INTERNATIONAL DATA SPACES ASSOCIATION

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Data Sovereignty – **Critical Success Factor for the Manufacturing Industry**

- (●) Position Paper of members of the IDS Association and of the IDS-Industrial Community
- ( ) Position Paper of bodies of the IDS Association
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1 Introduction

“The development of a sovereign European data infrastructure is a key project for the competitiveness and digital innovative strength of our economy and for future-proof jobs in Germany and Europe.” said Peter Altmaier, German Federal Minister for Economic Affairs and Energy in September 2020[1].

This applies in particular to the manufacturing industry, requiring digitalization to face global competition. Data sharing within factories and in the wider manufacturing ecosystems is a corner stone of the Industry 4.0 movement. Successful data sharing in industrial environments requires data sovereignty: enabling manufacturing companies to retain control over the collection and usage of their data.

Therefore, this document describes how data sovereignty and its main concepts explicitly support the manufacturing industry to keep competitive advantages, to fulfill customers' requirements better, to increase the Overall Equipment Effectiveness (OEE), to create and implement new and future orientated business models and services with the trusted use of more data that is available today.

In the following sections the main concepts of Data Sovereignty are briefly introduced. It is identified how and in which areas these concepts can be leveraged by the manufacturing industry and their customers. Find out if there are areas that are also beneficial for your company. Examples are given together with a recommendation to invest in these concepts.

Finally, this position paper describes how the concepts of the International Data Spaces (IDS) will enable manufacturing companies to scale and grow with data.

[1] https://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2020/09/20200915-zitat-altmaier-zur-gruendung-der-gaia-x-aisbl.html

2 Manufacturing industry benefiting from data sovereignty

2.1 Data driven competitiveness

Manufacturing companies seek to improve their operations and strategic positioning in an increasingly competitive global landscape. Costs need to be reduced, quality improved and at the same time flexibility and agility is required to adapt to changes and to the needs of the customer. Industry 4.0 and digitalization are bringing new opportunities in this field.

Focus areas for manufacturing companies include:

- **Collaboration with customers, suppliers and service providers** to improve supply chain visibility, work together on design, engineering, manufacturing, support and logistic challenges. These collaborations are resulting in supply networks, which are more agile, allow more customized products, enable companies to specialize and reduce the time-to-market. Data sharing is a critical enabler to lower transaction costs and to introduce new collaborative platforms for product design, supply networks, long-term maintenance and lifecycle management.
- **Modular and more flexible manufacturing** with many industries changing from mass-production to mass-customization and even custom-made production. To implement this, the manufacturing environment needs to be adaptive. This ranges from being able to reconfigure a production line or machine, to responding to changes coming from the internal organization or customer/suppliers and support operators working in such environments. Data sharing is needed for 'plug & produce' concepts in which manufacturing equipment needs to be quickly re-configured when changes are needed in a production line.
- **Improvement of quality and lowering of maintenance costs** by the collection, aggregation, and analysis of data. This enables the shift to zero defect manufacturing and the involvement of third parties in the maintenance of products and manufacturing equipment (collaborative condition monitoring / predictive maintenance).

The scalable sharing of data, very often company-internal confidential data, with many different systems and stakeholders is the basis for these kinds of collaborations.

2.2 Digital sovereignty: interoperability + data sovereignty + cloud sovereignty

Different vendors need to work together on open standards and infrastructure with no vendor lock-in. This is a critical issue in particular for small and medium sized enterprises, which cannot afford the investment in custom-made standards and architectures.

Organizations need to work together. However, with data becoming such a strategic asset, it is important to be able to align data sharing approaches as well as business

models and interests. New platform business models help manufacturing companies to retain a competitive edge to new intermediaries.

Trusted infrastructures are strongly required to share data between organizations. They should not only control the access, but also the usage of the data after the data has been accessed. Companies need to be able to make informed choices over edge, private cloud and public cloud infrastructure and other service offers. The emerging 5G networks together with increasing IoT connectivity of nearly all assets drive the confluence of data sharing and the development of edge and cloud infrastructures.

Further important aspects to be considered are:

- **Scaling** is required: It is no longer sufficient to connect two separate machines or two separate companies. Concepts are required to connect entire supply networks and large-scale production machinery, often over multiple sites.
- Data needs to be stored and shared for a **longer period**. Whereas in a traditional industrial control system data is primarily used in real time, many Industry 4.0 concepts require the storing and sharing of data during a larger timeframe for example during a complete product lifecycle. For instance, to use the data to train future AI algorithms or to use it as part of future recycling or re-configuration of a product.

