INTERNATIONAL DATA SPACES ASSOCIATION

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Data Spaces Landscape

Overview and relations of data spaces initiatives, standards, and tools

- (●) Position Paper of members of the IDS Association
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1 The Data Spaces Landscape

The Data Spaces Landscape is growing rapidly with numerous initiatives, standards, frameworks, and tools being developed and used. Some initiatives have a regional focus, while others have their focus on a global level, some focus on specific domains, while others aim to develop industry-wide standards.

Obtaining an overview of all these different initiatives and understanding their relations and interactions is challenging. This is both due to the sheer number of initiatives as well as due to the different objectives and maturity levels. While some have a global reach, others are in a phase where they are still defining their objectives without concreting results yet. Additionally, there are some overlaps between different initiatives. It should also be noted that there is still no common terminology used across all initiatives. For example, where this paper uses the term 'initiative' to indicate an endeavor related to data spaces, the DSSC uses that term specifically for what is here called a 'data space instance'.

The goal of this paper is twofold: First we aim to provide an overview of the most relevant data spaces initiatives to those getting started with data spaces. For that purpose, we also provide insights in the relations between different initiatives and how they reinforce each other as well as give references to further reading. Secondly, we hope to support the continuing discussion and further elaboration of a common understanding regarding the state of the art in data spaces. Given the fast and continuous developments and discussions in data spaces, this paper requires updates to keep it up to date and hence comments and support are encouraged by the editor.

Given the many actors who are nowadays working within the data spaces domain, it is nearly impossible to provide a complete overview. We therefore focus on the following subset: IDSA, Gaia-X, FIWARE, IDS Testbed, OpenDEI, Data Spaces Radar, DSBA, DSSC, iSHARE, MyData and Sitra.

The following chapters in this IDSA position paper are structured as follows: Chapter 2 drafts an overview of data spaces, explains the relations between several data space initiatives and identifies how these initiatives support each other. Chapter 3 provides a short description of each of the mentioned data space initiatives with references to further documentation. Finally, Chapter 4 concludes this paper by providing an outlook on how this work is continued.

2 Data spaces overview: the big picture

Regardless of the specific initiatives, in essence a data space consists of software to provide data sharing functionalities, distributed and trustworthy platforms on which this software can run, and rules and agreements about the interactions between the participants in the data space. Different initiatives work on different combinations of these three aspects. A more general view of the structure of data spaces as centralized, decentralized, or federated systems is given in the IDSA Rulebook Version 2 [1].

Common goals of most data space initiatives are, among others, data sovereignty and interoperability. Data sovereignty means that control of the access and use of data remains with the owner, even if that data is shared with others.

Data space interoperability is more than merely the interoperability of technical components. The European Interoperability Framework (EIF) [2] distinguishes four interoperability levels: technical, semantic, organizational and legal under an overarching integrated governance approach. Interoperability is needed both within individual data spaces and between multiple data spaces, referred to as intra and inter data space interoperability.

The graphic below (Figure 1) shows some data space initiatives, and in a simplified manor their relations and the foundations they are built upon. In the rest of this chapter, we will use this graphic to describe these initiatives and the relation between them. As mentioned in the introduction, this represents the current status of data space initiatives, some initiatives are still developing and changing.

The end goal, of course, is to enable parties to share data, so we'll start with some examples of data spaces that are already operational. Then we continue with a description of the initiatives related to the architecture on which those data spaces are built. Finally, certification and further support for data spaces will be presented. In this chapter the initiatives are only briefly mentioned, some more details and references to further reading are provided in chapter 3 per initiative.

