Data spaces for a sustainable aerospace industry

Position Paper of the domain Aerospace

About the paper

This position paper was initiated in the aerospace domain of the Gaia-X Hub Germany and during the domain workshop on November 18th, 2024. The paper is a collaboration between the Gaia-X Hub Germany, the Gaia-X Lighthouse Project COOPERANTS (Collaborative Processes and Services) and the Gaia-X European Association for Data and Cloud AISBL.

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Publisher

Gaia-X Hub Germany c/o acatech - National Academy of Science and Engineering
Karolinenplatz 4
80333 Munich

Publication

May 2025

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Summary

Aerospace is facing major challenges for the future and is linked to digitalisation and the data economy like no other sector: technology and digitalisation promote aerospace, which in turn enables the data economy. As a key sector, aerospace plays a central role in digitalisation. It develops solutions and security standards for critical technologies and sensitive data that are also used in other sectors and secure the sovereignty of Germany and Europe. Aerospace shares synergetic scientific specialisms such as flight dynamics, structural airframe design, satellite data acquisition, propulsion technologies, callipers, and fluid systems. Together, they master new challenges in the individual design, production and manufacture of internationally leading products and offer innovative solutions: In this way, they are driving digitalisation and climate protection and ensuring economic and technological sovereignty. These commonalities are also reflected in international norms and standards (ISO, 2024).

The concept of sovereignty also plays a central role in the utilisation of the data obtained: one opportunity for the aerospace industry lies in the creation of data spaces. With the Data Governance Act (DGA), the Data Act (DA) and the GDPR, among others, guidelines have been developed as part of the European data strategy to improve the sharing and management of data within the EU and strengthen the European market. In view of the increasing importance of data, these regulations will affect millions of companies in Europe and also the aerospace sector.

Gaia-X, a pan-European project that supports the creation of a trustworthy, federated, and sovereign data infrastructure, helps to implement the requirements and strengthen the development of data spaces, by enabling both the necessary governance mechanisms and the interconnection of decentralised infrastructures for data sharing. Gaia-X relies on open and transparent standards that enable interoperability between different services and data spaces and promote market transparency. These services help companies to fulfil legal requirements by enabling not only technical interoperability, but also legally compliant and trustworthy collaboration. This promotes the development of European data spaces that fulfil the principles of data interoperability, sovereignty, and innovation.

The aerospace ecosystem of Gaia-X has jointly developed a position paper in which it identifies the strengths and opportunities of a common data space for aerospace and advocates its establishment. The joint vision and an outlook with recommendations for action are explained in the paper.

Recommendations of the domain

As part of the domain work and the workshop of the Gaia-X Hub Germany domain aerospace, on November 18th, 2024, the members of the domain outlined the following recommendations for setting up a common data space:

Gaia-X as a key to promoting data-driven innovation

The aerospace industry should use Gaia-X as a strategic platform to create interoperable and secure data spaces. These enable data exchange, promote data-driven innovation and ensure the highest standards of data protection, security and interoperability. In this way, the industry increases its competitiveness and drives digital transformation.

Using Gaia-X as a guarantee for data protection and legal compliance

Gaia-X helps to implement requirements and legal specifications, especially those related to export control which are prevalent in our industry: It promotes open and transparent standards that make services and data spaces interoperable and increase market transparency. Data spaces do not pool data centrally but aim to interconnect decentralised infrastructures in a trustworthy environment thus, such standards are essential. In this way, it drives the development of European data spaces.

Building an active community

The domain should specifically build an active user community, promote partnerships and establish a shared information platform. In this way, it facilitates the exchange of knowledge and data and strengthens the common understanding of the use of Gaia-X.

Partnerships and strategic alliances

The aerospace domain should actively utilise partnerships and alliances such as the Data Spaces Business Alliance (DSBA)[1]. In this way, it promotes collaboration with other data infrastructures, creates interoperable data spaces and strengthens the digital transformation through a secure and sovereign exchange of data.