This adds **complexity** which is difficult to manage with current approaches. For instance: how to find and link so much data? How to ensure data security over the time, especially when multiple systems and companies are involved?

Data-related security is a significant requirement today that must be considered according to the results of a security management analysis, e.g. according to IEC 62443 or regulatory laws and standards.

Imagine a scalable technology existed, where all parties in these networks could work effectively together in a secure, standardized, certified, and trusted environment. For example, a manufacturing company would replace a supplier with another supplier with a better service on the fly and data could be easily shared between the two parties in a secure manner directly from the beginning of the collaboration. Scalability in a collaborative manufacturing space also offers potential to position available capacities in the network easily with very less effort. Instead of plug and produce/play you then have plug, share and exchange.

2.3 Ability to execute

Europe and in particular Germany is the leading region in Manufacturing and Automation technology. There are many contributors to this success. Europe has a lot of successful machine builders such as Trumpf, Arburg, Schuler and many others, as well as a large pool of highly educated engineers, advanced universities, research centers, innovative suppliers, and service providers. It is a collaborative success of industry, academic organizations, and politics.

As illustrated in Figure 1 the manufacturing industry is the industry willing the most to share data[2].

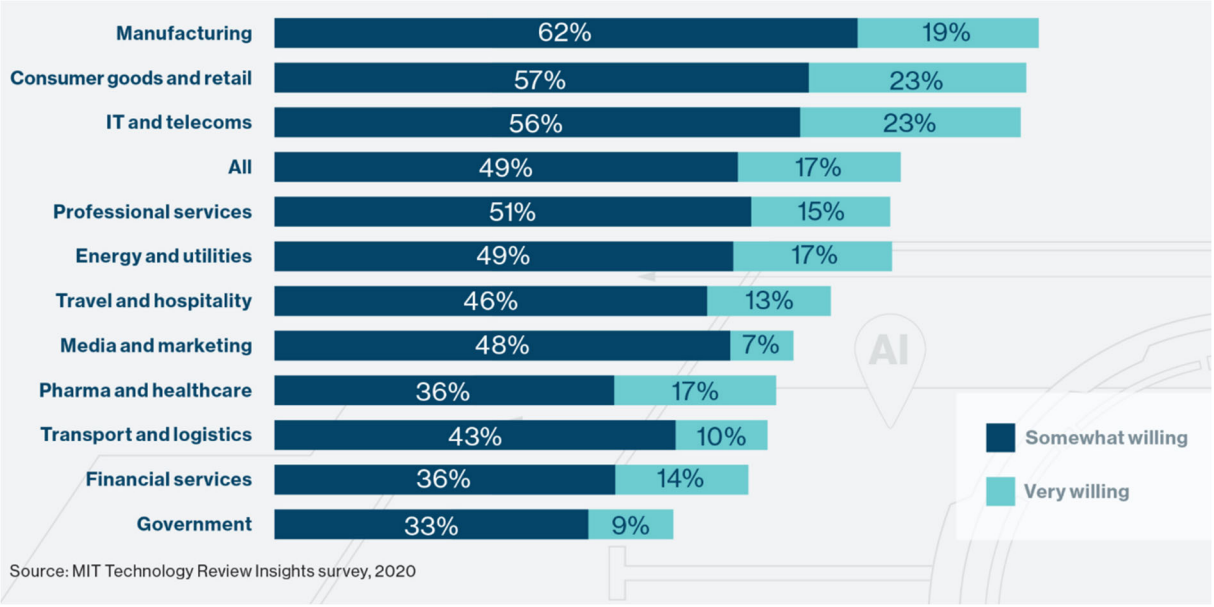


Figure 1: Willingness of Industries to share internal Data with third Parties for the Purpose of building new Value Chains, Products, or Services

The opportunity of sharing data in a secure and sovereign manner by implementing the concepts of data sovereignty supports the manufacturing industry in the following processes or segments. This list is not claiming to be complete.

- Self-registry and completing a digital twin with manufacturer information

  Assets are strategically managed in asset management systems throughout their lifecycle to maximize their business value. A self-registry of an asset to such a system could automatically create such an asset master in the system landscape of your customer to avoid the manual and incorrect creation. Here customer specific data are securely transmitted, completed or updated by the manufacturer to the customer or user of the sold asset.

- Data centered business models and services

  With better knowledge of your customer or his business by sharing confidential data with you as manufacturer, new business models could be offered. For example, instead of selling the machine you may now operate the machine at the customer site and charge a usage fee or the output of this machine. As an example, for data-centered business models, instead of selling a compressor you sell compressed air in a certain quality and availability during the working day.