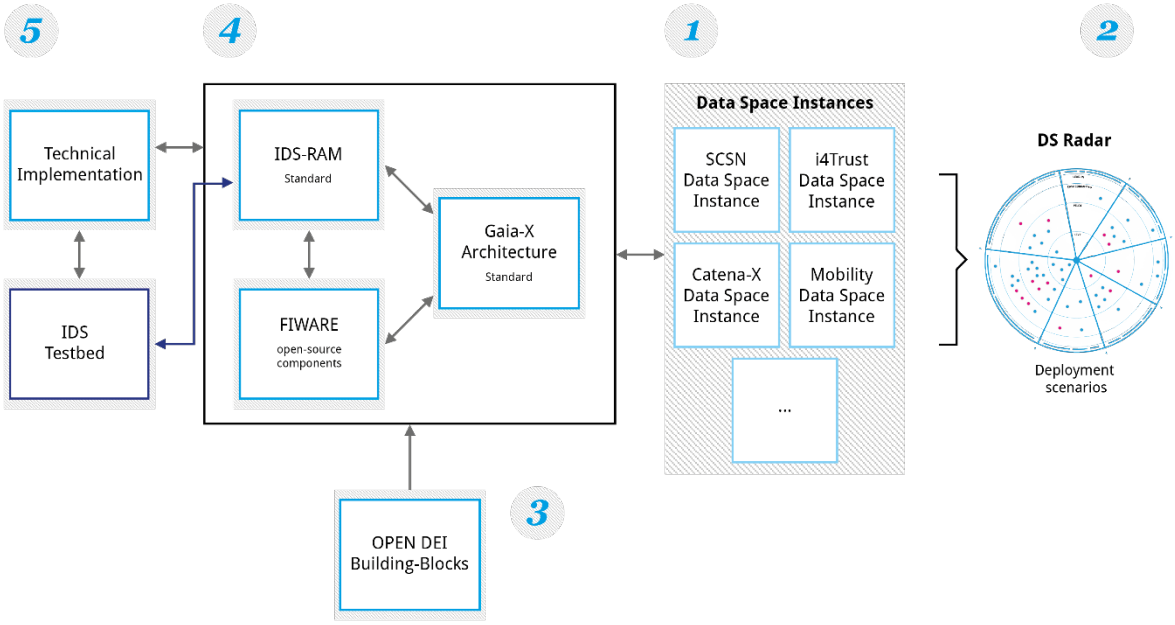

Figure 1: Overview of data space initiatives

Data space examples

Some well-known examples of data spaces that are actively being used are SCSN [3], Catena-X and the Mobility Data Space.

SCSN (Smart Connected Supplier Network) is a data standard that makes sharing of information in the supply chain more efficient, allowing companies to share data more easily, quickly and reliably.

The Mobility Data Space [4] is a data sharing community with a wide range of data related to mobility. It aims to facilitate competition around innovative, environmentally sustainable, and user-friendly mobility concepts by giving all users equal and transparent access to relevant data.

Catena-X [5] is a data space in which players in the automotive industry are connected in an end-to-end value chain. The goal is a standardized global sovereign data sharing based on European values, where participants gain above-average resilience, innovative strength and earnings opportunities.

In addition to these data spaces there are numerous other public and private data space initiatives. An overview of all those different initiatives is provided by the Data Space Radar where an inventory of data spaces in various domains are shown and an indication of their maturity level is given. More information about individual data spaces can be also accessed through the Data Space Radar.

Data space architecture

Generic building blocks

With a large number of existing data spaces, it is to be expected that individuals and organizations will act in multiple ecosystems at the same time.

To prevent fragmentation of data spaces and ensure interoperability, it was realized that a 'soft infrastructure' is needed, specifying legal, operational and functional agreements as well as technical standards to be adopted by users. Just like other soft infrastructures, data spaces are sector-agnostic, with many requirements and functions being similar or even identical across different sectors and data spaces. Realizing interoperable data spaces is a coordination challenge: agreed on standards and design principles that are accepted by all participants.

The OpenDEI initiative aims to do just that by creating a conceptual overview of all data space building blocks and is driving the adoption of generic standards to guide the development of data spaces.

Specifically, OpenDEI aims to align reference architectures, open platforms and large-scale pilots in digitizing the European industry. High level categories taken into account by OpenDEI: interoperability, trust, data value and governance. With more detailed building blocks identified for each of these topics as indicated in the figure below.

