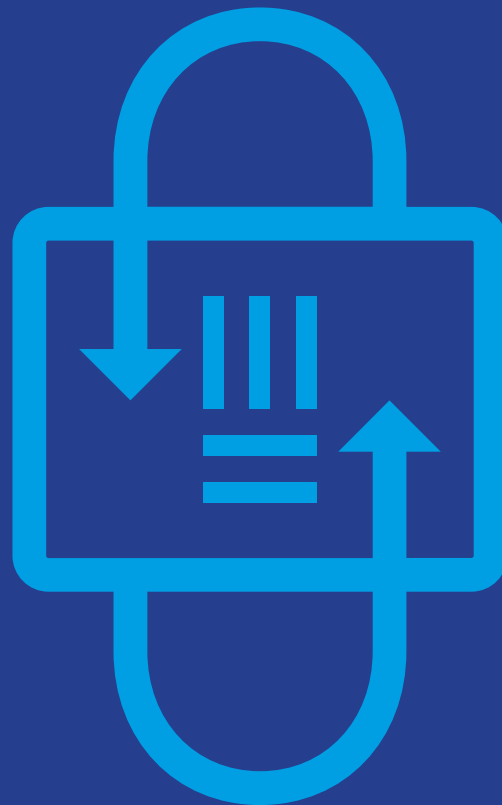


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Data Connector Report





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We thank the maintainers of the data connectors for their contribution to this report.

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What's new?

Added

- 1.4 Interoperability of data connectors

Changed

- 2.2.16 TeraLab Connector. Updates on: short description, Features, License type and External Resources
- Editorial changes to 1.3 What is a data connector?

Removed

- None



1 Introduction

1.1 The data connector report

The IDSA connector report describes technologies and concepts to participate in data spaces based on data connectors. Data and data sharing are central to today's economy. A common understanding of how data can be used and shared, based on standardized technology is therefore an important foundation for all organizations, projects and initiatives involved. The report will publish insights into current developments on a monthly basis.

Following the information on data connectors, their usage, capabilities, and functionalities we provide an overview of existing data connector implementations. The assessment and evolution of data connectors brings clarity about their application potential, maturity, and certification status, as well as their adoption in industrial use cases and research. Beyond data connectors, this report describes emerging technologies and concepts of data spaces as well as the technologies they are based on. Please also refer to the Data Space Radar¹ for an overview of data spaces.

Please contribute to the report via the Data Connector Report Contact Form²:

- Send your general feedback and comments on the report (see section 1 of the form).
- Add a new connector (see section 2 of the form).
- Update the information about a connector (see section 3 of the form).

1.2 Why do we need data connectors?

We need data connectors to share data - because **connectors enable secure and effective communication and exchange in data spaces**. They are a tool to connect many data endpoints to increase the pool of available data and to accelerate the data economy. By linking data connectors, data spaces become protected environments where participants can freely share data. Data sovereignty, transparency and fairness are ensured by adherence to a set of rules. Data connectors act as nodes in a data space and provide data sovereignty by design.

Sharing and exchanging data is not a new thing, but the requirements for it are evolving. A data connector essentially realizes two relevant aspects: It provides Data Exchange Services that are (1) the Application Programming Interface (API) to other participants in a data space to achieve interoperability and (2) the trustworthy component to handle data by implementing policy enforcement mechanisms and a common baseline for cybersecurity. However, as data can be different and the requirements for data sharing can be different as well, variants of connectors are needed (see the IDS RAM section 2.2³ and

¹ <https://internationaldataspaces.org/adopt/data-space-radar/>

² <https://forms.office.com/r/gbu1yv9K25>

³ https://docs.internationaldataspaces.org/ids-ram-4/context-of-the-international-data-spaces/2_1_data-driven-business_ecosystems/2_2_data_sovereignty_as_a_key_capability



section 2.4⁴ for more information). This report provides an overview of these data connectors, their purpose, use and distinctions.

The figure below shows the diversity of requirements in industrial ecosystems. A data connector for (I)IoT devices may have substantially different requirements (in terms of resource consumption, efficiency, and cyber security), then a connector of a data marketplace or an industrial cloud platform. At the same time, such services must seamlessly integrate open data. A data connector will enable interoperability and will put data to use, to link it with other data and to support modern concepts such as (shared and distributed) digital twins, AI, or federated learning. To do so, the connectors realize archetypical patterns for management service, orchestrate cloud-based service, lightweight API gateways, or IoT gateways. They may use concepts like distributed ledgers, but they will rely on state-of-the-art data management capabilities.

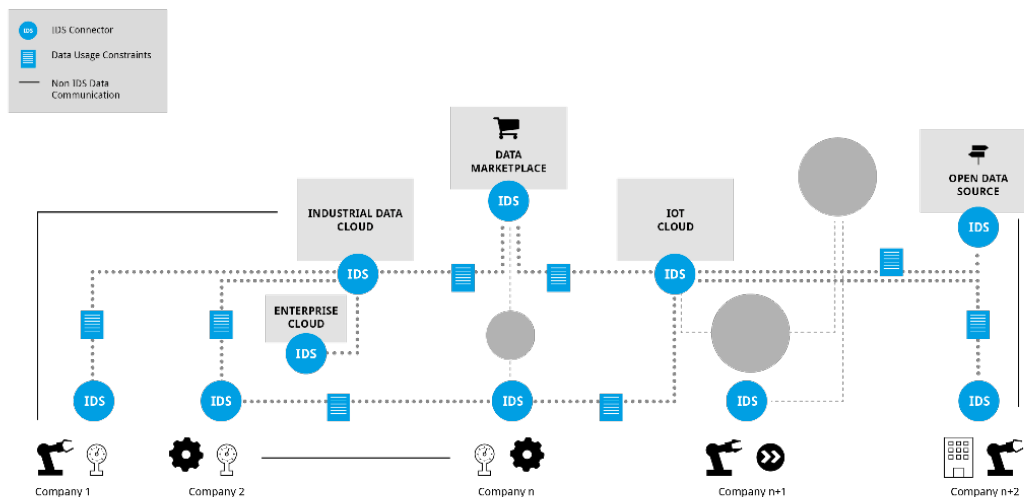


Figure 1 International Data Spaces connecting different clouds, on-premises applications, devices, marketplaces, and open data in an industrial scenario.

1.3 What is a data connector?

Data connectors are essential for enabling trust and interoperability in data sharing and exchange within data spaces, which are designed to provide data sovereignty. Data spaces, and with that, data sovereignty will be the level playing field on a global scale. This represents a significant advantage and revolutionizes the data economy of the future – with the goal of benefiting society, businesses, and individuals.