International cooperation

Strategic alliances and long-term partnerships between companies, research institutes, and governments ensure the continued existence and promote the further development of the aerospace industry as a driver of the global economy. It is important to think European and to intensify cooperation beyond Europe.

Increase accessibility

In order to improve the user-friendliness and accessibility of data spaces, simple onboarding processes and intuitive service provisioning should be developed. Trust can best be fostered through commercial solutions based on opensource software, as they combine transparency with reliable support and long-term sustainability.

Guarantee of the highest safety standards

In the aerospace industry, it is crucial to guarantee data protection and sovereignty. In the further development of technologies, the focus should be on data sovereignty, the implementation of automated and enforceable data usage agreements and the strict accreditation and identity verification of participants.

[1] For more information on the DSBA see: https://data-spaces-business-alliance.eu/

Development of operator models

To ensure the long-term success of data spaces, it is crucial to develop operator and business models with a clear governance structure. This structure regulates the responsibilities and interactions between the players and includes a comprehensive set of rules with technical specifications and internal guidelines.

Identification, refinement and implementation of use cases

The domain should actively develop and integrate specific use cases. This includes a structured process: from identification to refinement and implementation. It should promote cross-industry cooperation in order to maximise the economic, technological, and social benefits of data spaces and strengthen the industry's competitiveness.

1. Introduction

Europe is facing numerous challenges: The increasingly noticeable effects of climate change, for example the increase in extreme weather events, developments in digitalisation and artificial intelligence (AI), geopolitical changes and economic competition are just some of the tasks for the future. Aerospace offers solutions: Its infrastructures promote the economy, research, innovation, mobility and safety. Additionally, its technological capabilities make an important contribution to climate protection through developments such as low-emission propulsion systems, satellite-based Earth observation and digital twins. As a key technology, it strengthens the economy in Germany and Europe. As part of the European data strategy, guidelines have also been developed to strengthen the European market and improve the sharing and management of data within the EU. The Gaia-X initiative plays a central role in this. In contrast to most existing cloud offerings, which are not federated by design, Gaia-X prioritizes transparency and user control, in addition to established principles like data protection and interoperability. The Gaia-X initiative aims to create a trustworthy framework for a secure and sovereign exchange and use of data.

1.1 Introduction and motivation

More than any other sector, aerospace is closely intertwined with digitalisation and the data economy: technology and digitalisation promote aerospace, which in turn is an enabler for the data economy. Satellite and space technologies generate extensive data that is required for numerous applications, making them indispensable for the information and industrial society: they network IoT systems, enable telecommunications, control mobility and logistics, navigate ships and aeroplanes, and improve weather forecasts. Non-space-related sectors also benefit from these technologies. They provide precise earth observation data that is used in areas such as environmental monitoring, climate research, agriculture, and disaster management. Aviation also plays a central role as a key technology: as a driver of innovation, it is driving the digital transformation. It develops solutions and security standards for critical technologies and sensitive data that are also used in other sectors. This creates synergy effects that extend far beyond the aviation sector and strengthen the automotive industry, the energy sector and the logistics industry, for example. Innovation and European cooperation are important to secure this basis and the sovereignty of Germany and Europe.

Sovereignty also decisively strengthens competitiveness in the data economy: the Data Governance Act (DGA), the Data Act (DA) and the GDPR form a comprehensive legal framework for the protection, collection and exchange of data as part of the European data strategy.[2] This is intended to ensure fair competition and strengthen data sovereignty. Companies have major knowledge gaps in this area, and the need for consulting, implementation, and operation will grow strongly and offer great potential. Germany's lead in digitalisation along the entire digital supply chain is an important factor in securing the country as a business location and for job security.

