

Introduction to data economy

Data dilemma, Data spaces, Data ecosystems

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Fischer et al.

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About the series

This paper contains the content of the free online course ‘Introduction to data economy: data dilemma, data spaces, data ecosystems’ organised by the Gaia-X Hub Germany. It provides interested parties with a basic understanding of the data economy and promotes discourse and the exchange of ideas.

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1. The data dilemma

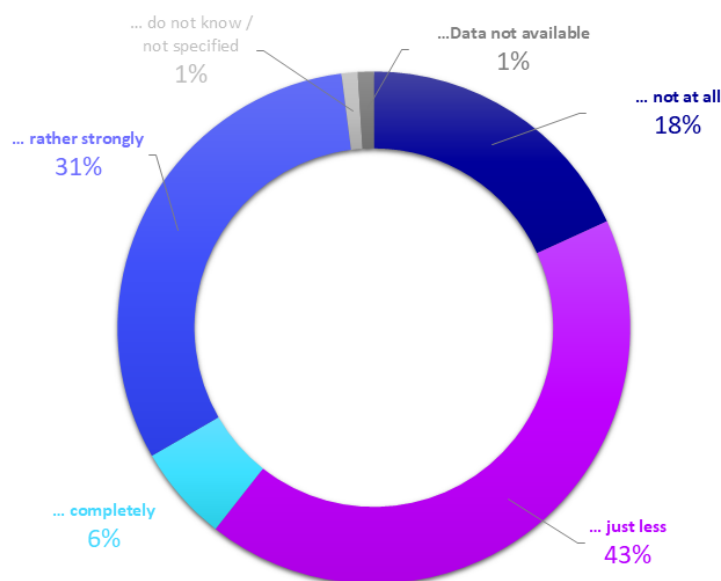
1.1. Europe's digital backlog and the path to a data economy

Imagine you're in a room full of treasures, but the doors are firmly locked and you don't have a key. Frustrating, isn't it? This is exactly what European companies are experiencing today: they are beginning to realize the value of their data but are unable to fully benefit from it or share them with others. Why is this the case? And what impact does this have on Europe's digital future?

1.2. The paradox of unused data

Let's start with a surprising figure: [80% of industrial data in Europe remains untapped](#). That's like leaving four out of five gold mines untouched. But why are companies not even coming close to utilizing this potential?

German companies are exploiting the potential of their data...



Source: Bitkom 2024

There are many reasons for this:

1. **Legal concerns:** 58% of companies are reluctant to share data due to legal uncertainties.
2. **Technical hurdles:** For 33%, incompatible systems are an obstacle.
3. **Protection of trade secrets:** 21% are afraid of disclosing sensitive information.

These figures show: there is not a lack of data, but a lack of trust and suitable tools for exchange.

However, even when companies, research institutes, associations or public authorities share data with third parties today, they face considerable challenges. A key reason for their hesitation is the lack of standardized and legally secure concepts that make data sharing practicable even for those organizations that do not have an IT department.

Let's assume a company wants to exchange data with ten partners in its supply chain. This means ten separate contracts in which system requirements, data formats, usage types, and access rights must be defined in detail. Added to this is the programming and maintenance of possibly proprietary interfaces at each end point of the data exchange. It's as if you have to invent and learn a new language for each new business relationship.

This complexity has far-reaching consequences:

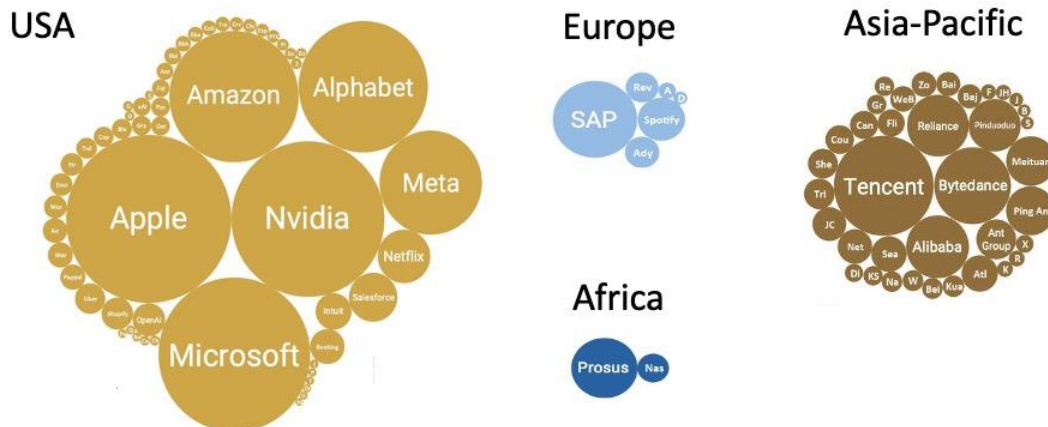
- It **prevents the agility** of companies that have to face the digital transformation of their industry and markets.
- It **drives up the transaction costs** for the emerging data economy - or prevents them from arising altogether.
- It **puts small and medium-sized companies in particular at a disadvantage**, as they shy away from the bureaucratic and technical requirements.

The result? A vicious circle of reservation and missed opportunities. Companies that shy away from data exchange miss out on innovation opportunities. At the same time, a lack of participation means that there is a lack of critical mass and pressure in the market for more efficient solutions to emerge.

1.3. The price of digital reservation

But what is the cost of this restraint? Let's take a look at the global data economy::

Geographical distribution of the world's top beneficiaries of data value creation



World's top 100 platforms

Source: Hosseini und Schmidt, 2025

| Region | Share of the enterprise value of digital platforms |
|--------------|--|
| USA | 67 % |
| Asia-Pacific | 29 % |
| EU | 3 % |
| Africa | 2 % |

This table shows that Europe, once a pioneer of the industrial revolution, is at risk of being left behind by the USA and Asia when it comes to data value creation in the digital age.

[Figures from the UN Conference on Trade and Development](#) paint a similar picture.

According to these figures, the United States and China alone account for 90% of the market capitalization of digital platforms, 94% of investor capital for AI start-ups and half of all large cloud data centres.

But why is data exchange so important in the first place?

1.4. Collaboration: the key to digital growth

Imagine a puzzle. Every company has a few pieces, but it is only when they are put together that the big picture emerges. It's the same with data in the digital economy. An example:

A machine manufacturer wants to supplement its products with digital services in

order to make production more efficient and sustainable. This includes services that make better use of machine capacity and plan maintenance work with foresight. To do this, the company needs to combine real-time data from its own production with that of suppliers and customers in a legally compliant manner. This allows downtimes to be identified at an early stage, maintenance intervals to be better coordinated and additional capacity to be planned for external orders. The project [EuProGigant](#) has shown how such data can be securely combined to optimize production processes and protect sensitive information.

This scenario makes it clear: in the networked economy of the 21st century, no company acts in isolation. Success increasingly depends on the ability to exchange and share data.

The urgency of this development is reinforced by two current trends: the boom in artificial intelligence and the explosive growth of the [Internet of Things \(IoT\)](#). Large AI-based language models, which are currently revolutionizing the economy, require enormous amounts of data for training. At the same time, [billions of connected IoT devices](#) in industry are generating an unprecedented stream of data. Experts predict that the number of these devices will more than double by 2030.

This development holds immense potential: a [study by the European Parliament](#) estimates that intelligent automation and AI could double annual economic growth in developed countries by 2035. But to achieve this, companies must learn to share their data effectively and use it collaboratively.

The path to achieve this is paved with stumbling blocks. How can companies work together securely and confidentially without disclosing sensitive information? How can data from different sources and formats be merged in a meaningful way? And how do we ensure that everyone involved participates fairly in the value creation process?

Answers to these questions will determine the future of the European economy in the digital age. In the next section, we will look at what concrete steps are already being taken to overcome these challenges.

1.5. Regulatory pressure is increasing

The European Union has recognized the importance of data exchange and is responding with corresponding laws. The [EU Data Act](#), which will apply starting from September 2025,

regulates the access and use of data in certain cases, for example between companies, consumers, and public authorities. [It creates a clear framework for the fair use of data and interoperability.](#)

But what does this mean in concrete terms for you as an entrepreneur or manager?