  Besides that, you are capable to provide customer specific and additional services with the knowledge how and under which circumstances your products are used

[2] https://www.technologyreview.com/2020/03/26/950287/the-global-ai-agenda-promise-reality-and-a-future-of-data-sharing/

by your customer. Today's industrial machines have many sensors that produce valuable data your customer could share with you. Based on the usage information a manufacturer could provide for example:

- Predictive Maintenance
- Pay per use or other financial offerings
- Recommendations for the improved operation of the machine
- Early offer for a new replacement machine
- Timely spare parts delivery
- Specific service offerings

- Collaborative Scenarios between different parties
  - Spare part business

    The Spare part business is changing from a transactional to collaborative supply-chain model. Greater data visibility and faster information sharing has resulted in improved productivity, shorter lead times, faster procurement processes, and increased integration between planning, procurement, and usage. This leads to significant reductions of inventory held across the complete supply chain.

  - Circular economy

    A circular economy is an economic system aimed at eliminating waste and the continual use of resources[3]. To develop to a circular economy, data has to be exchanged and investigated during the complete lifecycle of a product and between the most involved parties from the engineers or designer who developed the product up to the user of the product and the disposal company.

  - Collaborative Configuration Management

    As manufacturing changes to more collaborative and distributed supply chain models, the proportion of software and the configuration capabilities in manufacturing companies is increasing. Configuration has to be adopted depending on regular changing requirements and optimized along the complete supply chain. This makes the exchange of process and configuration data between the involved parties even in a distributed manufacturing networks necessary.

  - Distributed manufacturing networks or marketplaces

    The term distributed manufacturing networks refers to a provider that has access to a network of different manufacturers. Customers upload their CAD data on a website and after a short time receive a list of suppliers who can manufacture this component. In this list the customer also finds the respective

[3] https://en.wikipedia.org/wiki/Circular_economy (Wikipedia)

price offer of the supplier. By ordering via the website, the distributed manufacturing network receives a commission from the manufacturer.

- Connected manufacturing

  Connected manufacturing connects the varying scheduling applications of the suppliers along the whole supply chain. It aims to enable the sovereign exchange of data about orders, articles and estimated delivery dates. The connected planning tools should then be able to automatically transmit relevant data to each other and update their schedules accordingly.

- Risk management in supply networks

  In order to lower the risks of failed delivery of products or material due to unforeseen events such as natural disasters, pandemic diseases or political unrest, it is necessary to permanently investigate alternate suppliers, organize them in supply networks and associate multiple risks to the supply chains. Using automatized data acquisition from multi-media and applying machine learning techniques, these risks could be permanently calculated and assessed against pre-defined risk levels.

- Supply chain planning and supply chain transparency

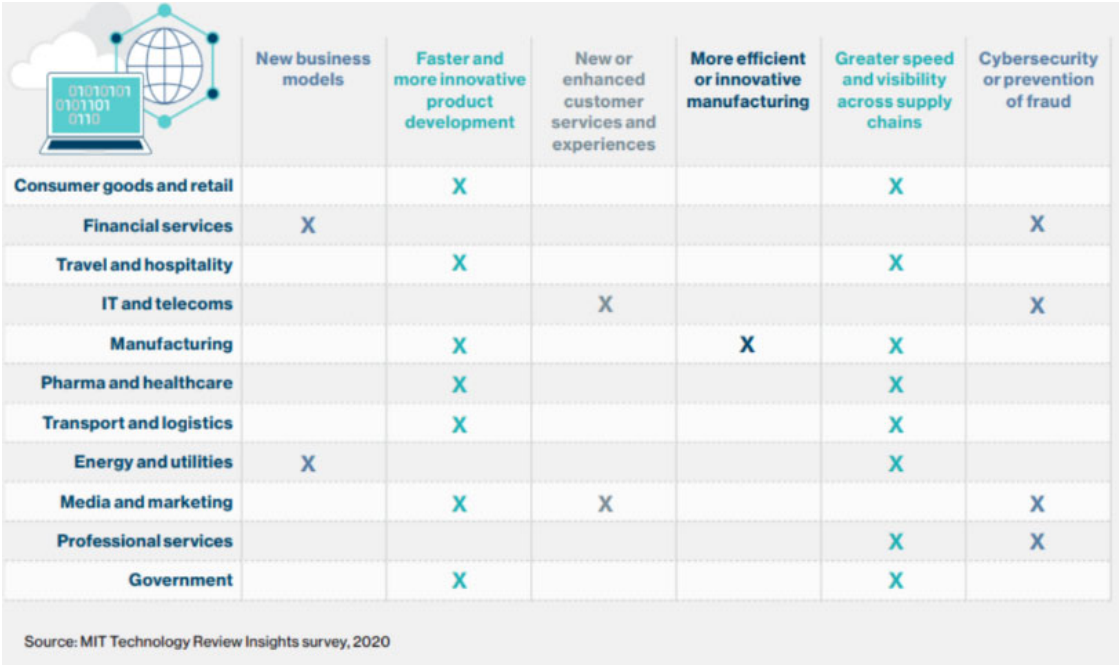
  Supply chain planning and supply chain transparency could make sense in collaboration with your customer and supplier, where you as manufacturer share relevant manufacturing data like inventory levels, production progress, order milestones, order completing dates or quality parameters. With data sovereignty, you are capable to share specifically the data that is relevant to a partner at that point in time for a specific use and benefit. For example, to increase the transparency towards your customers to maximize customer loyalty. Furthermore, sustainability goals such as the calculation of CO2 footprints over complete supply chains require dedicated sharing of ecologically relevant data over the complete supply chain. Other drivers for more transparency are ethical and social requirements, e.g., the demand to exclude child labor in the mining of raw materials.