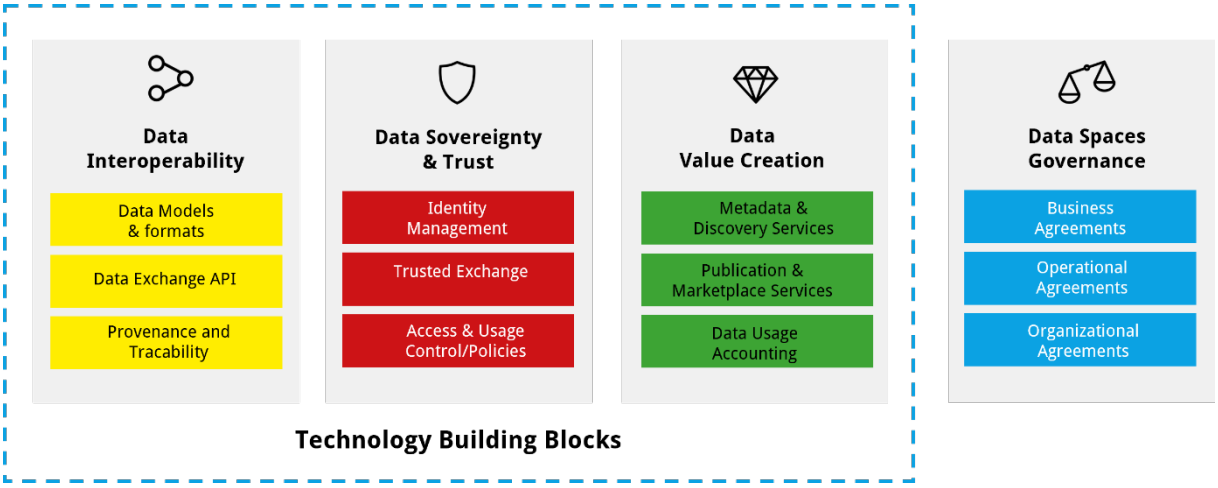

Figure 2: OpenDEI building blocks [27], modified by IDSA

Reference architectures

Where OpenDEI focusses on generic standards, other data space initiatives implement reference architectures that serve as standards for the creation of data spaces. The initiatives that cover the core of a data space are IDSA, Gaia-X, FIWARE and iSHARE. Each of these goes into more detail for some of the individual OpenDEI building blocks and together they cover most of the OpenDEI building blocks.

IDSA focuses on data sharing and data sovereignty, governance and architecture of data ecosystems. Gaia-X focuses on sovereign cloud services and cloud infrastructure by defining

guidelines for the soft data infrastructure. Gaia-X also develops the software components that allows a federated data ecosystem to be set up. Between them, IDSA and Gaia-X mainly focus on the OpenDEI categories interoperability, trust and governance.

The interaction of Gaia-X and IDS has three main objectives: self-sovereign data storage, trustworthy data usage and interoperable data sharing. For more details on how Gaia-X and IDS reinforce each other see the IDSA position paper "Gaia-X and IDS" [6].

FIWARE provides standards for applications developed on top of IDS; applications that gather and combine data from different sources and produce information for specific purposes. Hence FIWARE is more focused on the OpenDEI category data value.

iSHARE finally, is a generic trust framework that aims to form a set of agreements for identification, authentication and authorization that enables anyone to share data with everyone else in a simple and controlled way, hence it is more focused on sovereignty and trust.

Data space implementation and verification

Using the architectures defined by the before mentioned initiatives, a technical implementation of the data sharing functionalities can be realized to create an actual data space.

To ensure that the technical implementation of a data space is according to the IDS specification, the IDS Testbed can be used. The IDS Testbed is a software suite that verifies that components are interoperable and implemented according to the specifications.

Additionally, components of a data space can be certified by the IDSA so that their compliance and interoperability is assured, both for human participants in the data space as well as for other components in the data space. This is especially important as the usage of a data space increases, and more and more services are developed and available in the data space.

Gaia-X also enables verification by means of Gaia-X Labels. Labels are optional and built on top of the trust framework, based on criteria related to data protection, transparency, security, portability and flexibility, and European control. Further labels, sector or country-specific, can be built on top of them.

Data space support and promotion

Finally, two initiatives should be mentioned that support data spaces in a broader sense, first the Data Spaces Business Alliance (DSBA) and second the Data Spaces Support Centre (DSSC).

The DSBA is a collaboration between Gaia-X Association for Data and Cloud (AISBL), the Big Data Value Association (BDVA), FIWARE and the IDSA. The DSBA aims to accelerate business transformation in the data economy by bringing together data providers, users and intermediaries. And developing a common framework based on existing architectures and models, leveraging each other's efforts on infrastructure and implementations.

The DSSC acts as a knowledge center regarding data spaces to support implementation and to guide all the initiatives in this field. The DSSC promotes and coordinates all relevant actions

on sectorial data spaces and will make available technologies, processes, standard and tools that will support the deployment of common data spaces and will allow reuse of data across sectors.

3 Data Spaces Landscape: introduction to some data spaces initiatives

This chapter provides a brief overview and references to additional material on a selection of the data space initiatives mentioned in the previous chapter.