Would you like to find out more about the Data Act?

Read our blog articles: [No more data silos: The EU Data Act forces digital openness](#)

> *Let's assume you produce intelligent household appliances.*

From September 2025, you must:

- *Make usage data from your devices directly available to customers.*
- *Allow third parties access to this data if the customer agrees.*
- *Ensure that your data is available in interoperable formats.*

At first, these requirements sound like additional work. But they also offer opportunities: imagine how many innovative services could be created if development teams had access to anonymized usage data from millions of household appliances!

1.6. The dilemma of digital platforms

Now you may be asking yourself: "Why not just collect all the data on a central cloud platform?" This question leads us to the heart of the European data dilemma.

Large digital platforms, often from the USA or China, have shown how effective centralized data collections can be. [But they also pose problems:](#)

1. **Data protection concerns:** Who controls the collected information?
2. **Distortion of competition:** Companies that operate platforms can gain unfair advantages.
3. **Dependencies:** Companies risk becoming dependent on individual providers ("lock-in effect").

An example illustrates this problem:

> *A medium-sized mechanical engineering company analyses production data via the services of a large cloud platform. In order to be able to use its interfaces, it has converted its operating technology to the provider's proprietary protocol in*

complex IT projects. However, new data protection regulations, changed production requirements and a revised pricing model for the platform are putting the company under pressure: costs are rising, new applications cannot be implemented on the existing platform in a legally compliant or efficient manner, and a new technical conversion or a change of cloud provider would require enormous investments.

This scenario shows why many European companies are justifiably hesitant to develop data-based services on centralized platforms.

1.7. The way forward: Europe's alternative

We are facing a dilemma: on the one hand, data exchange drives innovation and competitiveness. On the other hand, centralized platforms create dependencies and jeopardize data protection and fair competition.

What could a European solution look like, that:

- promotes the exchange of data,
- legally safeguards data protection,
- leaves control with the data owners,
- and minimizes dependencies on technology providers?

The answer to this question could shape the future of the European digital economy. In the next chapter, we showcase how the concept of "data spaces" meets this challenge and why it could be Europe's key to the data age.

What do you think? What experiences have you had with data exchange in your company?



Share your thoughts with us and let's shape the future of the European data economy together! Use our [contact form](#)!

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2. Data spaces

2.1. Europe's answer to the data age

Data spaces are Europe's innovative answer to the challenges of the digital age. They enable companies and organizations to exchange data confidently and securely. In contrast to centralized platforms, data spaces use a decentralized structure that leaves data owners in control. This concept combines data sovereignty with economic growth and opens up new [opportunities for innovation](#).

2.2. Origin of the data space: a misleading metaphor

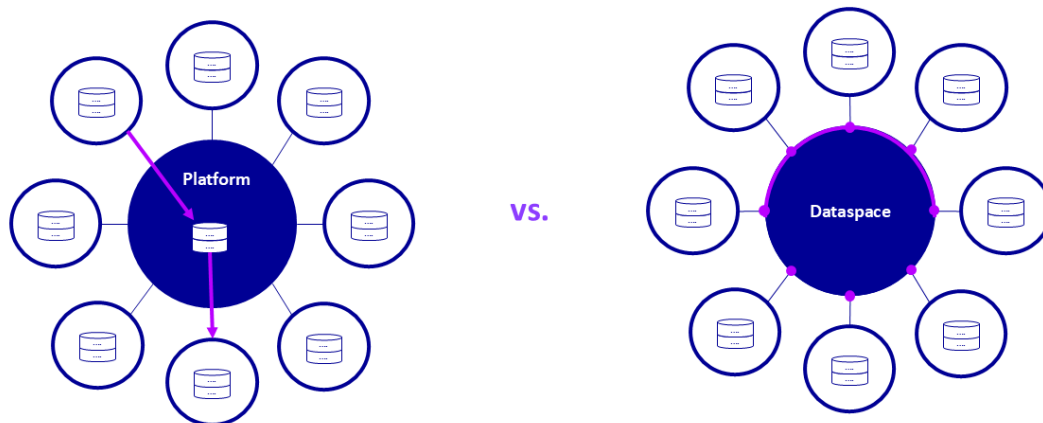
When you think of a "space", you probably imagine a physical place where things are brought together. This idea is slightly misleading when it comes to the term "data space". This is because, unlike a central data platform, data in a digital data space is not collected in one place.