Various data space initiatives, such as BDVA, FIWARE, Gaia-X or IDSA, deal with the generation and sovereign exchange of data (cf. Figure 1). The *Data Spaces Business Alliance* (DSBA) is an association of leading European organisations that have been focusing on the further development of data spaces and the convergence of approaches since its foundation in 2021. Its members are *the Big Data Value Association* (BDVA), the *FIWARE Foundation, Gaia-X Association* and *International Data Spaces Association* (IDSA). It connects companies and organisations to create a ***common and coordinated framework*** and international standards for sovereign and interoperable data sharing. Within the Data Spaces Business Alliance, the European Gaia-X initiative is creating the trust framework for a trustworthy, open, and transparent data infrastructure. It does not aim to replace cloud solutions but complements them—especially in scenarios where large cloud service providers are subject to extraterritorial data transfer laws. Gaia-X fosters data sovereignty and data sharing by offering European actors the transparency and flexibility to

[2] For more information on the legal frameworks visit Chapter 1.3.

choose how and with whom their data is shared. Through commonly agreed rules, standards, and federated governance models, the Gaia-X Association provides a framework that ensures transparency in the use of infrastructure services—an essential prerequisite for any secure and sovereign data exchange within federated data spaces. The aerospace domain at the Gaia-X Hub Germany is primarily concerned with the technical foundations of infrastructures for sharing sensitive and security-critical data in accordance with Gaia-X standards. The aim is to create a transparent and secure data infrastructure for cross-national and cross-sector collaborations that promotes innovation in the aerospace industry and enables new business models.

Projects such as the projects COOPERANTS (in Germany), Decade-X (in France) and Aerospace-X (in Germany) are developing concrete solutions in the form of use cases and open-source technology. These serve as the basis for application-independent software modules and fulfil the legal requirements for European data sovereignty. In this way, the domain strengthens the networking of stakeholders and the location of Germany and Europe. Existing ecosystems are already making a significant contribution: four Gaia-X lighthouse projects, including COOPERANTS, use Pontus-X and Ocean Enterprise to create interoperable and Gaia-X-compliant data spaces. Pontus-X is an open, federated environment for testing, demonstrating and validating Gaia-X compliant services and data spaces. It is built on Ocean Enterprise, a free and open-source software solution tailored for enterprise use, enabling organizations and public institutions to securely manage and commercialize proprietary AI and data products within a trustworthy and compliant environment.[3] These four lighthouse projects are publicly accessible in Pontus-X, fully interoperable and demonstrably compatible with the Gaia-X framework. Pontus-X already integrates six out of the eight recommended services from the Data Space Support Centre's (DSSC) Toolbox 1.5—a curated catalogue of essential data space components such as connectors, wallets, vocabulary hubs, contract templates, and more. By doing so, it actively contributes to aligning and harmonizing the various data space initiatives (DSSC, 2024b). [4]