- Faster and more innovative product engineering

  Complex and fast development or engineering of products[4] in today's competitive world is only possible if you integrate your suppliers, the supplier of your suppliers and partners closely into this process. Sharing data here is essential and mostly you share trustworthy information. To keep a competitive advantage, you have to focus on your core strength. By doing this you rely on

[4] https://www.technologyreview.com/2020/03/26/950287/the-global-ai-agenda-promise-reality-and-a-future-of-data-sharing/

others that have their strengths in other areas. Data sovereignty and security concepts are the key successor to do so.



	New business models	Faster and more innovative product development	New or enhanced customer services and experiences	More efficient or innovative manufacturing	Greater speed and visibility across supply chains	Cybersecurity or prevention of fraud
Consumer goods and retail		X			X	
Financial services	X					X
Travel and hospitality		X			X	
IT and telecoms			X			X
Manufacturing		X		X	X	
Pharma and healthcare		X			X	
Transport and logistics		X			X	
Energy and utilities	X				X	
Media and marketing		X	X			X
Professional services					X	X
Government		X			X	

Source: MIT Technology Review Insights survey, 2020

Figure 2: The greatest perceived Benefits of Data sharing, by Industry

- Subcontracting with or without provisioned material

  Subcontracting with or without provisioned material is a collaborative and very common manufacturing strategy to overcome capacity bottlenecks. Furthermore, subcontracting helps to integrate processes that lay outside the technological core competence of a company.

- Collaborative Condition Monitoring (CCM)

  The basis for CCM[5] is Big Data and fundamental access to it by all players. Only then it is possible to recognize recurring patterns in the operating behavior of individual components or to analyze the long-term wear of a machine. Simply put, the more data that is available from multiple sources, the clearer the insights gained from the data. And these insights are beneficial for all players in the value network.

- Multilateral data exchange

  If more parties exchange data, the situation becomes more complex. Clear guidance for standardized security requirement and data sovereignty must be established.

[5] https://www.plattform-i40.de/PI40/Redaktion/DE/Kurzmeldungen/2020/2020-02-18_Collaborative-Condition-Monitoring.html

- Data Analytics: AI-enabled use cases live from tremendous high amount of relevant data, the more the better. AI-enabled use case examples in manufacturing are:

  - Anomaly Detection

    The objective is, at an early stage, to detect if the status of a technical system differs from a "normal" one, such that there is a high probability that something will go wrong before someone (e.g. an operator) will notice it and especially before it will actually occur. These use cases are already reality for some types of locomotives, some types of engines, machines and pumps. Anomaly detection is typically based on machine learning and can only achieve a high quality if the amount of relevant operational data is sufficient. Usually, these data sets are not controlled by one company alone, hence there is a need for data between all companies who are involved.

  - Predictive Maintenance

    This is the holy grail of the Maintenance Community and at the same time it is currently the most unreliable. The algorithms and the achieved quality are not sufficient, because valuable data is lacking. Again, bringing usage data together from partners and even competitors can be of great benefit for all participants, if you want to predict maintenance. Lack of trust can be reduced by adding data sovereignty concepts and services.