The metaphor of the data space has its roots in the business world: law firms often set up physical data spaces when acquiring companies. Potential investors can view the business books there - but not take them with them. A historical example of this is the secret contract documents of the failed TTIP free trade agreement. They were stored in a physical data space at the Federal Ministry of Economics, accessible only to selected members of parliament.

A digital data space works in a similar way, but virtually: the data remains in the owner's source systems. Third parties access it via a connector - but only under strictly controlled conditions. The owner defines these, using a set of rules such as Gaia-X.

In this way, the data owners retain full control and remain in possession of their data. They only grant access to people or organizations they trust. You could say that a data space is like an Internet with a pass and copy protection.

In dataspace, data is not shared within the dataspace but is directly connected via "edge points".



Source: Gaia-X Hub Germany, 2024

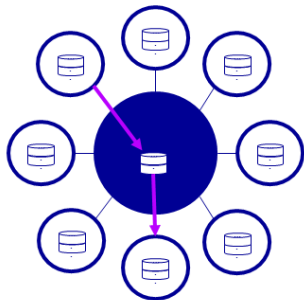
2.3. Digital data spaces as an anti-platform

Let's imagine that the European transport industry is planning a data space for autonomous mobility. It wants to use information from vehicles, smartphones, sensors along the roads, traffic management systems, local public transport, and weather services. The obvious way forward is to collect all relevant data in a central cloud and analyse it there. But what would the consequences be?

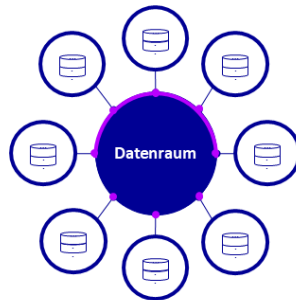
The entire transportation of our continent would depend on a single platform provider. If its headquarters were located in the USA or China, for example, decisions from other jurisdictions and economic regions could directly influence mobility in Europe. Even a European provider could take advantage of economic and technological dependencies. A monopoly with all its damaging consequences would be virtually unavoidable.

A data space takes a different approach: it networks different platforms, data sources, and data services in an ecosystem on a federated infrastructure. Sounds complicated? Let's take a closer look.

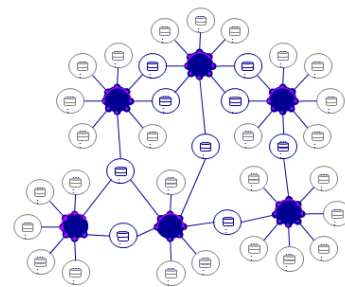
Data Platform



Data Space



Data Ecosystem



Source: Gaia-X Hub Germany, 2025

2.4. Store data decentrally, federate data usage

"Federate" - a favorite word among Europeans, and for good reasons. It comes from the Latin "foedus", which means "alliance" or "treaty". The idea of federalism is deeply rooted in European history.

Europe has always been a patchwork of small and large empires and states, characterized by exchange and competition in a confined space. The simultaneity of competition, mutual observation and inspiration accelerated progress.

Even today, the European Union is not a unified state, but a supranational association that federates state action - i.e. binds and coordinates it through alliances, treaties and procedures for legislation, jurisdiction, and administration. In other words: Europe is not a state, but a network with fixed nodes and edges.

In the context of IT, "federating" means the networking and collaboration of distributed systems. For a pan-European data infrastructure, the idea of a network is therefore more appropriate than that of a central platform. It reflects the historical DNA of our continent.