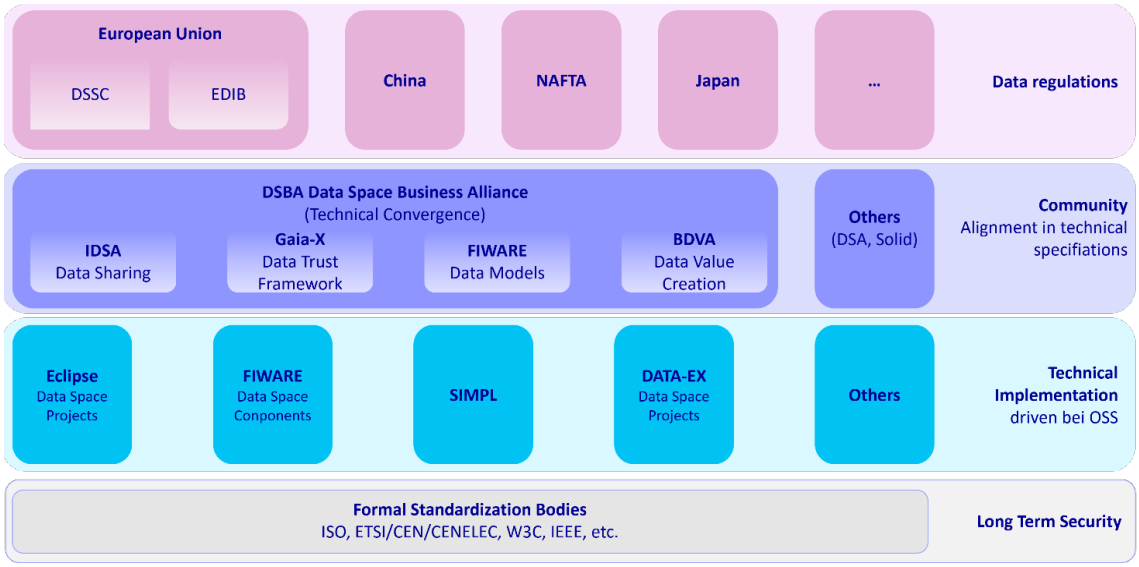


Illustration 1: Overview of data space initiatives (own illustration, based on Gaia-X Association)

1.2 Trends and challenges

Like other industries, the aerospace sector faces major economic, ecological, technological and political challenges and is influenced by regional, national, and international trends. In particular, it is shaped by technological

[3] More Information on: https://www.pontus-x.eu/#hero.

[4] More information on: https://dssc.eu/space/News/blog/533430342/The+DSSC+Toolbox+and+its+validation+scheme

innovations and digitalisation, climate compatibility, and sustainable initiatives as well as market changes. Digitalisation plays a transformative role and influences many areas. It utilises advanced technologies such as AI, big data, cloud computing, and the Internet of Things (IoT). These technologies increase efficiency, reduce costs, develop new business models, and open up opportunities for future-proof and sustainable solutions. One important aspect is the use of digital twins, which make it possible to simulate and monitor physical systems in real time. This optimises the operation of aircraft and satellites, improves maintenance processes and supports the development of innovative designs. The challenges and trends thus offer great potential for the economy and strengthen Germany and Europe as business locations.

The EU's dual-use regulation (2021/821) provides a special framework for the aerospace industry. The regulation has defined dual-use goods and regulated international export controls for them since 1995. Many aerospace technologies and goods, such as engines and propulsion systems, satellite and navigation technologies or unmanned aerial vehicles, can fulfil both civil and military purposes, are subject to the regulation and require strict export controls. The aerospace industry is faced with a complex task and must find a balance: It should promote innovation and international trade and at the same time must fulfil strict safety requirements.

The future of the Aviation sector in Europe depends on the ability to deliver on time and on quality, more than 8,000 commercial aircraft that make up the order book for the coming years, and on preparing the next generation of products and services that meet environmental and societal challenges. This success depends on our ability to involve and collaborate with more than 10,000 stakeholders in our complex and interdependent industry, a large proportion of which are small and medium-sized enterprises (SMEs) and mid-cap companies.

The four underlying priority areas are:

- the resilience of our supply chain
- the industrialization of new products
- product compliance and adaptation to regulations (e.g., exports, data)
- sustainable and responsible development

In 2023, 18 key stakeholders in the industry evaluated the innovative Data Space concept based on Gaia-X principles, which enables the sovereign exchange of data, and confirmed that it represents a major opportunity to develop multi-level and interoperable collaboration solutions for all stakeholders, particularly SMEs and mid-cap companies.

In 2025, we aim to unite the industry's strengths to develop a digital ecosystem for the sector of Aerospace and Defence, ***Decade-X***, based on this concept. To this end, an international consortium is currently being created.

Digitalisation also plays a major role in aviation production: projects such as ***Decade-X*** and ***Aerospace-X*** jointly develop solutions to improve supply chains with federated data systems through digital continuity and standardised processes and to make them efficient, resilient, and sustainable. The tasks ahead require innovation and investment as well as close cooperation between the stakeholders involved in order to strengthen the business location.