  - AI-enabled new business models

    These new or even disruptive business models comprise a further holy grail for management boards. They generate chances but also risks. Renting products instead of selling them, selling services instead of products or machines is resulting in a more long-term customer relationship. In order to achieve this in a profitable manner anomaly detection and predictive maintenance should be mastered. There are very few early movers who already drove this to a successful new pillar of their company. As a positive example, Heidelberger Druckmaschinen with their Heidelberg Cloud[6] as a central service platform for remote maintenance and other remote services can be named. They achieved the trust of their customers with 90% sharing their data within the Heidelberg Cloud. Heidelberger Druckmaschinen did it without relying upon today's concepts of data sovereignty, because some other market factors were helpful. The message here is: A business model like this is profitable and sustainable and requires two critical success factors: trust and data. Data Sovereignty is a concept to support both.

[6] https://www.heidelberg.com/global/en/services_and_consumables/digital_platforms/heidelberg_cloud/heidelberg_cloud.jsp

3 Available Concepts and Solutions

No doubt, digitization in the manufacturing industry is progressing and even booming in some markets. Many concepts and approaches exist, partly up and running. However, why do we need an additional concept? Why data sovereignty? And, how does it fit to the other already existing concepts?

3.1 Data Sovereignty

Ready to start with available technology and governance concepts: The International Data Spaces Association (IDSA) has published the first version of the International Data Spaces Reference Architecture Model (IDS-RAM) in 2017, the current version 3 is dated July 2019[7]. The IDS-RAM describes the key IDSA concepts. Strategic requirements are the trust and security between partners in a data centered ecosystem and the data sovereignty between them. Data remains decentral and is not copied into one central cloud environment or system. That is the basis for data sovereignty, which relates to both access control and usage control. The owner does not only decide with whom, how long and under which conditions he wants to share his data, he also wants to control the further usage of the data, once the data has been accessed.

Furthermore, it will always be a challenge to store all data in one environment as new data become available or new and other data becomes relevant to your question. The evolutionary context to gain insights about data and their interdependencies needs a governed and decentralized approach to make the most out of data and to give experts access to them in a traceable environment. Data should be accompanied with provenance related meta-data that allows the receiver to learn about the origin of the data and its circumstances.

International Data Spaces (IDS) enable the exchange of data between two parties or the sharing of data between many parties or between n to m parties in one trusted and certified eco-system. Parties can be software systems, data stores of every kind or physical assets that keep or generate data, for example process parameters like the spindle speed of a milling machine. In these trusted environments each party has full control of the usage of his data, as long as they stay in this environment. Each party in this environment must support IDS concepts fully and must be a certified member. The basic concepts of the IDS are illustrated in Figure 3.