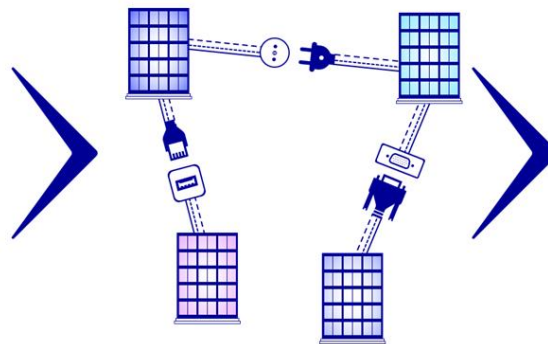
PREVIOUSLY: Data silos

- Data potential unused
- No cross-connections



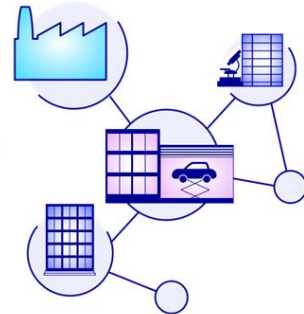
NOW: Data Sharing

- Single connections
- Proprietary standards



FUTURE: Data Economy

- Common rules and uniform standards
- Data sovereignty for diverse participants from different sectors



Source: Gaia-X Hub Germany, 2025

2.5. Example: Data-driven mobility for Europe

Let's look again at the example of a data space for mobility in Europe. With a central platform solution, all traffic data - from road conditions and vehicle movements to user behavior - would be stored in a single cloud. This would create enormous security risks and dependencies.

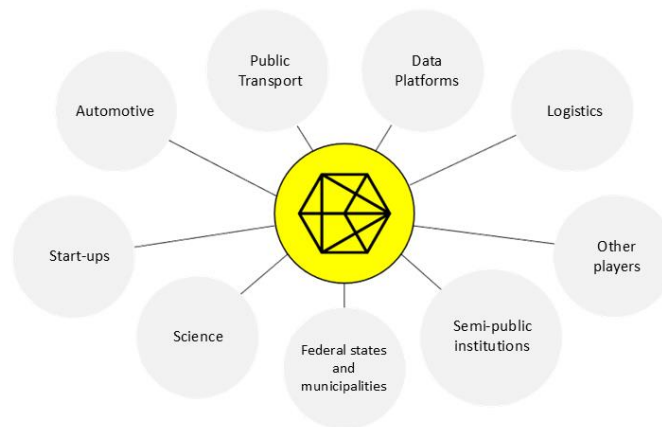
In a data space, on the other hand, the data remains decentralized:

- Cities retain control over their traffic management systems.
- Automotive companies manage the data of their connected vehicles.
- Map services pass on their current road information.

The data space allows all participants to exchange and link their data in a controlled manner, while at the same time everyone retains full sovereignty over their data. This allows innovative mobility services to be created without a single player controlling all the data.

2.6. Sketch: How does a data space work?

Let's stay with the example of transport - here the [Mobility Data Space \(MDS\)](#) shows in concrete terms how a European data space already works today, and which players are participating in it.



Source: DRM Datenraum Mobilität GmbH, 2023

Members of the MDS are:

- Automotive companies (e.g. vehicle position data, battery status)
- Cities/municipalities (e.g. real-time data on road conditions, construction sites, parking space)
- Weather services (e.g. storm reports, black ice forecasts)
- Insurance groups (e.g. accident statistics, risk profiles)
- Charging infrastructure operators (e.g. availability, charging speeds)

2.7. The key mechanisms for sovereign data exchange between these players are as follows:

1. Decentralized architecture

The data of these players remains in their source systems - a traffic authority does not store its traffic light circuits in the Mobility Data Space but keeps them on its own premises and grants access as required via a connector.

2. Automated Trust

Data spaces use mechanisms for automated identity and compliance management to ensure trust and interoperability. For example, the MDS uses a service called Dynamic Attribute Provisioning Service. The DAPS works like a digital ID stamp that provides data connections with up-to-date information to enable secure data exchange.

Other data spaces rely on the service of the [Gaia-X Digital Clearing Houses \(GXDCH\)](#). The GXDCH function like a bouncer for the entire Gaia-X network, checking whether participants and their offers comply with the rules and fit into the ecosystem. To participate in the data space, an organization must identify and legitimize itself to a GXDCH in a multi-stage process. At the end of this process, the GXDC issues a digital certificate that confirms an organization's or service's compliance with the Gaia-X standards.