The space industry in Germany and Europe is in a state of upheaval and faces a number of technological, economic and (geo)political trends and tasks that will characterise it in the future: access to space to secure European sovereignty, increasing use and commercialisation of space industry ("new space"), space logistics and the construction and expansion of space stations and infrastructure on the moon and Mars, technological innovation such as new propulsion systems and refuelling options (fuel depots in space), satellite constellations (IRIS²) and reuse of rockets, as well as a focus on sustainable solutions. Space industry and digitalisation are mutually dependent: the German government has therefore defined the future availability of data as a strategic goal in its digital strategy. Space therefore offers great application potential for sustainability and climate protection and interfaces with other sectors such as agriculture, urban and transport planning or mobility management. Space industry and the data generated by earth observations in the downstream sector (e.g. by Copernicus) are drivers of digitalisation and make

an important contribution to understanding climate change and sustainable development (see Space2030 Agenda). Space infrastructures will be an important area of the space economy.

The concepts of digitalisation and data use are also being taken up in the space sector and integrated into its processes - from the development and production of space technologies to their operation and the use of data in all missions. (see the Federal Government's space strategy). This is where the ***COOPERANTS*** (Collaborative Processes and Services) project comes in: The research project develops more efficient, decentralised working methods and processes across the entire life cycle of space and air vehicles and creates digital infrastructures for the secure and standardised exchange and sharing of data.

Data economy and data security will play an increasingly important role for both players in the future. The monetisation and trading of data and services requires security, transparency and interoperability. Other markets (certificates, property, art, energy, mobility) are already showing how new value creation models can be successfully utilised.

1.3 Legal framework

With the ***Digital Markets Act (DMA)***, the ***Data Act (DA)***, the ***Data Governance Act (DGA)*** and the ***eIDAS Regulation***, the European Union is creating a comprehensive legal framework (cf. Appendix, S. 26) This ensures fair competition, strengthens data sovereignty and establishes a standardised digital identity in Europe. This fundamentally changes how companies in almost all sectors handle data and offers new opportunities for data-driven business models. This also has an impact on the aerospace industry.

A central element of the new legal landscape is the ***DA,*** which promotes the sharing of data and obliges companies to make previously exclusive data accessible. This applies to both personal and non-personal data and covers companies in all sectors of the economy, from agriculture to aerospace. The DA distinguishes between data holders, users and third parties and stipulates that data holders, such as manufacturers of aircraft and satellite components, make production and operational data of their components available to their customers. Article 4 of the Data Act stipulates that this access must be in a structured, commonly used and machine-readable format. In this way, valuable operational data generated by aircraft, satellites or other aerospace systems is made accessible first, which means that this data does not remain in data silos, but can be used to optimise processes, improve maintenance or develop new services. In addition to the Data Act, the ***DGA*** also plays a central role in the European data ecosystem. Among other things, the DGA requires data brokerage services to be interoperable, which is crucial for cross-sector data spaces. Both laws promote interoperability but take different approaches: The DGA creates the institutional framework for secure and efficient data use by establishing data spaces and promoting data brokering services. The DA complements these efforts at an operational level by defining specific regulations for data sharing and technical interoperability. Together, the DGA and the DA promote the creation of a standardised European data space in which data can be used freely and securely. By combining the institutional framework of the DGA with the operational regulations of the DA, an environment is created that ensures both the innovative use of data and the protection and control of this data. This reduces fragmentation, enables collaboration and at the same time promotes user trust and data sovereignty.

Other significant legal developments in the area of the data economy are the Digital Markets Act and the ***eIDAS Regulation***. The ***DMA*** aims to regulate the market power of large digital platforms that act as gatekeepers and ensure fair competition. An example of the impact of this law is Apple's obligation to customise its iOS system to provide equal opportunities to third-party providers and prevent unfair competitive practices. The DMA, in particular Article 6(1)(f), requires gatekeepers not to discriminate against access to their platforms and to ensure that competing services can be integrated on an equal footing. This shows how seriously the EU takes its role as guardian of fair competition and at the same time sets a benchmark for other industries, including aerospace, where future data and service platforms must also be designed to be competition neutral. The ***eIDAS Regulation*** forms the basis for

electronic identification means and trust services in the EU. With the introduction of the EUDI Wallet, responsibility for digital identity will be transferred to the individual user, which will also bring significant changes for companies. Article 6 of the eIDAS Regulation obliges Member States to mutually recognise electronic identification means, which facilitates the cross-border use of digital identities. In the aerospace industry, where international cooperation and supply chains play a central role, this digital identity could create new opportunities for simplified and secure business processes.