[7] https://internationaldataspaces.org/publications/ids-ram/

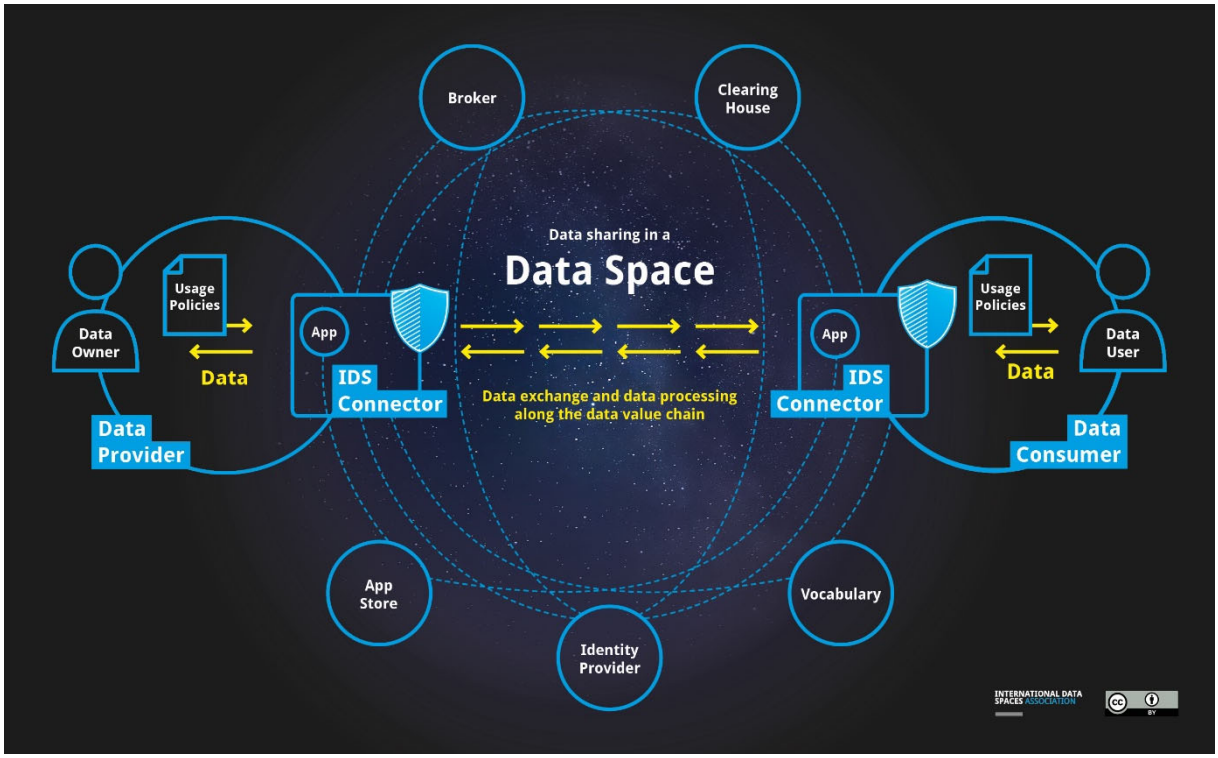


Figure 3: Basic Architectural Concepts of the International Data Spaces (IDS)

For details, please read the publications of IDSA[8]. In the following, you just find a short introduction to these concepts:

- **Data spaces** unlock the value of data.
- An **IDS Connector** is a dedicated software component that allows participants to attach usage policies to their data in a data space, enforce the usage policies and seamlessly track the provenance of received data. Hence, an IDS Connector acts as a kind of gateway for data and services. Furthermore, it provides a trusted environment for the execution of apps.
- **Data owner and data provider**: The data provider is a device that transfers the owner's data to the data space via the IDS Connector. It allows others to use the data while retaining control over the who, how, when, why and at what price.
- **Data user and data consumer**: The data consumer is a device that processes data on behalf of the user. The data is offered by data providers by their usage policies and with confidence in the data quality and reliability.
- An **Identity Provider** creates, maintains, manages and validates identity information of and for participants in the data space such as data providers and data consumers.
- **App Stores** provide software applications that can be deployed in IDS Connectors.

[8] https://internationaldataspaces.org/publications/most-important-documents/

- **Apps** may be downloaded from the App Store into the trusted environment of the IDS Connector. Apps perform tasks such as transformation, aggregations or analytics of data.
- A **Broker** provides information about data sources in terms of content, structure quality, currency and other features.
- A **Clearing House** provides clearing and settlement services for all data exchanges and financial transactions within a data space.
- **Vocabularies** provide standardized descriptors for data based on accepted best practices.

3.2 Interoperability

A lot of communities, research institutes and associations such as Plattform Industrie 4.0, OPC Foundation, IEEE, IEC, Fraunhofer, TNO, IDSA etc. push innovation on digitization in manufacturing ahead. They develop and deliver concepts and solutions to support the digitization of industrial assets and processes, especially,

- to interconnect the assets and the processes,
- to get fitting data out of them,
- to structure and organize the data,
- to add semantics, and, finally,
- to create data-driven applications and even new data-driven business models based on the gained data and data streams.

Interoperability shall be achieved between multiple factories and between multiple, possibly regional manufacturing data spaces. The list of concepts and related technologies to support the interoperability and digitization within the manufacturing industry is getting longer and longer, as illustrated by the following examples:

- RAMI 4.0, the Reference Architecture Model Industrie 4.0 of the Plattform Industrie 4.0 includes an asset type called “Connected World”. Assets of this category need data sovereignty capabilities to overcome e.g., trust barriers.
- Asset Administration Shell (AAS) of the Plattform Industrie 4.0: The AAS concept enables the design and development of interoperable digital twins of a manufacturing asset.
- OPC-UA of the OPC Foundation: OPC-UA enables interoperability on communication and information model level when including the various OPC UA Companion Specifications driven by the VDMA, e.g. umati[9], the universal machine tool interface for machine tools and manufacturing systems to external communication partners.
- Supply Chain / design world driving supply chain standards like 3D PMI / MBD

[9] https://opcfoundation.org/markets-collaboration/umati/

3.3 Cloud Sovereignty

Cloud Sovereignty has several perspectives.

- "To avoid vendor lock-in" requires the sovereignty to change cloud suppliers as easy as possible. However, to make this happen in practice, there is a need for technology standards, semantical standards and contracts.
- "To protect my IP" requires legal sovereignty in a closed, dedicated legal environment, e.g. German or European laws. Globally, the challenge is that legal values and environments differ from country to country and continent to continent. Translation: The same degree of digital sovereignty, means data and infrastructure sovereignty, will not be possible everywhere. Decisions and tradeoffs must be made.
- "To fulfill data protection laws" requires the sovereignty to fulfill the local data protection law.
- Finally, "to control data usage" requires acceptance and support of data sovereignty by the cloud provider

The unfortunate news is that in today's world there are only few open standards in cloud access and management that help to avoid vendor lock-in with today's cloud providers. So, the choice of the cloud provider is important due to legal constraints, data protection and data control. Compliance to concepts and specifications of Industrie 4.0, the OPC Foundation and the International Data Spaces Association (IDSA) are key criteria.