IDSA

The International Data Spaces Association [7] is a not-for-profit organization, a coalition of more than 140 member companies that share a vision of a world where all companies self-determine usage rules and realize the full value of their data in secure, trusted, equal partnerships. The goal is a global standard for international data spaces (IDS) and interfaces as well as fostering the related technologies and business models that will drive the data economy of the future across industries. IDSA is on a mission to create a digital future across Europe and around the world; in which all players can realize the full value of their data through equal access to secure and sovereign data sharing among trusted partners.

The vision is to create the environment for trusted data sharing taking place through federated, international data spaces that are globally certified by IDSA. IDS-certified products, services and systems open the door to a data economy in which businesses can share data up and down the value chain without security concerns. This approach will support new business models and enable a data economy based on true collaboration and trust, defined by data usage rules that are self-determined by data providers themselves.

The aim is to create a global standard for IDS as well as fostering technologies and business models that will drive the data economy of the future in Europe and around the globe.

Two important publications of the IDSA are the IDSA rulebook [1], focusing on the governance of data spaces. And the IDS-RAM [8] which goes into more detail on the architecture of data spaces. The data space protocol [9] is a set of specifications designed to facilitate interoperable data sharing between entities governed by usage control and based on web technologies developed under the umbrella of IDSA. These specifications define the schemas and protocols required for entities to publish data, negotiate usage agreements, and access data as part of a federation of technical systems termed a data space. An overview of the IDS architecture is shown in figure 3.

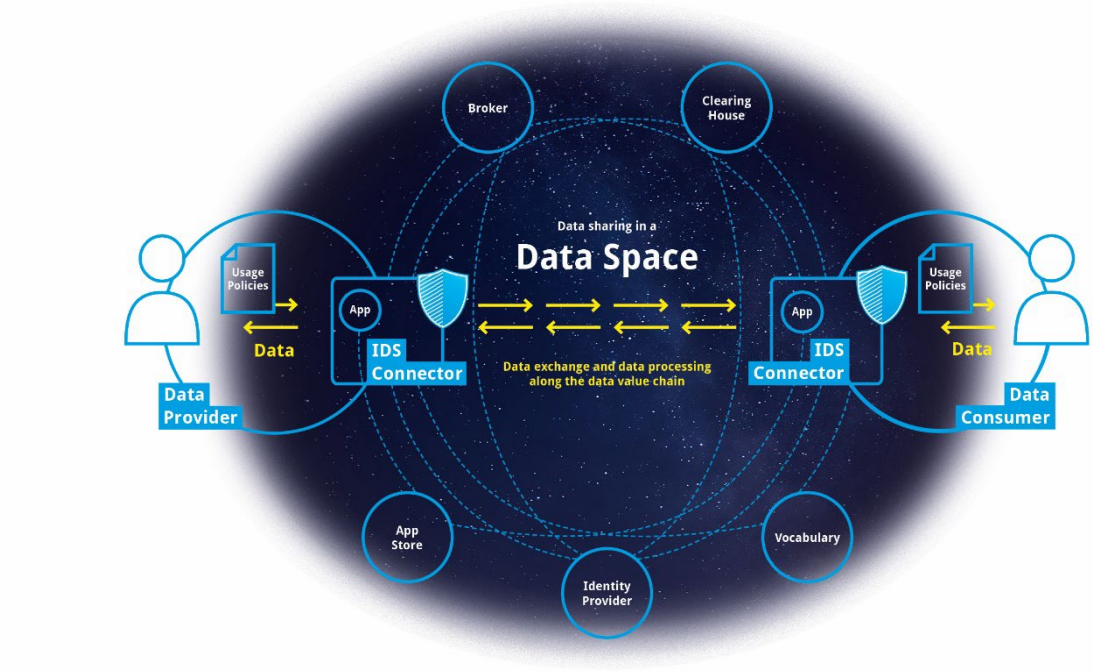

Figure 3: IDS architecture overview [10]

IDS Testbed

The IDS Testbed [11] is an open-source setup with IDS components that has been jointly developed by the IDSA open-source community. The testbed enables companies and organizations to develop IDS-compliant components and test their interoperability. It is also a preparatory tool for the IDS Certification. The testbed will enable the large-scale adoption of IDS components needed to bring this reality to fruition.

The IDS concepts, architecture, and components form the standard for sovereign data sharing. To move from theory to practice and to achieve large-scale adoption, technical components must be tested for interoperability compliance. For this reason, the IDS Reference Testbed [12] was created.