Gaia-X helps to implement the requirements and legal specifications by relying on open and transparent standards that ensure interoperability of services and increase market transparency. These aspects—transparency, compliance, and interoperability—are critical when building federated and decentralised data spaces that are trustworthy and scalable across sectors and borders. Decentralised data ecosystems, known as data spaces, are flexible and open IT structures that enable the stakeholders involved to use decentralised data in a trustworthy and transparent manner while retaining their full sovereignty. Gaia-X provides a general framework for trust in federated digital services, which can be applied to enable secure and transparent data sharing. In doing so, it makes an important contribution to the development of data spaces.

2. Data Spaces and Gaia-X

2.1 Interoperable data spaces

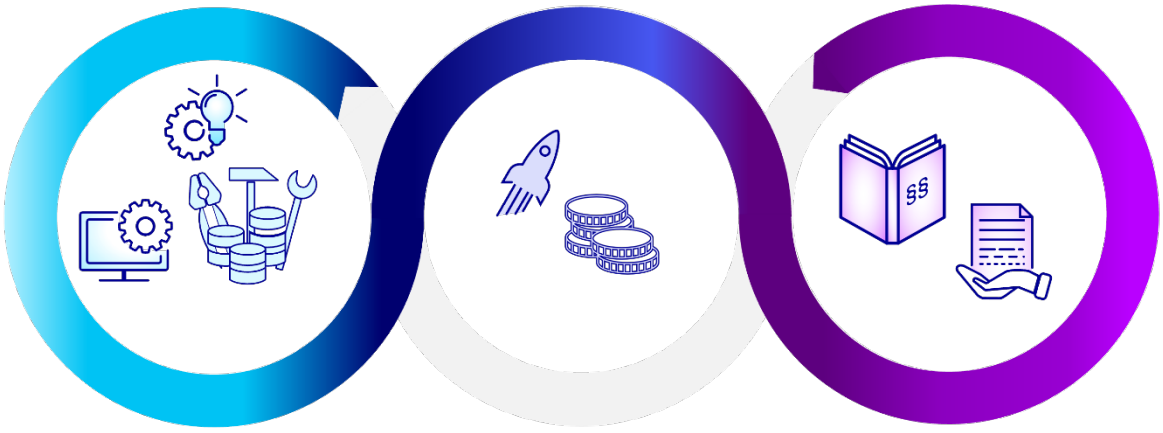
Unlike conventional data exchange, where data often has to be stored in proprietary silos or transferred in its entirety, in ***data spaces*** it remains at its point of origin. Instead of setting up individual data agreements and proprietary interfaces for each business partner, data spaces use standardised interfaces and interoperable solutions. They offer an efficient alternative to individual solutions, reduce administrative effort and enable flexible and fast data exchange between stakeholders. Technical barriers and incompatible systems that inhibit the free flow of data are overcome, which promotes data-driven business models.

The underlying federal organisational principle of the data spaces is based on various core concepts:

- Firstly, services for data space operation and management, known as ***core services***, provide the necessary infrastructure and technical components to operate and manage data spaces. These services include identity management, access control, data cataloguing and ensuring data security.
- Secondly, technical ***standards*** are defined to ensure that all systems involved can communicate seamlessly with each other. These standards promote interoperability and facilitate the exchange of data across different platforms.
- Thirdly***, operational processes*** must be established to ensure the smooth operation of the data spaces. These processes regulate access to the data, its exchange and use, as well as compliance with the defined standards and security protocols.
- Finally, ***governance frameworks*** play a central role. They define the rules and guidelines that apply within the data spaces and ensure the transparent and fair use of data. These governance mechanisms safeguard the rights of participants and ensure trustworthy data exchange.