3. Terms of use

A participant in the Mobility Data Space, for example an automotive group, ties access to its data to the following conditions:

- Access only for real-time route optimization
- No storage of data after use
- Exclusion of competitor companies X ,Y ,Z

4. Neutral hosting organization

In 2021, the hosting organization of the Mobility Data Space, the “DRM Datenraum Mobilität GmbH”, was founded. It is structured as a neutral non-profit organization and has the task of further developing the Mobility Data Space and orchestrating it technically and commercially. acatech - the National Academy of Science and Engineering is the majority shareholder and thus acts as a neutral mediator.

2.8. Practical benefits

Thanks to these mechanisms, practical use cases are being developed for various players in the Mobility Data Space. For example, a logistics company uses the MDS for:

- Weather forecasts from weather services
- Road closures in the city
- Charging capacities of infrastructure providers
- Live positions of their own e-trucks

The result: fewer empty runs and lower energy consumption - without a company controlling the data.

This example shows: data spaces don't just solve technical problems. They are a socio-

technical ecosystem that creates trust through clear rules and transparency and enables innovation and economic growth.

2.9. Growing economic importance of data spaces

The development of data spaces is not only a technological necessity, but also of enormous economic importance. Some figures and assessments from experts illustrate this:

1. A [study by Capgemini](#) expects data ecosystems to deliver significant performance improvements for companies: 15% more customer satisfaction, 14% more productivity/efficiency, 11% lower annual costs for 2-3 years
2. By applying the Data Act, [the EU Commission expects an increase in GDP](#) in the member states of 270 billion euros by 2028.
3. A [Bitkom survey](#) from 2024 shows that 61% of German companies are barely or not at all exploiting their data potential. Data spaces could help to leverage this huge potential.
4. According to the [German Economic Institute \(IW\)](#), new business models and products are often only possible if companies not only use their own data, but can also incorporate data from other organisations. This is why data sharing is now central to the future viability of companies.

These facts show how urgent and promising the development of data spaces is. Europe must act if it does not want to fall behind in global competition.

Data spaces create a solution that promotes economic growth and secures digital sovereignty. They are Europe's answer to the challenges of the data age - an answer that preserves our values and federal structure.

In the following chapters, we will look at how Gaia-X is realizing this vision and what concrete steps companies can take to benefit from it.

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3. Data ecosystems

3.1. A European network of interoperable data spaces

In the previous chapters, we explored the challenges of the data economy and the concept of data spaces. But how do we prevent data spaces themselves from becoming data silos again? The solution: we need an ecosystem that ensures basic interoperability between data spaces. Initiatives such as Gaia-X create standards and rules for such a data ecosystem. In this chapter, you will learn how Gaia-X contributes to this and how companies benefit from interoperable data spaces.

3.2. Simple, trustworthy, and efficient data collaboration on a global scale

Imagine the global data economy as a giant mosaic in which every company and every organization has unique pieces. The true value only becomes apparent when these pieces come together to form a bigger picture. But how can this be achieved in a world full of technical and legal hurdles?

Let's assume you run a logistics company and are a member of a mobility data space. Your efficiency could increase further if you combine your mosaic piece with tiles from other data spaces, such as smart cities or healthcare. Perhaps you want to optimize your routes with up-to-date environmental data or adjust the distribution of medical goods in real time. Without common standards and procedures, such cross-industry data links would become an expensive nightmare of individual agreements and technical adjustments.

If the Gaia-X specifications are used to build data spaces, they ensure that these data spaces are interoperable with each other by design. This basic interoperability is the key to enabling the European data economy to develop its full potential.

