeneity of the IT infrastructures within the Member States and the necessity to create a secure interoperability layer that will interconnect these heterogeneous systems [36]. The eDelivery solution helps public administrations to exchange data by providing the technical specifications and standards which enable every user to become a node in the network [36]. This distributed model of the eDelivery building block enables direct communication between the users without setting up a new bilateral channel [36]. The solution can be used not only in the cross-border environment by connecting different IT systems of Member States but also in the national and regional environment by connecting different IT systems within the country. The eDelivery building block is a generic and content agnostic solution for the secure and reliable electronic exchange of any kind of information within and between the Member States. The technical basis was created by different large scale EU projects, mainly the e-SENS⁵ project. The results are taken up by the CEF as part of the long-term sustainability strategy for eDelivery. The eDelivery solution is technically based on the 4-corner model.

7.2 Business Registers Interconnection System

Another relevant EU initiative that enables cross-border data exchange between the Member States is the Business Registers Interconnection System (BRIS). The BRIS infrastructure provides a cooperation platform for all Business Registers in the EEA countries. It provides to the citizens, business and public administrations a single point of access on the European eJustice portal⁶, on which they can search and find the relevant information on companies and their branches [21]. The purpose of the BRIS infrastructure is improved cross-border access to business information and is achieved by enabling communication between business registries. BRIS is using a public network in order to enable access to citizens business and public administrations to find a piece of information. The system is distributed with a central component of storing and indexing the published information [37, 38]. To enable secure and reliable data exchange, BRIS uses the CEF eDelivery solution. Finally, the benefits of BRIS are that it reduces administrative burden, increases consumer confidence, increases legal certainty and efficiency of procedures [21, 38].

⁵ Electronic Simplified European Networked Services (e-SENS); www.esens.eu

⁶ www.e-justice.eu

7.3 EESSI

The Electronic Exchange of Social Security Information System (EESSI) is the IT platform that enables data exchange by social security institutions across borders. Most exchanges between public administrations related, inter alia, to sickness, occupational disease and accidents at work, pension, unemployment, were paper-based which was being replaced by the electronic data exchanges by the rollout of EESSI [39]. The first data exchange related to the social security of EU citizen took place in 2019, and since 2019 all EEA countries are required to connect to the system [39]. To exchange the information, EESSI uses a private network, and it has a routing component that enables the secure and reliable exchange of information [39]. Use of EESSI benefits public administrations but also to citizens by enabling: Faster and more efficient information exchange, more accurate data exchange, safe IT environment for data exchange, secure handling of personal data and verification of social security rights [40].

7.4 EUCARIS

The European Car and Driving Licence Information System (EUCARIS) is a decentralised IT system that connects the Member States, which enables the sharing of information related to vehicle and driving licence and other transport-related data [41]. EUCARIS is an exchange mechanism and not a database nor a central repository, and it is developed in order to reduce car theft and registration fraud within the EU [42]. The value of EUCARIS is that it enables the cross-border data exchange within the transport and mobility sector by enabling a peer-to-peer connection between the Member States. Also, the goal of EUCARIS is to avoid the creation of the new system for data exchange every time when a new agreement, treaty or directive comes into force [43]. By having one exchange information system, it achieves costs and time savings and higher interoperability [43].

7.5 OpenPEPPOL

OpenPEPPOL provides a set PEPPOL-based ICT products and services that enables the cross-border interconnection of eProcurement systems through loosely coupled building blocks. The PEPPOL eDelivery network uses Access Points and gateways to enable the interconnection between multiple parties in the EU. This solution provides technical specification and open-source software for data exchange related to public eProcurement processes by enabling the communication between heterogeneous data exchange infrastructures. Exchange of information, similarly to the eDelivery building block, is enabled through the 4-corner model and access Points acting as interoperable nodes. This enables a many-to-many interoperability environment, and it reduces costs and burden on creating bilateral agreements and the creation of new systems [44].

7.6 TOOP

The OOP solution created by the TOOP project was discussed and analysed in the previous section on technical and semantic interoperability. TOOP architecture proved the feasibility of achieving a OOP in a cross-border setting, and therefore having SDGR as a basis of the creation is the best example to explain the technical and semantic interoperability of federated data-exchange architecture.

7.7 Evaluation

Evaluation Matrix presents the collection of the cross-border solutions and the specifications criteria on the features of the cross-border solutions. The selection of criteria is done on the basis of the public access, Public Network (the general public can access the solution and search for information) or Private Network (only public administrations have access to the solution); the system distribution, Purely Distributed System (the system is purely distributed when it enables peer-to-peer communication without a central platform or routing component) or Central Platform/Routing Component (the system is connected to the routing component and/or central platform); organisation level, Centralised organisation (the solution is maintained and administrated by one authority) or Decentralised organisation (the solution is maintained and administrated by the users). The results of this evaluation matrix can be seen in **Table 1**.