A data space can be described as a "federated, open infrastructure for sovereign data exchange based on common agreements, rules and standards" (Reiberg et al., 2022, p.11). Initiatives such as Gaia-X, the International Data Spaces Association (IDSA) and the FIWARE Foundation provide the necessary tools and structures for this. [5] Overall, data spaces can be viewed from different perspectives: as a means of data integration, as a platform for economic exchange and as a tool for strengthening data sovereignty (see Figure 2, p.). It is important to develop a common understanding of data spaces that integrates the different requirements and objectives. A consensual definition of the term "data space" is a first step towards establishing such a common understanding and successfully advancing the practical realisation of data spaces. Data spaces thus form the foundation of a European data economy based on trust, security, and openness.

[5] For more information on the different data space initiatives view Chapter 2.3



Technical perspective

Data that is available at one location and needed at another does not necessarily have to be transferred completely and permanently. Instead, it is only integrated to the extent and for the duration necessary. The federated architecture uses data efficiently and in a way that conserves resources.

Data spaces are used for data integration.

Economic perspective

The distributed nature of data opens up opportunities for economic exchange and innovation. They create incentives for companies to participate in data sharing, thereby achieving economic and geopolitical sovereignty and societal prosperity.

Data spaces facilitate the exchange of data between companies and between companies and consumers.

Legal perspective

Participation opportunities and neutrality obligations for certain intermediaries are of great importance. These requirements and regulations are being integrated into the legal systems of various EU member states to ensure user protection.

Data spaces give users control over their data, which is often stored in a fragmented manner with different providers and beyond their control.

Illustration 2: Perspectives of data spaces (own illustration)

2.2 Gaia-X value proposition

Gaia-X creates a comprehensive framework that enables companies in Europe to develop innovative, data-driven business models while complying with strict European data protection and security regulations. It not only supports large companies, but also facilitates access to a competitive, open and secure data infrastructure for SMEs in particular.

Gaia-X is based on ***the legal framework and values*** of the European Union and helps companies to implement complex regulations such as the Data Act (DA), the Data Governance Act (DGA) and the General Data Protection Regulation (GDPR) (see Figure 3, p. 10). With clear guidelines and best practices, Gaia-X offers solutions to the challenges posed by these regulations and helps companies to organise their compliance strategies more efficiently. Standardised contracts, transparent data offerings and harmonised security protocols minimise legal risks and significantly reduce costs. Although compliance with Gaia-X does not automatically guarantee full compliance with all specific regulations, it does provide structured support that reduces uncertainty and simplifies the implementation of legal requirements.