Good news is, that the currently launched GAIA-X[10] concept fulfills all required points in Europe. It is driven by German and French Governance and is anticipated from European Commission, which means, the European legal values are secured. For cloud migration efforts new GAIA-X standards a going to be defined. And finally, for data usage control and data sovereignty the already existing concepts auf IDSA are adopted in GAIA-X, as described above. Time to start.

[10] https://www.bmwi.de/Redaktion/DE/Dossier/gaia-x.html

4 Call for action

The conclusion and recommendation to the manufacturing industry:

As data has become the new oil or the new gold, at a minimum the new raw material, the digitization of the manufacturing industry is progressing. The trend is moving towards decentralized and distributed data ecosystems associated with emerging business models and networks. The logical consequence is to manage the distributed data with minimal effort.

The following steps are strongly recommended by the authors being members of the IDS-Industrial community[11]:

- Deepen your knowledge on data sovereignty, IDS-RAM and the IDS concepts.
- Create a data landscape showing the "oil, gold, data" of your company.
- Increase your data quality and harmonize your data internally in your IT system landscape on structural, syntactical and semantic level.
- Follow relevant standards to increase interoperability across different systems and external parties. Examples are here OPC UA, Asset Administration Shell and ECLASS, more information in the Standardization Roadmap on Industry 4.0[12].
- Classify your data: what can be shared and cannot be shared.
- Find out, what kind of more data you would need yourself.
- Discuss and assess which of the IDS concepts could be an appropriate approach to ensure data security, sovereignty, and usage control.
- What should be the supported scenario and who are the players of this scenario?
- Dependent on the scenario, define which components are necessary. What could be the task of an additional app?
- Figure out what apps you should offer in the app store of your data space in order to support, enable and advance your data-sharing business model.
- Build, buy or use IDS Connectors for your intelligent products or to the internet connected products, machines, or components.
- Make sure that the GAIA-X infrastructure supports all the basic security concepts such as trusted identity provision in an operational manner.
- Discuss the usage of data sovereignty concepts with your business and engineering partner.
- Drive Data Sovereignty in context of Digital Sovereignty of GAIA-X.

And, finally: Data Entrepreneurship is urgently required. Use your data and share your data and get rich. If you don´t, others will definitely.

[11] https://internationaldataspaces.org/make/communities/

[12] https://www.din.de/en/innovation-and-research/industry-4-0/german-standardization-roadmap-on-industry-4-0-77392

5 Join the IDS-Industrial Community

IDS-I comprises an international community of industrial partners that unites more than 60 organizations from around the world. It is a verticalization community of the International Data Spaces Association (IDSA)[13].

The IDS-I objective is to analyze the mapping of IDS concepts and principles of data sovereignty to the requirements of the industrial sector. In this sense, the mission of the IDS-Industrial Community is:

- To gather requirements on data sovereignty incl. data sharing, data usage monitoring and control as well as data provenance tracking by means of reference use case specifications.
- To map these requirements systematically to the standards, capabilities and recommended technologies of the IDSA and the Platform Industrie 4.0.
- To derive profiles of IDS/Industrie 4.0 specifications that support the requirements in industrial business eco-systems based upon standards and by means of common governance models.
- To validate and demonstrate the applicability of these specifications by means of reference testbeds, e.g. Smart Factory Web[14] and GAIA-X use cases.
- To contribute to the outreach of the IDS architecture and specifications to the community of industrial production and smart manufacturing.

For more information please contact the authors or join the IDS-Industrial (IDS-I) community by expressing your interest in a mail to info@internationaldataspaces.org.