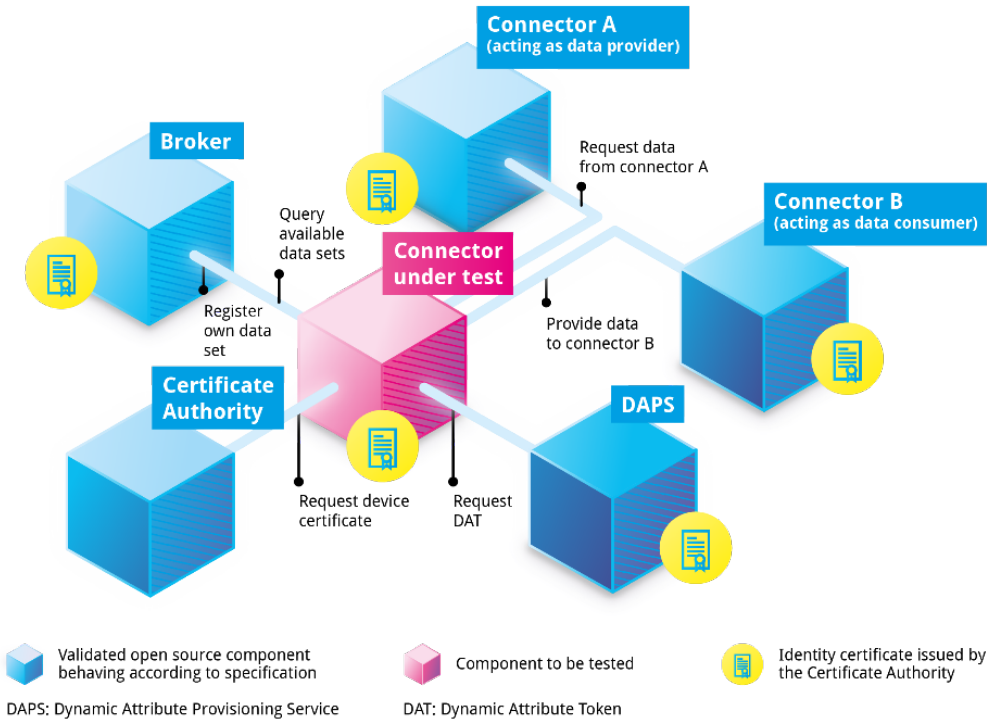

Figure 4: IDS testbed components [13]

Data Spaces Radar

The Data Spaces Radar [14] is a platform for finding use cases and help bring data spaces to life. The Data Spaces Radar maps all data spaces in one easy-to-use tool. The radar covers use cases of different degrees of maturity from the phase of creating a business case to real data spaces, from planned to pilot to fully operational, across industries and functional domains.

Deployment scenarios [15] are the further explanation of the use cases in the Data Spaces Radar, providing details on which components have been used; how the implementation has been made; what other purpose this deployment can be used for.

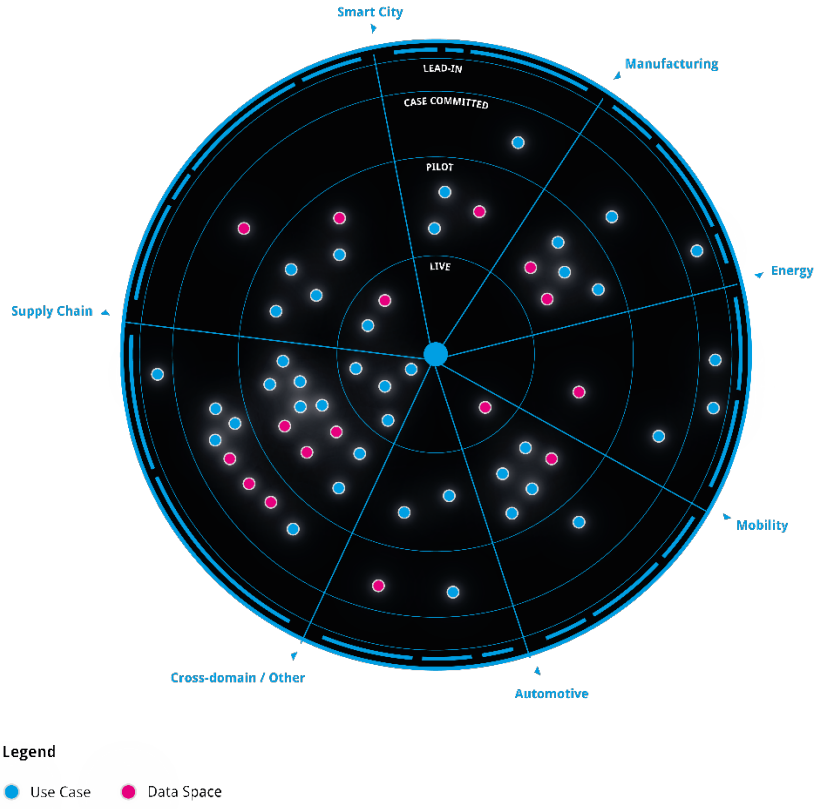

Figure 5: Data Spaces Radar [14]

DSBA

The Data Spaces Business Alliance [16] accelerates business transformation in the data economy. It's the first initiative of its kind, uniting industry players to realize a data-driven future in which organizations and individuals can unlock the full value of their data.