New data spaces may have different implementations and standards, which can lead to the creation of new data silos. Therefore, a strong push for convergence is needed to enable

⁴https://docs.internationaldataspaces.org/ids-ram-4/context-of-the-international-data-spaces/2_1_data-driven-business_ecosystems/2_4_data_exchange_and_data_sharing



interoperability, data continuity, and common governance models that support data sovereignty for all data spaces.

The International Data Spaces Association's (IDSA) core role is developing and maintaining a reference architecture for data sharing and exchange that prioritizes data sovereignty in data-driven business ecosystems. The IDSA has created a global standard and a reference architecture model (RAM)⁵ that facilitates secure and self-determined data sharing between trusted parties across various ecosystems.

Certified users gain access to the data ecosystem and attach usage restriction policies to their data before making it available to other users. The IDS Connector is a central component of the IDS standard and enables data exchange services as described in the IDS-RAM section 3.5.2⁶ (see also figure below). It uses container technology to ensure "trusted execution," which means that the data within the container is always protected from unauthorized access and manipulation.

The IDS standard addresses technical, operational, and legal agreements in data spaces⁷, which combine technical, organizational, and legal complexities. It provides guidelines for data sharing and adds features such as identity management, communication security, and usage control. The IDS Connector is defined in DIN SPEC 27070 as part of the German standardization work and subject to international standardization in ISO/IEC, CEN/CENELEC, IEEE, and W3C.

To prove compliance with these requirements the IDS Certification⁸ was launched in 2022, offering different trust and assurance levels for both connectors and operational environments. Some connectors are labelled as 'IDS-Ready' indicating they successfully underwent a pre-certification, a third-party assessment to prepare for certification.

Implementations of data connectors based on the IDS Standard can be found as closed-source software and as open-source software. Regarding the latter, The IDSA has developed the IDS Graduation Scheme⁹, which provides a set of rules, processes, and criteria to manage these open-source implementations on the IDSA GitHub¹⁰.

⁵ https://docs.internationaldataspaces.org/ids-ram-4/introduction/1_1_goals_of_the_international_data_spaces

⁶ https://docs.internationaldataspaces.org/ids-ram-4/layers-of-the-reference-architecture-model/3-layers-of-the-reference-architecture-model/3_5_0_system_layer/3_5_2_ids_connector#ids-connector-functionalities

⁷ <https://internationaldataspaces.org/rule-book-on-structures-and-processes-for-implementing-ids-in-the-real-world/>

⁸ <https://internationaldataspaces.org/offers/certification/>

⁹ https://github.com/International-Data-Spaces-Association/idsa/tree/main/graduation_scheme

¹⁰ [International-Data-Spaces-Association/idsa](https://github.com/International-Data-Spaces-Association/idsa): This is the main repository of International Data Spaces Association on GitHub, where you can find general overview and useful information on IDS Landscape.

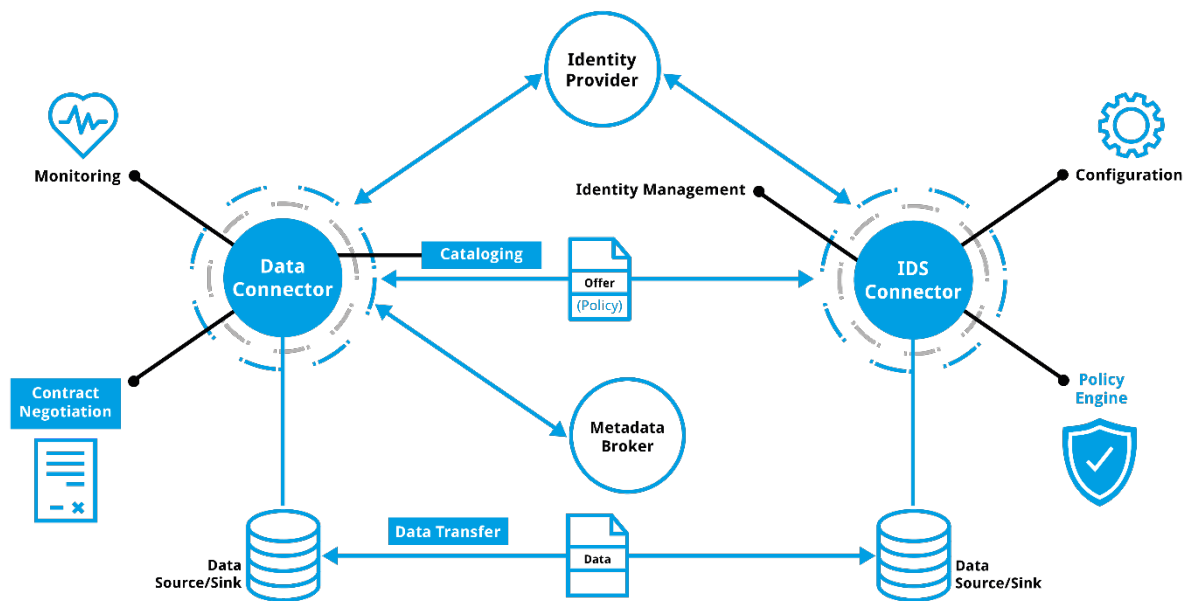


Figure 2 Data Exchange Services realized by a data connector as described in the IDS-RAM section 3.5.2

1.4 Interoperability of data connectors

Technical Interoperability is a major requirement in data spaces. It should be realized by data connectors, based on specifications and standards rather than relying on singular implementations or reference implementations. To do that, multiple levels of interoperability must be addressed: first, the general interaction between the connectors for the description of data assets and the related endpoints must be addressed including the definition of policies for access control and usage control, followed by the negotiation of those policies and contracts. The initiation and management of the data exchange process needs a clear specification, which can be mapped then to tangible protocols, like https, MQTT, web sockets or others. This is the handover to use case specific, domain-specific or ecosystem-specific definitions and standards. General interactions require a robust standard that can be implemented by the different connectors, while the subsequent data exchange makes use of domain or use case-specific standards. The same applies to semantic interoperability, which can be achieved on the foundation of the Data Catalog Vocabulary (DCAT)¹¹. The further definition of the data exchanged is handled by semantic models, taxonomies, schemas or other similar mechanisms, the so-called “vocabularies”.

To achieve robustness and reliability in a data space, the interoperability of connectors requires verification. Based on standards and specifications, compliance to those can and must be continuously evaluated to maintain this foundation in addition to the continuous management and verification of security aspects related to the data connectors.