Table 1. Evaluation Matrix

Evaluation Matrix	Public Access		System Distribution		Governance Level	
	Public Network	Private Network	Purely Distributed System	Central Platform / Routing Component	Centralized Organisation	Decentralized organisation
BRIS	X			X	X	
EUCARIS		X	X			X
EESSI		X		X	X	
TOOP		X		X	X	
OpenPeppol		X		X		X

This number of existing and ongoing projects in development provide a heterogeneous landscape, when looking at the national and European level. At the national level, we can differentiate between two different cross-border service participation types – either as 1) data provider or 2) as data consumer. In the former case, the public authority is providing data for a cross-border use case, while in the latter, the public authority is requesting data and thus consuming it. Usually, such data providers and data consumers are organised in the form of base registries, in particular when public

IT systems are organised following the OOP model. In rare cases, such base registries interact with other, foreign, base registries directly. This forms the first type of connection to national data, 1) the direct access. More commonly, the access is provided through some form of mediator, either 2) data aggregators which pool data of a sector, or 3) national/context-dependant data exchange layers.

Next to these organisation and access types on MS-level, the cross-border integration can also take place on a 1) vertical level in a domain-specific way, e.g. within sector specific private networks (EESSI, EUCARIS). Alternatively, and this is what is proposed within the TOOP project, a horizontal, content- and sector-agnostic, integration, in the format of a federation of federations. Within TOOP, this hierarchy has also been put together in a graphical format, see the figure below (**Error! Reference source not found.**).

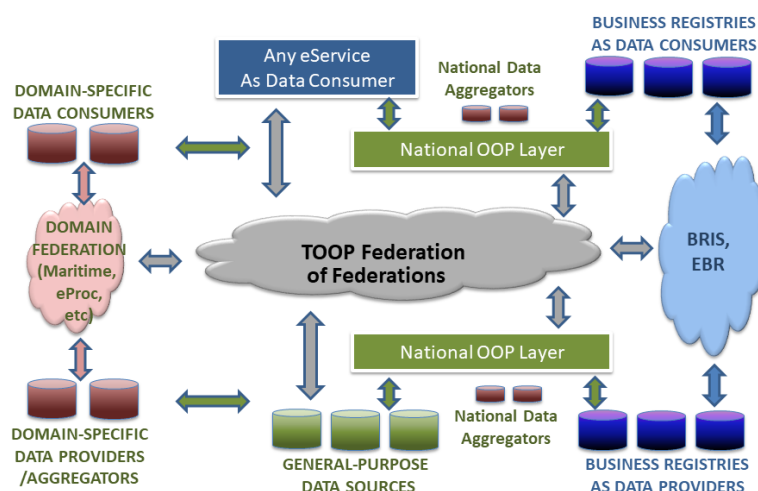


Fig. 2. The TOOP Cross-border Framework [45]

8 Conclusions

To summarise, the different approaches for cross-border e-governance and the cross-border integration were analysed based on the different layers of the EIF to identify the **drivers**, **barriers** and **opportunities** in the wider context of e-Government. The main **barriers** for the EU-wide cross-border implementation, inter alia, are the heterogeneity of the data exchange infrastructures, existing legacy systems, and lack of willingness to undertake significant technological changes for the sake of enabling it on the cross-border level. Several authors address these barriers by stating that Member States should re-use already developed cross-border solutions such as CEF eDelivery [21, 46]. Furthermore, the lack of interoperability can be solved by following and adopting the

solutions created by the CEF, ISA², and by designing interoperable public services following recommendations, principles, and interoperability model suggested by the EIF. Legislation is perceived to be the most significant **barrier** and **driver** (once it exists) at the same time for European data integration [16].

Finally, as already mentioned, the Single Digital Gateway regulation must be seen as an **opportunity**; it requires that all Member States offer access to fully online procedures by also cross-border users through the Your Europe portal. Having multiple agreements between the Member States and also bilateral agreements might create many interconnection points and networks, which might further deepen the heterogeneity of IT systems within the EU.

As recommendations, based on the analysis of the projects, the following can be concluded; the possibly best option to overcome this hurdle and to enable cross-border data-exchange could be through a data-exchange connector which will enable the interconnection of different IT infrastructures of public administrations. Therefore, the technically most successful solution for cross-border integration probably would be a federated approach as proposed in the Single Digital Gateway Regulation.

Besides that, related to the evaluation, from an organisational point of view, it is important to establish a governance structure that ensures the involvement of all relevant stakeholders (e.g. EC, Member States, standardisation bodies etc.). This governance structure should be on the one side institutionalised to ensure the long-term sustainability and on the other side provide the necessary flexibility to react as fast as necessary to any kind of needs for amendments of the solutions.

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