[13] https://internationaldataspaces.org/make/communities/
[14] https://www.smartfactoryweb.de

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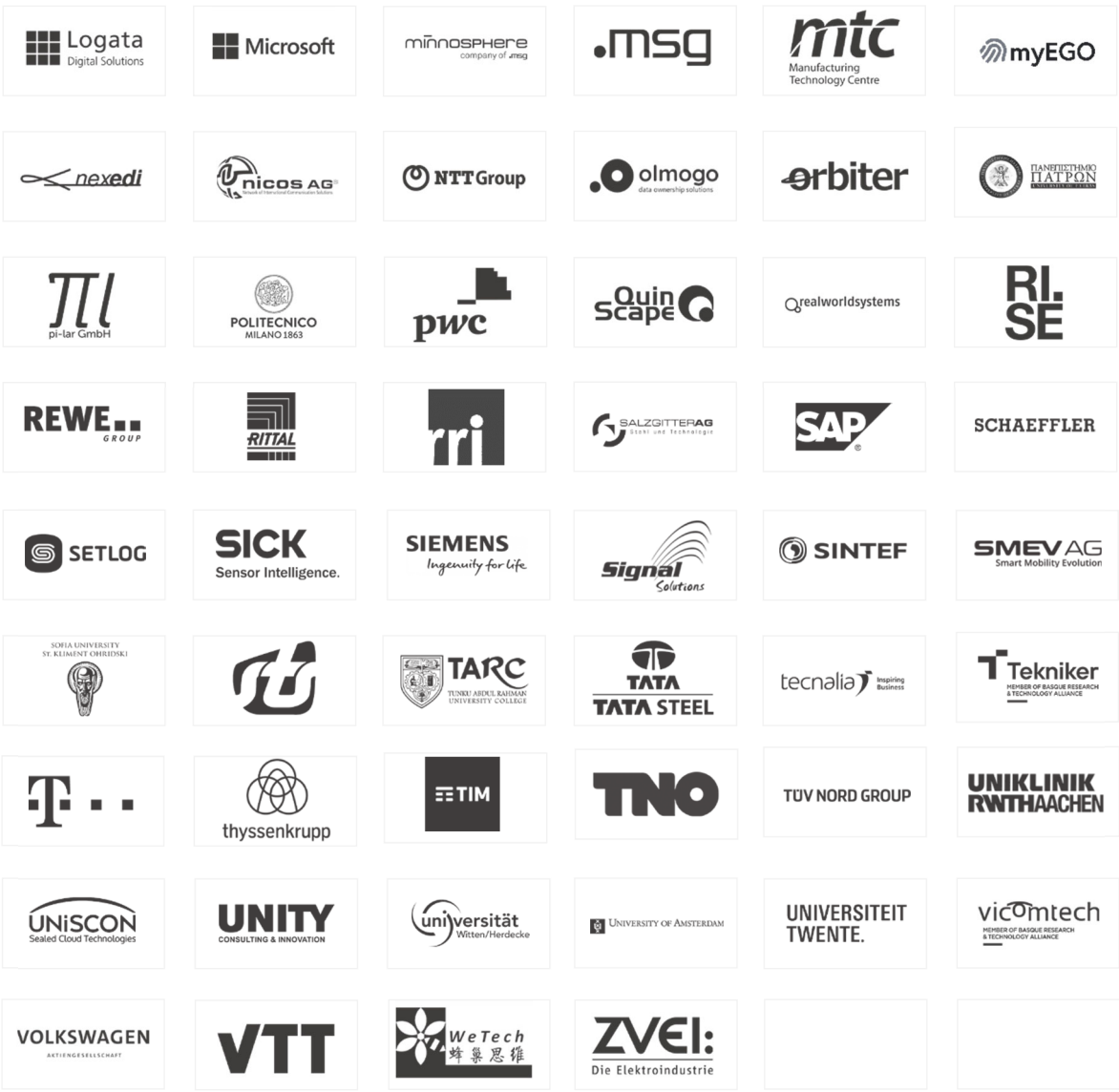
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Executive Summary

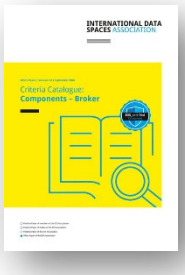
Image Brochure

Infographic

Use Case Brochures

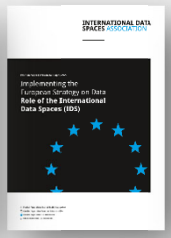
Rule Book

Specifications



Criteria Catalogues

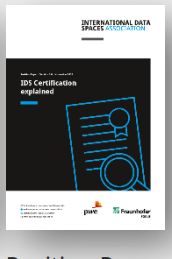
Position Paper GAIA-X and IDS



Position Paper Implementing the European Data Strategy

Position Paper GDPR Requirements and Recommendations

Position Paper Usage Control in the IDS



Position Paper IDS Certification Explained

White Paper Certification

Sharing data while keeping data ownership

Magazine Data Spaces_Now!

For these and further downloads: www.internationaldataspaces.org/most-important-documents

Code available at: https://github.com/industrial-data-space

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