¹¹ <https://www.w3.org/TR/vocab-dcat-3/>



Today we already have a set of usable standards to achieve the goals described above, but additional standards are required. The interaction of the connectors on the general level as depicted in Figure 2 requires a protocol agnostic standard as foundation for interoperable data spaces. For this reason IDSA is working on a specific Dataspace Protocol, a set of specifications designed to facilitate interoperable data sharing between entities governed by usage control and based on Web technologies. 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. The Dataspace Protocol, therefore, represents the foundation for technical interoperability in data spaces. More information on the Dataspace Protocol is provided on GitHub¹².

1.5 The relation of data connector solutions and frameworks

Data connectors differ based on various dimensions. They can nonetheless be grouped into four main categories: data connector frameworks, OSS generic solutions, proprietary generic solutions and off-the-shelf data connectors or connectors integrated in data-related products. More details on each of them are provided below.

Data connector frameworks are modular data space components to be used as a basis to implement a data connector. Most of the data connector frameworks are available as Free and Open-Source Software (FOSS). Based on this common foundation, extensions are available and being developed to create solutions. The Eclipse Data Space components, the FIWARE ecosystem including the TRUE Connector and the IDS Messaging Library are good examples of such frameworks. The frameworks are for developers that use it to implement their solutions. They are not intended for direct use of end-users to share and consume data.

Generic open-source solutions offer data connectors that can be integrated directly into an IT-Landscape and connected to services. Often, these act as proxies or gateways to companies' IT-Services. Configuring the components and adding custom extensions is typically required to share and consume data. The Data Space Connector and the TNO Secure Gateway are good examples of such connectors. Some connectors mentioned later in this report build on and extend generic open-source solutions to provide additional generic open-source solutions or proprietary software.

Generic solutions are provided by companies and organizations as proprietary software for generic usage. Like the open-source solutions described above, they cannot be used directly for sharing and consuming data, but need additional configuration and extension, such as the nicos GAIABOX.

Data connectors are off-the-shelf solutions that are provided as a service or as a directly usable connector solution without requiring any development activities to consume and share data. Nevertheless, configuration and adaption to the companies IT-Services is still needed, but with minimal effort, such as the connector as a service offering by soviety. In extension to such data connector offerings, this report also includes data connectors that are already **integrated in data-related products**, like the Data Intelligence Hub and the Tech2B Connector.













¹²Github: <https://docs.internationaldataspaces.org/dataspace-protocol/overview/readme>.










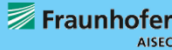



2 Implementations of data connectors

This section provides an overview of some of the available connectors with information about each of them. This list is not exhaustive and will be regularly updated by the IDSA to document progress and new developments.

2.1 Overview of data connectors

Section	Name of connector	Maintainer	Open source
2.2.1	AI.SOV connector	 Cefriel [®] POLITECNICO DI MILANO	
2.2.2	Dataspace Connector (DSC)	 SOVity	✓
2.2.3	ECI IDS Connector powered by TNO	 eci Gatewise [™]	
2.2.4	Eclipse Dataspace Connector (EDC)		✓
2.2.5	EGI Datahub connector	 esi	✓
2.2.6	IDS Integration Toolbox	 open logistics foundation	✓
2.2.7	GAIABOX [®] .IDS. BasicConnector	 NICOS	
2.2.8	IIOC (Intel IONOS Orbiter Connector)	 truzzt	Planned
2.2.9	Kharon IDS Connector	 HOLONIX [®] BRING THINGS TO LIFE	
2.2.10	MPAD-C	 m MONDRAGON UNIBERTSITATEA	✓
2.2.11	OneNet Connector	 ONENET one network for Europe	Planned
2.2.12	Silicon Economy EDC	 open logistics foundation	✓



Section	Name of connector	Maintainer	Open source
2.2.13	sovity Connector		Partially
2.2.14	Tech2B SCSN Connector		
2.2.15	Telekom DIH connector		
2.2.16	TeraLab Connector		✓
2.2.17	TNO Security Gateway (TSG)		✓
2.2.18	Tritom Connector		
2.2.19	TRUE connector		✓
2.2.20	Trusted Connector		✓
2.2.21	Trusted Supplier Connector (TSC)		
2.2.22	VTT DSIL Connector		
2.2.23	WeTech Smart Data Connector		



2.2 Description of the connectors

The connectors are described based on the following aspects:

- Name of the connector
- Logo of the connector or company logo
- Maintainer (company name)
- Type of connector (Based on 1.5, i.e. Data connector framework / open-source generic solution / proprietary generic solution / off-the-shelf solution, either provided as a service or directly usable integrated in data-related products)
- Short description: Describing unique value proposition and/or main field of application (e.g.: cloud, IoT...)
- Maturity level: indicators vary based on the preferences of each company. Examples of indicators are levels of IDS Graduation Scheme¹³, IDS Certification¹⁴, TRL¹⁵.
- License type.
- Features: e.g., usage control capabilities, information model version used, protocols supported.
- Adoption: This field provides information on the application of the connector. It gives visibility to the projects where the connector is used.
- External resources: List of links to other resources to dive deeper into each connector.


¹³ <https://docs.internationaldataspaces.org/knowledge-base/ids-open-source-strategy/ids-graduation-scheme>

¹⁴ <https://internationaldataspaces.org/use/certification/>

¹⁵ https://www.nasa.gov/directorates/heo/scan/engineering/technology/technology_readiness_level Please note that the TRL level provided is based on a self-assessment by the company



2.2.1 AI.SOV Connector

Name of the connector	AI.SOV connector
Logo of the connector or company logo	
Maintainer (company name)	Cefriel
Type of connector	Generic open-source solution, which requires little development efforts or just some configuration. It provides integration via REST API.
Short description	The AI.SOV connector was created based on the open-source Dataspace Connector (DSC). The DSC has been extended to enable data sharing within the AI.SOV Exchange Platform. A Resource Catalogue within the AI.SOV Exchange Platform acts as user interface to allow participants to easily configure a connector. The exchange data rules are based on policy and trust level. Data exchange is purely machine-to-machine.
Maturity Level	TRL 7/8
License type	Closed source software. Please contact Cefriel to know how to licence the AI.SOV connector.
Features	AI SOV adopts the RAM 3.0, the usage control policy includes resource grant access based on user (not only machine) and user based usage of part of the exchanged resource (e.g. only some columns of a csv file)
Adoption	<p>The connector has been deployed in the AI.SOV project. After the completion of the project, the platform has been enriched with an outdoor tracking device called Ologer. The Exchange Platform has been used to exchange AI results in a predictive maintenance context, to exchange project requirements for collaborative design and to collect data from tracking devices (Ologers).</p> <p>The connector and the AI.SOV Exchange Platform are part of a Smart Manufacturing hands-on training offered by Cefriel.</p>