The Alliance aims to converge the best skills, assets, and experience in Europe in a one-stop-shop for data spaces, from inception to deployment.

The Data Spaces Business Alliance are Gaia-X European Association for Data and Cloud (AISBL), the Big Data Value Association (BDVA), FIWARE Foundation, and the International Data Spaces Association (IDSA). Together they represent 1,000+ leading key industry players, associations, research organizations, innovators, and policymakers worldwide. With this cross-industry expertise, resources and know-how, the Alliance drives awareness, evangelizes technology, shapes standards, and enables integration across industries.

With the Technical Convergence Discussion [17] the DSBA defines a common reference technology framework. This framework is based on the technical convergence of existing architectures and models, and leverages mutual infrastructure and implementation efforts. The goal is to achieve interoperability and portability of solutions across data spaces by harmonizing technological components.

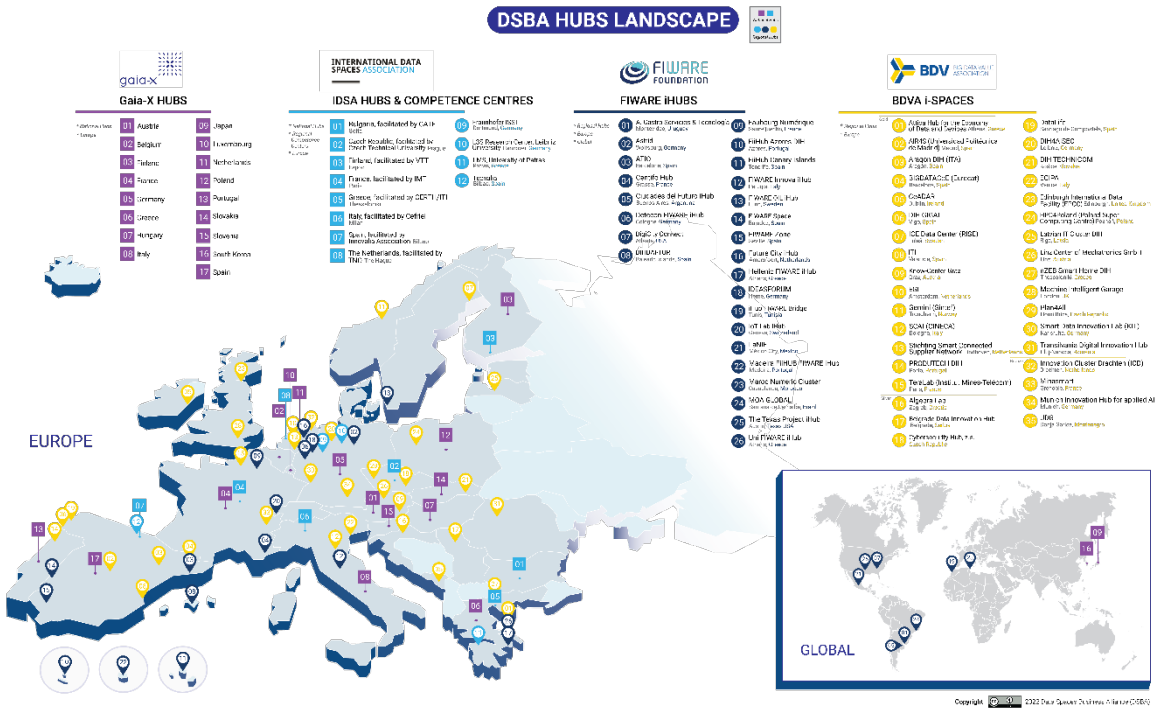

Figure 6: DSBA hub landscape [18]

Gaia-X

Gaia-X [19] aims to establish a data space ecosystem, where data is shared and made available in a trustworthy environment. It is designed to give control back to users by retaining digital and data sovereignty. It is not another cloud service but a trust framework [20] system, linking many cloud service providers and users in a transparent, open environment that will drive the European data economy of tomorrow.