3.3. Gaia-X as a European initiative of committed companies

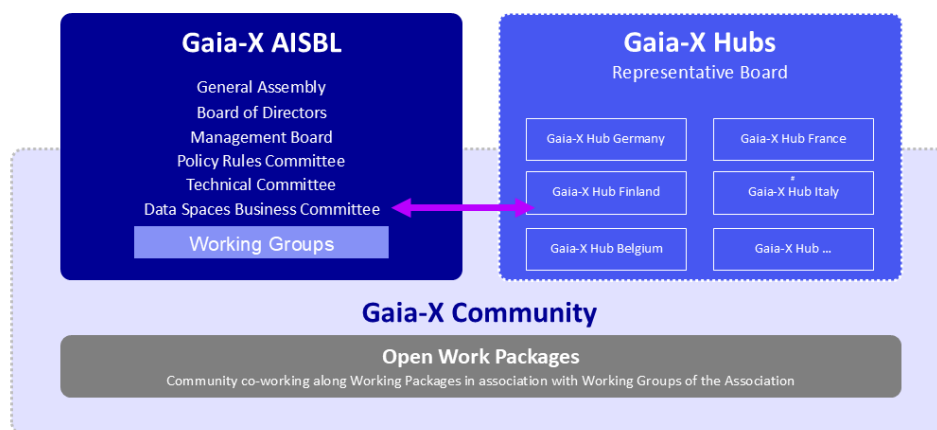
Gaia-X works closely with initiatives such as [International Data Spaces Association \(IDSA\)](#), FIWARE Foundation, e.V., the [Big Data Value Association \(BDVA\)](#) and the [Data Spaces Support Center \(DSSC\)](#). Under the umbrella of the [Data Spaces Business Alliance \(DSBA\)](#), this cooperation ensures that not only Gaia-X data spaces harmonize with each other, but also

that all other architectures, specifications and concepts are aligned (further information on this can be found in the following courses).

Gaia-X is not a state institution, but an initiative from the private sector. At its heart is the Gaia-X European Association for Data and Cloud AISBL, an international, non-profit association. With over 220 members from business and science, it forms the backbone of the initiative.

The goal? An open, transparent, and secure ecosystem in which data and services flow securely according to common standards. Gaia-X contributes the practical experience of its members. The initiative describes in detail how cooperation between AISBL and the hubs in the various countries is organized at <https://gaia-x.eu/who-we-are/association/>.

Overview: Board and collaboration of the european initiative Gaia-X



Source: Gaia-X Hub Germany, 2022

Public institutions such as the EU Commission or the German Federal Ministry of Economics support Gaia-X without directing it. This independence ensures acceptance in the economy and the flexibility to react to new challenges.

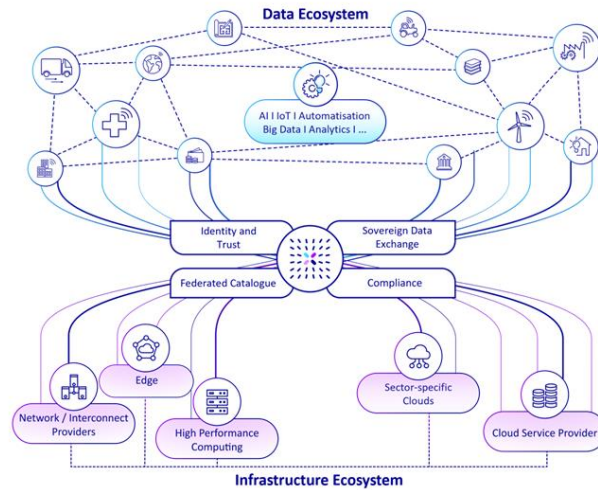
But how exactly does Gaia-X contribute to a European data ecosystem?

3.4. Gaia-X ensures trust beyond individual data spaces

What applies within a data space applies even more so between different data spaces: no collaboration without trust! Participants must be able to rely on the identity of other players and on descriptions of the data and services offered. This is the decisive prerequisite for

cross-industry cooperation with anonymous third parties.

Development of a European data ecosystem with Gaia-X considering the functions listed



Source: Gaia-X Hub Germany, 2024

Gaia-X's contribution to the European data ecosystem starts at this crucial point. The initiative does not provide a ready-made software package for complete data spaces, but rather the so-called [trust framework](#).

In information technology, a framework is a structured collection of rules, standards, and tools. They help developers to create consistent and efficient solutions, similar to a blueprint that facilitates the construction of a house - in the case of Gaia-X, the trust framework serves to ensure trust and security in data-based cooperation.