External resources	AI.SOV website ¹⁶ AI.SOV on the EIT Manufacturing website ¹⁷ <ul style="list-style-type: none">• AI.SOV on the Data Space Radar¹⁸
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¹⁶ <https://ai-sov.eu/>

¹⁷ <https://www.eitmanufacturing.eu/news-events/activities/ai-sovereignty/>

¹⁸ <https://internationaldataspaces.org/adopt/data-space-radar/>



2.2.2 Dataspace Connector

Name of the connector	Dataspace Connector
Logo of the connector or company logo	
Maintainer (company name)	sovity
Type of connector	Generic open-source solution
Short description	<p>The Dataspace Connector is an IDS connector that is currently being maintained by sovity. The connector was originally developed at the Fraunhofer ISST.</p> <p>With the help of the Dataspace Connector, existing software can easily be extended by IDS connector functionalities in order to integrate them into an IDS data ecosystem. Furthermore, it is possible to use the Dataspace Connector as a basis for the development of own software that is to be connected to an IDS data ecosystem.</p>
Maturity Level	IDS-Ready and part of the IDS Graduation Scheme
License type	Open-source software
Features	<p>The Dataspace Connector integrates the IDS Information Model and uses the IDS Messaging Services for IDS functionalities and message handling.</p> <p>The core component in this repository provides a REST API for loading, updating, and deleting resources with local or remote data enriched by its metadata. It supports IDS conform message handling with other IDS connectors and components and implements usage control for selected IDS usage policy patterns.</p>
Adoption	The Dataspace Connector has been used in different projects and it is also part of the IDSA Reference Testbed ¹⁹
External resources	<ul style="list-style-type: none"> • Project website²⁰ • GitHub repository²¹


¹⁹ <https://github.com/International-Data-Spaces-Association/IDS-testbed>

²⁰ <https://international-data-spaces-association.github.io/DataspaceConnector/>

²¹ <https://github.com/International-Data-Spaces-Association/DataspaceConnector>



2.2.3 ECI IDS Connector powered by TNO

Name of the connector	ECI IDS Connector - powered by TNO
Logo of the connector or company logo	
Maintainer (company name)	ECI Software Solutions B.V.
Type of connector	Off-the-shelf solution, offered both as a service and integrated in data-related products
Short description	From digital spaghetti to EDI lasagna! No more one-to-one EDI connections, but companies can exchange digital messages with all connected and yet to be connected companies after the one-time connection.
Maturity Level	We are using the TNO IDS Connector live for users of our EDI platform ECI Gatewise. The TNO IDS connector is on its way to become IDS-Certified.
License type	The standardized message format SCSN is open source and specially developed for companies in the manufacturing industry and its suppliers.
Features	We use the TNO IDS connector to exchange digital messages safely and reliably between multiple parties.
Adoption	For our EDI platform ECI Gatewise we use the TNO IDS Connector, and all digital messages are based on the standardized SCSN message format. SCSN is a kind of evolved UBL2.1 message
External resources	<ul style="list-style-type: none"> • ECI webpage²² • Animation explaining SCSN²³ • SCSN process documentation manual²⁴ • SCSN homepage²⁵

²² <https://www.ecisolutions.com/nl/supply-chain-management/gatewise/>


²³ <https://youtu.be/vapiKD3xzbE>

²⁴ <https://smart-connected-supplier-network.gitbook.io/processmanual/>

²⁵ <https://smart-connected.nl/en>



2.2.4 Eclipse Dataspace Components

Name of the connector	Eclipse Dataspace Components
Logo of the connector or company logo	
Maintainer (company name)	Committer Group in Eclipse Foundation
Type of connector	Data connector framework
Short description	<p>Whatever the individual setup is – on-premises bare-metal, different cloud vendors, hybrid, even single end-user machines – the EDC can be customized to work within any environment at scale. The connector’s added value is achieved through the separation of control and data plane, which enables a modular and thereby customizable way to build data spaces. Due to common interfaces and mapping of existing standards, the connector adds capabilities of contract negotiating and policy handling in an interoperable manner. As an open-source project hosted by the Eclipse Foundation, it provides a growing list of modules for many widely deployed cloud environments “out-of-the-box” and can easily be extended for more customized environments, while avoiding any intellectual property rights (IPR) headaches.</p>
Maturity Level	TRL 8-9
License type	Apache 2.0
Features	<ul style="list-style-type: none"> • Modular and highly extensible framework • Separate control and data planes • System is asynchronous and highly available • Policy Negotiation and Data Transfer Orchestration • Transfer processes are fully auditable • Eliminate single points of failure • Cloud aware policy enforcement and projection • Default implementations and blueprints available



Adoption	<ul style="list-style-type: none"> • Catena-X homepage²⁶ • Eona-X • Health-X DataLOFT • Various research projects (PoC phase)
External resources	<ul style="list-style-type: none"> • Source code repository of the EDC connector²⁷ • EDC homepage²⁸


²⁶ <https://catena-x.net/de/>

²⁷ <https://github.com/eclipse-edc/Connector>

²⁸ <https://projects.eclipse.org/projects/technology.edc>



2.2.5 EGI DataHub connector


Name of the connector	EGI DataHub connector
Logo of the connector or company logo	
Maintainer (company name)	EGI Foundation
Type of connector	Generic open-source solution
Short description	<p>The EGI DataHub Connector is based on the Dataspace Connector available open source.</p> <p>Policy based access via IDS to multiple storage backends supported by EGI DataHub (e.g. S3, Swift, NFS, GlusterFS, etc). The EGI DataHub is a high-performance data management solution that offers unified data access across globally distributed environments and multiple types of underlying storage, allowing users to share, collaborate and perform computations on the stored data easily.</p>
Maturity level	TRL 4-5
License type	Planned to become open-source. License type unknown.
Features	<ul style="list-style-type: none"> • All usage control supported by IDSA Data Space Connectors (9 in total) • Information model version 4.2.7 • Protocol supported: https
Adoption	EUHubs4data
External resources	<ul style="list-style-type: none"> • DataHub webpage²⁹ • DataHub documentation³⁰

²⁹ <https://www.egi.eu/service/datahub/>

³⁰ <https://docs.egi.eu/users/data/management/datahub/>




2.2.6 IDS Integration Toolbox

Name of the connector	IDS Integration Toolbox
Logo of the connector or company logo	 silicon economy
Maintainer (company name)	Open Logistics Foundation
Type of connector	generic open-source solution
Short description	The IDS Integration Toolbox (formerly known as Wrapper Toolbox) is a Java framework that aims to help developers to configure and manage the Dataspace Connector (DSC) on code level.
Maturity level	N.A.
License type	Open Logistics License 1.0, based on Apache License 2.0
Features	Support a large feature set of the Dataspace Connector (DSC)
Adoption	Silicon Economy projects
External resources	<ul style="list-style-type: none">• GitLab repository of the IDS Integration Toolbox³¹