Gaia-X is a European beacon project that will both connect existing cloud services and spark innovative new modes of connectivity to create a federated digital infrastructure for Europe. A critical success factor is to ensure data sovereignty and interoperability — a shared goal of Gaia-X and IDSA, which is why IDSA concepts are an integral element of the GAIA-X architecture [21].

Specifically, Gaia-X is an initiative to develop an open software layer of control and governance that can implement a common set of policies and rules to any existing cloud

technology stack, obtaining transparency, sovereignty and interoperability across data and services and creating competitive advantage for Europe in a global market.

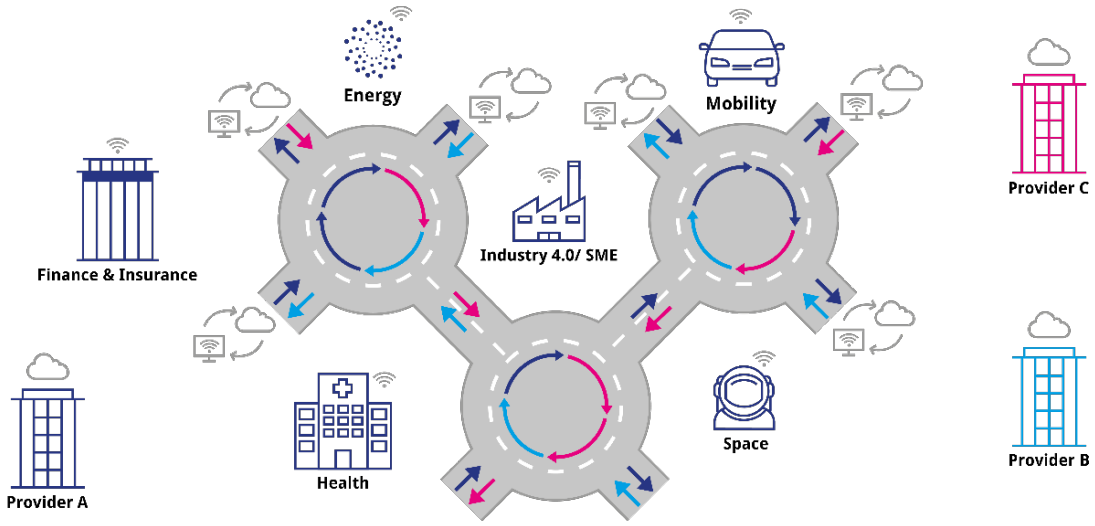

Figure 7: Gaia-X infrastructure vision [22], modified by IDSA

FIWARE

FIWARE [23] is a curated framework of open-source platform components to accelerate the development of smart solutions in 5 main Domains: Smart AgriFood, Smart Cities, Smart Energy, Smart Industry and Smart Water.

The FIWARE Foundation drives the definition – and the open-source implementation – of key open standards that enable the development of portable and interoperable smart solutions in a faster, easier and affordable way, avoiding vendor lock-in scenarios, while also nurturing FIWARE as a sustainable and innovation-driven business ecosystem.

FIWARE provides standards for applications developed on top of IDS, intended to gather and combine data from different sources and produce information for specific purposes.

FIWARE's mission is "to build an open sustainable ecosystem around public, royalty-free and implementation-driven software platform standards that ease the development of new Smart Applications in multiple sectors".

FIWARE components be found in the GitHub Repository [24].

OpenDEI

The digital transformation strategy of the European Union [25] has, among others, a particular priority: the creation of common data platforms based on a unified architecture

and an established standard. Manufacturing, agriculture, energy and healthcare represent key fields for the deployment of the EU strategy for digitalization. In this framework, the EU-funded OpenDEI [26] project aims to detect gaps, encourage synergies, support regional and national cooperation, and enhance communication among the innovation actions implementing the EU digital transformation strategy. These objectives are achieved by aligning reference architectures, open platforms and large-scale pilots in digitizing the European industry.

Results of the OpenDEI project are published in "Design Principles for Data Spaces" [27]. The project also conducted a survey to create a taxonomy of available building blocks, the repository of building blocks is available on GitHub [28].

DSSC

The objective of the Data Spaces Support Centre [29] is to set up and operate a support center, which coordinates all relevant actions on sectorial data spaces and makes available (blueprint) architectures and data infrastructure requirements for the data spaces, including possible technologies, processes, standard and tools that will support the deployment of common data spaces and that will allow reuse of data across sectors by the public sector and European businesses, notably SMEs.