In concrete terms, this means:

1. Companies and organizations no longer have to manually check whether other participants in their data space or another adhering to the rules of the game. Instead, they can use automated checking procedures.
2. Information on the identity of actors and on the data and data services offered complies with the Gaia-X rules.
3. A two-tier system of control bodies checks the conformity of such information.

This basic interoperability prevents data silos. It allows companies to work together securely and efficiently across value chains and industries.

3.5. How does Gaia-X work in practice?

Gaia-X creates centralized trust mechanisms for data-based cooperation within and between data spaces. The initiative relies on [Verifiable Credentials \(VC\)](#), a standard of the [World Wide Web Consortium \(W3C\)](#) for digitally signed and forgery-proof proofs. VCs contain information on identity or qualifications and can be checked cryptographically without having to contact the issuer.

1. **Participant Credentials:** Organizations that wish to participate in a data space must prove their digital identity - for example with an X509 or, in future, an eIDAS certificate. To do this, they contact a Gaia-X Digital Clearing House, which issues them with a participant certificate. After agreeing to the general terms and conditions of the data space, they sign with their digital identity. The Clearing House then creates a compliance credential that confirms the verified identity of the participant.
2. **Service Credentials:** Data and digital services are also checked in data spaces. A service credential, which contains cryptographically signed information about the respective service, is used for this purpose. An organization is considered Gaia-X-compliant if it can present a participant credential for itself and service credentials for the services it offers.
3. **Gaia-X Digital Clearing Houses (GXDCH):** These Clearing Houses independently check whether participants and services comply with the Gaia-X rules. They rely on so-called trust anchors - particularly reliable organizations in the EU member states that define testing standards and procedures, such as the Bundesdruckerei in Germany. In this way, the GXDCH create a trustworthy environment.

These trust functions of Gaia-X form the basis for legally secure, credible and sovereign data exchange. The following video summarizes the conceptual ideas of data spaces and federations with the help of an example from e-mobility: <https://youtu.be/F8bRCJw12-U?si=6waZUUjclvojUfVT>

3.6. How does data ecosystems improve data-based cooperation?

Let's look at another example from the industry that demonstrates the benefits of an interoperable data ecosystem: a medium-sized mechanical engineering company wants to optimize its production processes while simultaneously verifying and optimizing its CO₂-footprint. It uses a data space for [Industry 4.0](#) to integrate energy consumption data from

suppliers and anonymized production data from similar companies.

Without an interoperable data ecosystem, it would be difficult to add data from other industries or regions. The company would have to:

- Negotiate individual contracts with dozens of data providers
- Implement various technical interfaces
- Carry out extensive security checks for each partner

In a Gaia-X-compliant data ecosystem, an industrial company would use the following data and services, for example:

- Identity verification by a Gaia-X Digital Clearing House
- GXDCH-verified conformity of data and data service information
- Research of relevant data sources and data services in federated catalogs of different data spaces
- Data from a product carbon footprint calculator
- Real-time data from IoT sensors in your own machines
- CO₂ emissions data from the supply chain
- **In addition:** real-time market data from an energy data space to optimize energy costs, CO₂ emissions and grid load

Thanks to standardized interfaces and interoperable standards, the company can easily integrate this data from different data spaces into its IT processes. Sovereignty-preserving rules ensure that sensitive data remains protected. An AI model optimizes production and helps to demonstrably reduce CO₂ emissions.

The result? Increased efficiency, reduced costs and a competitive advantage through sustainability - all thanks to simple, secure, and interoperable data collaboration in the Gaia-X ecosystem.

3.7. How can my company benefit economically from data room technologies?

The advantages of data spaces and data ecosystems are inherent. The following video briefly summarizes them: <https://www.youtube.com/watch?v=Euclid7gMMY0g>

But how can your company become part of this forward-looking ecosystem? How can you make concrete use of the new opportunities offered by the data economy? In the next chapter, we will introduce you step by step to the world of creating value from data. From membership of the Gaia-X Association to active participation in data spaces - we show you how to use the European data strategy to your company's advantage.

Help shape the future of the data economy. Your entry into the European data ecosystem starts now!

3.8. References

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