³¹ <https://git.openlogisticsfoundation.org/silicon-economy/base/ids/ids-integration-toolbox>




2.2.7 GAIAbOX by nicos AG

Name of the connector	GAIAbOX®.IDS. BasicConnector
Logo of the connector or company logo	
Maintainer (company name)	nicos AG
Type of connector	Generic solution (proprietary software)
Short description	IDS BasicConnector, based on IDS-G specifications and ready to be equipped with additional protocols and/or application-functionalities.
Maturity level	Up and running for and in nicos.testbed.IDS, following given IDS Certification criteria for components. Starting with Certification Trust Level 1 – Assurance Level 1 (Checklist Approach) and preparing for next level of certification.
License type	Closed-source Software
Features	<ul style="list-style-type: none"> • Uses IDS DAPS as identity provider • Ready for VC/VP • Usage Control (subset of IDS Usage Control, plus superset of well-known access control features) • Aligned to current IDS Information Model (IDS-IM) • Works as a Linked Data Platform (LDP, so aligned to W3C “solid”) • Aims to work with gRPC as an additional (but IDS-aligned) application protocol.
Adoption	Used by nicos.testbed.IDS as “Alice and Bob” Base for “Delegated Access Control Service” (expressed by DACL, the “Dynamic Access Control Language”) Base for Clearing House / Logging Service, too (Linked Data Notification, IDS Multipart Message, etc.).
External resources	Homepage will be provided in the next version of the Report.



2.2.8 IIOC (Intel IONOS Orbiter Connector) by truzzt


Name of the connector	IIOC (Intel IONOS Orbiter Connector)
Logo of the connector or company logo	
Maintainer (company name)	truzzt
Type of connector	Generic open-source solution and off-the-shelf solution, offered both as a service and integrated in data-related products
Short description	<ul style="list-style-type: none">• IoT Version of IDSA Connector – compatible to EDC.• Extra resource-saving executable for sensors and small devices.
Maturity level	Connector is already live and usable. Connector is a part of IDSA Base Camp.
License type	Planned as open-source software
Features	DAPS, Connector, Connector Communication, Intel – SGX Protocols supported: https, neuropil, IDSCP2
Adoption	IDS Base Camp Daimler Witte Car Online Logical Unit
External resources	<ul style="list-style-type: none">• Truzzt homepage³²• truzzt GitLab³³

³² www.truzzt.com

³³ <https://gitlab.truzzt.com/ionos/gsc-setup>



2.2.9 Kharon IDS Connector - powered by the Dataspace Connector





Name of the connector	Kharon IDS Connector
Logo of the connector or company logo	
Maintainer (company name)	HOLONIX SRL
Type of connector	Generic solution (proprietary software) and off-the-shelf solution, provided as a service
Short description	IoT data and augmented intelligence results are now manageable through IDS thanks to the integration of the Kharon solution with the Dataspace Connector; this enables companies to enlarge their IoT network interacting with other device providers and users in a secure way keeping sovereignty and industrial confidentiality.
Maturity level	TRL 6
License type	Closed Source Software
Features	We use the dataspace connector to enable multiple parties to retrieve IoT messages safely and reliably.
Adoption	<ul style="list-style-type: none">• Kharon platform• Dat4Zero project European project (G.A.958363)
External resources	<ul style="list-style-type: none">• Holonix website³⁴• Dat4zero website³⁵

³⁴ <https://www.holonix.it/en/>

³⁵ <https://dat4zero.eu/work-packages/>




2.2.10 AD-C by Mondragon

Name of the connector	MPAD-C (Manufacturing Process Anomaly Detection Connector)
Logo of the connector or company logo	 
Maintainer (company name)	 
Type of connector	Generic open-source solution
Short description	The technologies and tools for anomaly detection analysis are not always available within the company and 3rd party experts and algorithms are required to analyze this data. The IDS Connector can assure that this data is used only by the desired company agreeing to the terms established in the contract.
Maturity Level	TRL 4-5 – the solution presented is a prototype using the connector available in Github where we have implemented/tested different control capabilities and connection modes (direct, subscription ...).
License type	Open-source software
Features	Different control capabilities (temporarily, certificates ...) have been implemented, as well as connection modes (direct, subscription ...) creating different resources in the IDS Connector.
Adoption	QU4LITY project homepage ³⁶
External resources	The repository is currently closed for the Qu4lity consortium. Updates will be provided in the next versions of this Report.

³⁶ <https://qu4lity-project.eu/>



2.2.11 OneNet Connector

Name of the connector	OneNet Connector
Logo of the connector (or company logo)	
Maintainer (company name)	Engineering Ingegneria Informatica S.p.a. and EUROPEAN DYNAMICS Luxembourg S.A.
Type of connector	Generic open-source solution
Short description	<p>The OneNet Connector, based on TRUE Connector, aims to enable a European Energy Data Space, combining the IDS principles with the advantages of the FIWARE ecosystem ensuring a seamless and secure data exchange in a completely end-to-end decentralized approach. The OneNet Connector is ready to be deployed and integrated in any existing platform and offers user-friendly interfaces (both as REST APIs and GUI) enabling users and platforms to share data. In addition, the OneNet Connector offers a pre-defined, dynamically evolving list of Cross Platform Services, business objects and corresponding Data Profiles is available enabling semantic and data interoperability.</p>
Maturity level	TRL 4 – The OneNet Connector was already validated in development environments and the validation in real environments is ongoing. Targeting TRL 8 at the end of the OneNet project.
License type	Upon project conclusion, it will be open source under a GPLv3 or similar license.
Features	<ul style="list-style-type: none"> • Ready-to-go, ready to be installed in any environment and integrated with existing platforms via APIs • Fully integrated with the FIWARE Context Broker (in the NGSI-LD version) • Offers a rich graphical user Interface for connector's configuration and for a series of additional services (KPI's, data exchange timeline, cross-platform services catalogue, vocabularies, etc.) • Facilitates through the GUI or via API the data exchange process, and extends the interaction between data producer/consumer by providing an




	<p>"offered service" handshake and publish/subscribe mechanisms, accordingly</p> <ul style="list-style-type: none"> • Integrates additional services for data harmonization • Can be integrated with third-party Identity Management Services • Supports more than 60 different harmonized services and data profiles in the smart grid and energy field, but can be easily extended with additional services also in other domains • Further features under development: Marketplace for energy applications, Identity Management and Data Access Policies, Data Quality checking, Resource Management and Usage Control, and an "orchestration workbench" that allows participants to deploy and evaluate their own services on data coming from the OneNet system and integrate it with analytics and data visualization.
Adoption	<p>The connector is being developed and tested in the OneNet project, that has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 957739. A preliminary integration test was also conducted in Platone and INTERFACE H2020 projects.</p>
External resources	<ul style="list-style-type: none"> • OneNet homepage³⁷ • Source Code: it will be available in GitHub upon project completion.