Practically the Data Spaces Support Centre has created a starter kit to help organizations navigate the challenges of creating and maintaining a successful data space. The kit includes a resource inventory that provides an overview of state-of-the-art and state-of-practice resources available for organizations interested in creating or participating in data spaces.

It will also support the work of the envisaged Data Innovation Board in view of enhancing the interoperability of data as well as data sharing services between different sectors and domains. In particular, it will identify cross-sector standards to be used and developed for data use and cross-sector data sharing, it will carry out cross-sectoral comparisons and identify best practices with regards to sectoral requirements for security, access procedures, while taking into account sector-specific standardization activities.

iSHARE

iSHARE [30] is the European standard for a trust network for international business data sharing in a sovereign way, governed by iSHARE Foundation, enabling federated trust governance of data spaces.

The iSHARE scheme's scope focuses on three main topics that are crucial in any data sharing context: identification, authentication, and authorization. That enables everyone to share data with everyone else in a simple and controlled way. The underlying assumption is that if data can flow in a controlled and smart way, it will lead to competitive advantages.

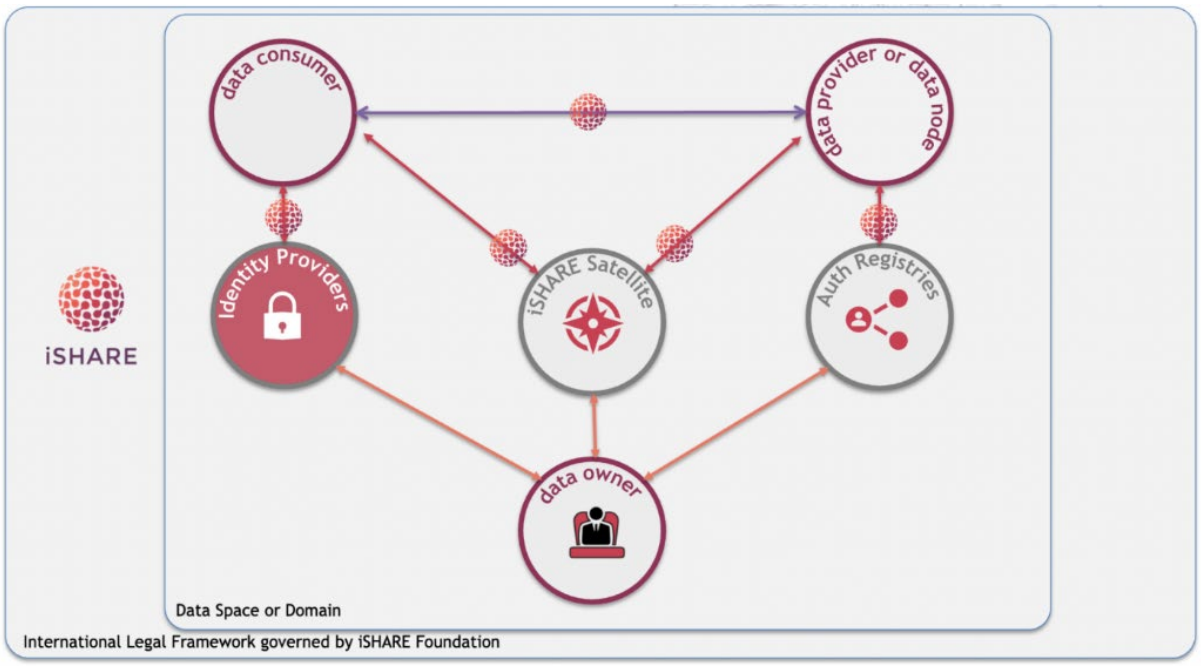

Figure 8: iSHARE framework [31]

4 Conclusion and further work

Towards a future with data sovereignty and data interoperability, the need of multiple data spaces emerges. For this to be realized, various initiatives are already creating the ground for implementation and further development.

In this paper, some of the most important initiatives have been described, as wells as the relations and interactions between them. Some initiatives appear to reinforce each other while others have overlapping objectives. Nevertheless, in the foreseeable future, continuous progression is as important as continuous alignment between initiatives.

The number of emerging initiatives is increasing and some of those not described in this paper are for example: MyData [32], SITRA rulebook [33], AIOTI [34]. Participation in developing new versions of this paper is encouraged so these and future developments can be included.

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