³⁷ <https://onenet-project.eu/>




2.2.12 Silicon Economy EDC

Name of the connector	Silicon Economy EDC
Logo of the connector or company logo	
Maintainer (company name)	Open Logistics Foundation
Type of connector	Data connector framework and generic open-source solution
Short description	The Silicon Economy EDC is a configured version from the Connector of the Eclipse Dataspace Components (EDC). It is used and specialized to easily integrate Silicon Economy components with the IDS.
Maturity level	N.A.
License type	Open Logistics License 1.0, based on Apache License 2.0
Features	<ul style="list-style-type: none"> • Data Exchange between HTTP-backends • IDS-Multipart protocol supported • separated control and data plane
Adoption	Silicon Economy projects
External resources	<ul style="list-style-type: none"> • GitLab repository of the Silicon Economy EDC³⁸

³⁸ <https://git.openlogisticsfoundation.org/silicon-economy/base/ids/silicon-economy-edc>



2.2.13 soivity Connector

Name of the connector	soivity Connector
Logo of the connector or company logo	
Maintainer (company name)	soivity GmbH
Type of connector	Off-the-shelf solution offered as a service
Short description	The easiest access to sovereign data exchange with Connector-as-a-Service: Industry-ready Connector based on open-source software like Eclipse Dataspace Connector (EDC) and Dataspace Connector (DSC). The soivity Connector can be used as manages solution compliant with key data space initiatives like IDSA, Catena-X or Mobility Data Space.
Maturity level	TRL 8-9 – in productive use, IDS Ready, approved for IDS graduation (IDS Sandbox).
License type	Open core software: based on open-source components, enriched with key features as commercial version. A community version as open source will be available soon.
Features	<ul style="list-style-type: none"> • The Connector-as-a-Service by soivity provides easiest access to data spaces. • Highly automated deployment, scaling and integration. • Usage via user friendly frontend without deep technical skills. • Connects to data sources and sinks (REST, data bases or via Camel). • Communication between EDC federated catalog and IDS Broker • Exchanges data between IDS Connectors based on HTTP Multipart and IDSCP protocols. • Use of IDS Apps and Routes to incorporate business logic. • Enforcement of Usage Control based on IDS standards.



	<ul style="list-style-type: none"> • Eclipse Dataspace Components Connector (EDC) and Dataspace Connector (DSC) •
Adoption	<ul style="list-style-type: none"> • Excerpt of projects and use cases: • Mobility Data Space • soivity product • Catena-X • IDSA Testbed • Demand and capacity app • Application to calculate estimated time of arrival
External resources	<ul style="list-style-type: none"> • EDC framework³⁹ • EDC components⁴⁰ • soivity product open-source components⁴¹


³⁹<https://github.com/eclipse-edc/Connector>

⁴⁰<https://github.com/International-Data-Spaces-Association/DataspaceConnector>

⁴¹<https://github.com/soivity>




2.2.14 Tech2B SCSN Connector

Name of the connector	Tech2B SCSN Connector
Logo of the connector or company logo	
Maintainer (company name)	Tech2B
Type of connector	Off-the-shelf solution integrated in data-related products
Short description	NextGen manufacturing ecosystem to enable data sharing, resulting in an optimized and transparent international supply chain. Significantly accelerating adoption of digitalization by appealing to small & medium sized enterprises in the manufacturing and adjacent industries.
Maturity level	TRL 8 - actual system completed and operational and extensively tested in test and staging environments.
License type	Closed Source Software
Features	<p>Supported Models: Request, Quotation, Order, Order Response, Invoice</p> <p>Use Cases:</p> <p>1on1 Transactions: Share daily order transactions with suppliers that have none or an outdated software system. Standardized, secure and easy to use for companies without digitization knowledge, to build a future-proof and connected supply chain.</p> <p>Supply & Demand: Enable the opportunity for buyers to use the reach of our network in the quotation phase. Our service provider will act as a proxy to place incoming RFQ on Tech2B Supply & Demand and return the quotations directly to the buyer.</p>
Adoption	Smart Connected Supplier Network - Market 4.0
External resources	<ul style="list-style-type: none"> • Tech2b homepage⁴²

⁴² <https://www.tech2b.cc>



2.2.15 Telekom DIH connector

Name of the connector	Telekom DIH connector
Logo of the connector or company logo	
Maintainer (company name)	T-Systems International GmbH
Type of connector	N.A.
Short description	Based on the Eclipse Data Connector (EDC) – an up-and-coming, extensible connector development framework. We provide managed EDC service which is compliant with IDSA specification as well as DSC.
Maturity level	Preparing for IDS Certification (Trust Level 1 Assurance Level 2)
License type	This EDC extension work is conducted within GX4AI project, which requires the result delivered in open source. Therefore, we will open-source part of our work, within GX4AI delivery.
Features	<ul style="list-style-type: none"> • Sovereignty: Connect to existing and emerging dataspace, to enable data transactions with sovereignty protection. Interoperability: one connector solution to be compatible with any platforms and ecosystems, including contract negotiation from edc to dsc/ dsc to edc, filetransfer from edc to dsc/ dsc to edc. • Reliable and efficient: cloud agnostic • Info Model Version: 4.1.3 • Protocols: IDS • Identity provider: DAPS
Adoption	The connector can be used I autonomous driving, robotic production, ML training pipeline The connector is used in the Data Intelligence Hub and in the GAIA-X4AI as a sub-project of the project family "GAIA-X 4 Future Mobility" in the mobility domain of the German Gaia-X Hub.



External resources	<ul style="list-style-type: none">• Eclipse Dataspace Connector repository⁴³• Data Intelligence Hub (DIH) homepage⁴⁴• Gaia-X4AI project website⁴⁵ (The project is part of the GAIA-X 4 Future Mobility⁴⁶)
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⁴³ <https://github.com/eclipse-dataspaceconnector/DataSpaceConnector/>


⁴⁴ <https://dih.telekom.com/en/>

⁴⁵ <https://gaia-x4ki.eu/>

⁴⁶ <https://www.gaia-x4futuremobility.dlr.de/>



2.2.16 TeraLab Connector

Name of the connector	TeraLab Connector
Logo of the connector or company logo	
Maintainer (company name)	TeraLab
Type of connector	Generic open-source solution
Short description	Test connector used to get familiar with IDS and interact with EUHubs4Data partners. It is based on the Dataspace Connector ⁴⁷ (v8.0.2).
Maturity level	TRL 3 – experimental proof of concept
License type	Proprietary
Features	<ul style="list-style-type: none"> • RAM Version: 3.0 • Info Model version: 4.2.7 • Protocol: HTTPS / multipart • Usage Control Capabilities: in line with the Dataspace Connector v8.0.2
Adoption	TeraLab Marketplace: Enabling data to move between the Marketplace and the connector using a back-end server.
External resources	<ul style="list-style-type: none"> • TeraLab Marketplace⁴⁸ • Code repository: internal (protected in a private network) • TeraLab Connector URL⁴⁹


⁴⁷ Dataspace Connector repository: <https://github.com/International-Data-Spaces-Association/DataspaceConnector/blob/main/LICENSE>

⁴⁸ <https://marketplace.teralab-datascience.fr/home>

⁴⁹ <https://ws37.tl.teralab-datascience.fr:30089>



2.2.17 TNO Security Gateway (TSG)


Name of the connector	TNO Security Gateway (TSG)
Logo of the connector or company logo	
Maintainer (company name)	Netherlands Organization for Applied Scientific Research (TNO)
Type of connector	Generic open-source solution
Short description	Multi-purpose connector
Maturity level	Preparing for IDS Certification (Trust Level 1 Assurance Level 2).
License type	Open-source software under Apache 2
Features	Technological stack: Kotlin combined with Spring Boot & Apache Camel, IDS Multipart & IDSCPV2, Kubernetes/Docker.
Adoption	Used in several projects, e.g., Smart Connected Supplier Network (SCSN).
External resources	<ul style="list-style-type: none">• Architecture & connector documentation repository⁵⁰• SCSN process documentation manual⁵¹

⁵⁰ <https://tno-tsg.gitlab.io/>

⁵¹ <https://smart-connected-supplier-network.gitbook.io/processmanual/>




2.2.18 Tritom Connector

Name of the connector	Tritom Connector
Logo of the connector or company logo	
Maintainer (company name)	DataSpace Europe Oy
Type of connector	Off-the-shelf solution provided as a service
Short description	Enables data source and target systems technical connectivity to the Tritom service to produce services based on data sovereignty principles. Tritom also brings together ecosystem parties and provides the capabilities to create data and service catalogues.
Maturity level	TRL 7 – system prototype demonstration in operational environment.
License type	Proprietary commercial license.
Features	End-to-end encryption. Consent management. Supports data channel and data set descriptions configured in the Tritom solution. REST protocol for sending/receiving data.
Adoption	Tritom solutions.
External resources	Tritom - the solution DataSpace Europe ⁵²

⁵² <https://www.dataspace.fi/en/tritom-as-a-solution>



2.2.19 TRUE Connector by Engineering

Name of the connector	TRUE Connector
Logo of the connector or company logo	
Maintainer (company name)	ENGINEERING INGEGNERIA INFORMATICA SpA
Type of connector	Data connector framework
Short description	The TRUE Connector enables trusted data sharing in order to be an active part of an IDS ecosystem, a virtual data space leveraging existing standards and technologies, as well as governance models well-accepted in the data economy, to facilitate secure and standardized data exchange and data linkage in a trusted business ecosystem. The TRUE connector is also part of the FIWARE Catalogue: the integration of existing FIWARE ecosystems is guaranteed by the dedicated Data APP, enabling the IDS-based interaction in a plug-and-play way.
Maturity level	TRL 6 – part of the IDSA Graduation Scheme (Sandbox). Preparing for IDS Certification (Trust Level 1 Assurance 2).
License type	Open-source software and part of the IDSA Graduation Scheme (Sandbox), released under aGPLv3 license
Features	<ul style="list-style-type: none"> • OSS Usage Control (it can work also with FhG MyData optionally) plus Personal Data/GDPR Enforcement (integratable with ENG CAPE digital solution). • Information Model 4.1.1HTTP/HTTPS, WS over HTTPS, IDSCPv2
Adoption	<p>The connector is used in the following projects:</p> <ul style="list-style-type: none"> • MARKET4.0 • AI REGIO • EUR3KA • PLATOON • MUSKETEER • ONENET



External resources


- Engineering website⁵³
- TRUE connector repository⁵⁴

⁵³ <https://www.eng.it/en/case-studies/true-connector-per-facilitare-la-condizione-di-dati-in-gaiax>

⁵⁴ <https://github.com/Engineering-Research-and-Development/true-connector>



2.2.20 Trusted Connector by Fraunhofer AISEC

Name of the connector	Trusted Connector
Logo of the connector or company logo	
Maintainer (company name)	Fraunhofer AISEC
Type of connector	Generic open-source solution
Short description	<p>IoT edge and cloud platform "Trusted Connector" for the International Data Spaces.</p> <p>The connector is based on Spring Boot, includes Camel message routing, IDSCP2 support as well as IDS-Multipart and a management web console. It allows for remote attestation between connector instances and enforcement simple Usage Control contacts, limiting processing containers and allowed time of usage</p>
Maturity level	<p>IDS Ready Review, v1.1, 14.01.2021</p> <p>TRL 5</p>
License type	Open-source software (Apache 2)
Features	<p>It supports Docker and trust me as containerization environments and provides the following features:</p> <ul style="list-style-type: none"> • Message routing and conversion between protocols with Apache Camel • Apps in isolated containers • Data flow- and data usage control • IDSCP2 for secure communication and remote attestation between Connectors. <p>The Trusted Connector has acquired the IDS_ready label. Trusted Connector is a composite of the Core Container and the overall system.</p>
Adoption	Several research projects, first customer evaluations, first adoption in industrial context.
External resources	<ul style="list-style-type: none"> • Trusted Connector repository on the IDSA GitHub⁵⁵

⁵⁵ <https://github.com/International-Data-Spaces-Association/trusted-connector>




- Trusted Connector code repository on the Fraunhofer GitHub⁵⁶
- Trusted Connector user documentation⁵⁷

⁵⁶ <https://github.com/Fraunhofer-AISEC/trusted-connector>

⁵⁷ <https://industrial-data-space.github.io/trusted-connector-documentation/>




2.2.21 Trusted Supplier Connector (TSC) by German Edge Cloud

Name of the connector	Trusted Supplier Connector (TSC)
Logo of the connector or company logo	
Maintainer (company name)	German Edge Cloud GmbH & Co. KG
Type of connector	N.A.
Short description	The TSC can be used in any industry or domain. It stands out in its usability and operability in an enterprise context, especially for non-technical people. The TSC strives to be interoperable with all major IDS Connectors available.
Maturity level	„IDS_ready“ Tested interoperability with major IDS Connectors on the market
License type	Closed Source Software
Features	Supported Protocols: IDS Header, IDS Multipart Contract Negotiation, Usage Control, Info Model 4.1.0
Adoption	<ul style="list-style-type: none"> • ICNAP Data Space project • Fraunhofer Edge Cloud • SmartFactory-KL with TNO
External resources	<ul style="list-style-type: none"> • GEC homepage⁵⁸

⁵⁸ <https://www.gec.io>




2.2.22 VTT DSIL Connector by VTT Technical Research Centre of Finland

Name of the connector	VTT DSIL Connector
Logo of the connector or company logo	
Maintainer (company name)	VTT Technical Research Centre of Finland
Type of connector	Off-the-shelf solution
Short description	The VTT DSIL Connector extends the dataspace connector reference implementation with two additional features: support for OPC UA communication protocol and user / role-based access management of shared data resources. Main field of application is in the manufacturing sector.
Maturity level	As the VTT DSIL connector is based on the Dataspace connector, the maturity level is the same. The Dataspace connector is labelled as "IDS_ready component" and it is tested for the base certification level.
License type	Closed-source software
Features	<ul style="list-style-type: none"> • The connector supports the enforcement of eight usage condition classes of the International Data Spaces Association. • Supported Info Model versions: Outbound: "4.2.7"; Inbound: "4.0.0", "4.1.0", "4.1.2", "4.2.0", "4.2.1", "4.2.2", "4.2.3", "4.2.4", "4.2.5", "4.2.6", "4.2.7". • Protocols supported: Multipart, IDSCP2
Adoption	<ul style="list-style-type: none"> • OSME (Open Smart Manufacturing Ecosystem) project; manufacturing supply chain transparency use case • TRUSTEE project; multi-disciplinary data exchange pilot
External resources	IDSA Hub Finland ⁵⁹

⁵⁹ <https://www.idsa-finland.fi/>



2.2.23 WeTech Smart Data Connector

Name of the connector	WeTech Smart Data Connector
Logo of the connector or company logo	
Maintainer (company name)	WeTech Holding Co., Limited
Type of connector	N.A.
Short description	<p>With the standard data usage strategy and asymmetric encryption technology defined in IDS, this connector achieves safe and reliable data transmission between the data sharing parties, and the implementation of the data provider's policies in the control of data usage time interval, usage times, usage methods and other policies. It can be applied to the sharing, use and control of important official documents, finance data, and market or business opportunities etc. between internal departments of large enterprises.</p> <p>A big tech firm in China has been using the connector, and its reliability has been proven.</p>
Maturity level	Preparing for IDS Certification (Trust Level 1 Assurance Level 2)
License type	Closed-source software
Features	Technological stack: Java, IDSCP, Personal Host
Adoption	Cross-border data sharing for a major Chinese telecom operator
External resources	



3 Additional initiatives and promising emerging solutions

In addition to the existing IDS-based data connectors described above, other approaches also support data sharing in data-driven business ecosystems and data spaces. The diversity of data sharing requirements, all based on confidentiality, regulatory aspects, technology limitations and more, leaves room for additional initiatives and promising (new) technologies. To realize the full potential of the available data, all data sharing approaches need to be interoperable – therefore IDSA is building a global standard for data connectors, gradually including other technologies and concepts. As this is the project of many years, we will conduct an ongoing assessment, and continuously update this section with further information and items on the list:

- Ocean Protocol: The Ocean Protocol is a comprehensive framework for data services in crypto ecosystems. Based on crypto tokens it provides mechanisms for smart contracts, marketplaces, and compute 2 data. It is available as open source. For more information visit their website⁶⁰
- OKP4 Protocol: OKP4 is a domain-specific layer-1 dedicated to trust-minimized data sharing. The blockchain orchestrates assets shared by participants in the Data verse: data, algorithms, software, storage and computation to enable a new generation of applications. Any contributor earns rewards thanks to these new value chains. For more information visit their website⁶¹

⁶⁰ <https://oceanprotocol.com/>

⁶¹ <https://okp4.network/>



4 Other technologies contributing to trustworthily share data

Data sharing in data spaces is built on more than the use of data connectors in distributed networks. A soft data infrastructure based on centralized or decentralized essential services is the foundation for data sharing. This is not just technology put into practice, but it provides a frame for solutions based on the BLOFT thinking (business, legal, operational, functional, technological) that span data spaces. Additionally, it makes a difference if the data to be shared is personal data or not, and whether the data is shared by an organization, a service or an individual. Various initiatives and approaches work on these aspects. We will list some of them below and continue to assess and expand on them.

- Gaia-X trust framework⁶² and GXFS⁶³
- iShare trust framework⁶⁴
- MyData Operators⁶⁵
- SOLID⁶⁶

Data connectors and the soft data infrastructure do not aim to reinvent the wheel, but to use common standards and frameworks and combine them into a comprehensive solution. Important standards to consider are for the realization of identity and access management, claim management, data and data contract policies. Some of the relevant standards are listed below:

- The W3C Tech Stack:
 - RDF⁶⁷
 - ODRL⁶⁸
 - DCAT⁶⁹

⁶² <https://gaia-x.eu/gaia-x-framework/>

⁶³ <https://www.gxfs.eu/>

⁶⁴ <https://ishare.eu/>

⁶⁵ <https://oldwww.mydata.org/mydata-operators/>

⁶⁶ <https://solidproject.org/>

⁶⁷ <https://www.w3.org/RDF/>

⁶⁸ <https://www.w3.org/TR/odrl-model/>

⁶⁹ <https://www.w3.org/TR/vocab-dcat-3/>



5 Conclusion

The goal of this report is to demonstrate the importance of data connectors, highlight the diversity of their usage, capabilities and functionalities and list examples of existing data connector implementations. It also includes insights into emerging and enabling technologies to ensure a more complete overall picture. The report will be published monthly to support the continuous assessment and development of data connectors, providing clarity on their application potential, maturity, certification status, as well as their adoption in industrial use cases and research.

Feedback and suggestions, information on new connectors or updates on connectors already listed in the Report can be provided to the IDSA Head Office via this contact form⁷⁰



⁷⁰ <https://forms.office.com/r/gbu1yv9K25>

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