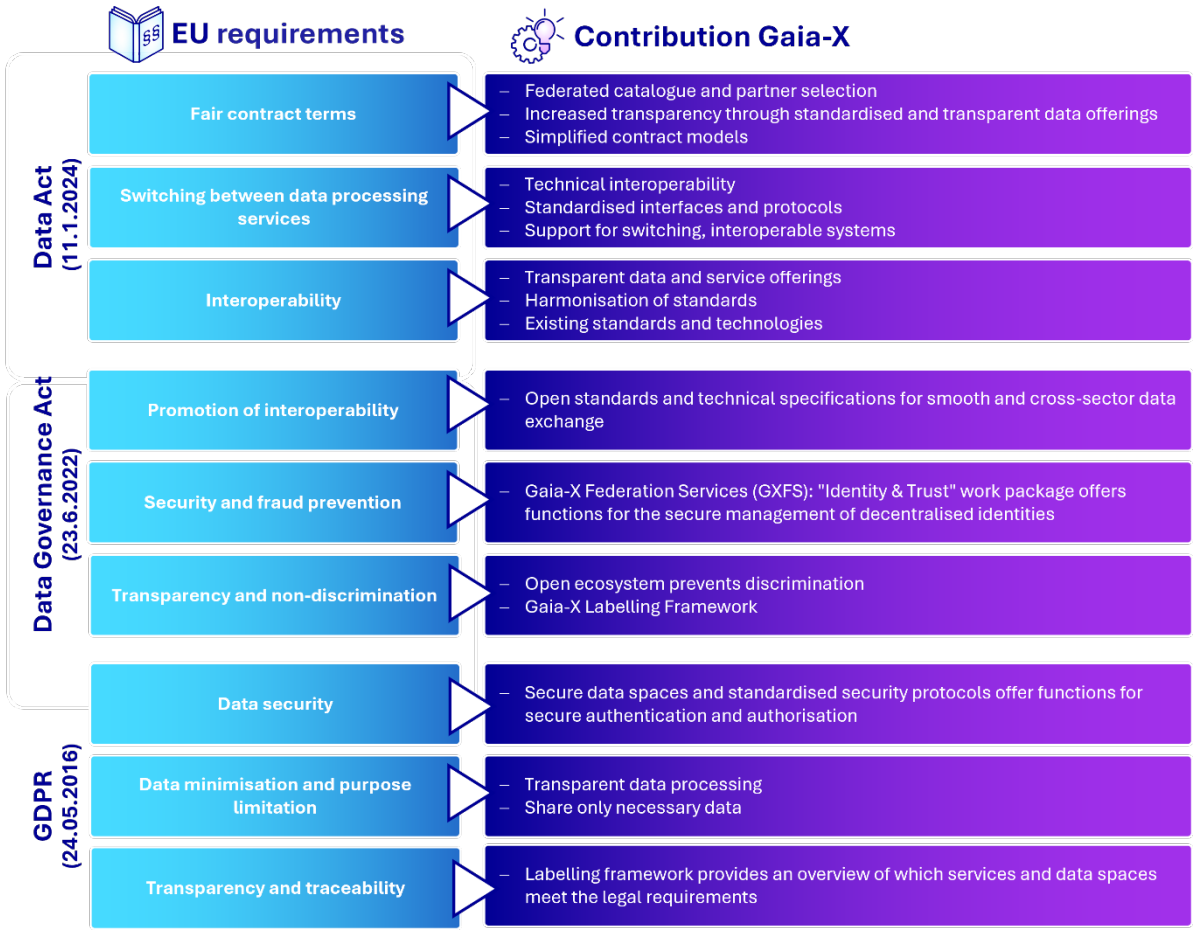


Illustration 3: Particularly relevant EU legislation (part of the European data strategy) and Gaia-X's contribution to compliance with this (own illustration)

Advantages of Gaia-X

Gaia-X opens up new, data-driven ***business models***. Following the Gaia-X Trust Framework, a decentralised and secure infrastructure is created from composable services. This federated approach enables the active integration of companies into the digital data economy and fosters a trustworthy environment for highly secure data exchange in the aerospace industry. Companies can expand their core competencies such as data generation, analysis or secure data exchange in a targeted manner and at the same time draw on the expertise of other players in the ecosystem through collaborative cooperation. This promotes new value creation opportunities by offering data as a service or creating added value through analysis and forecasting services.

Gaia-X opens up the opportunity to ***participate*** in the data economy, especially for SMEs involved in the production of individual parts or small batches in the aerospace industry. Smaller companies often face challenges due to limited infrastructure and resources, especially when dealing with complex data projects and navigating regulatory requirements. Gaia-X lowers these entry barriers by providing easy access to advanced data processing and analytics. By following a common, open, and coherent foundational framework, smaller providers use the same system as larger players and can participate in an open and fair market. This expands the range of available and customisable solutions.

Another significant added value of Gaia-X lies in the preservation of ***data sovereignty***. Companies retain full control over their data and decide who is authorised to access it and for what purpose. This is particularly important for industries with high security requirements and sensitive data, such as aerospace. Features such as end-to-end encryption and compute-to-data technologies ensure that data remains secure and sovereign throughout its lifecycle. This data sovereignty creates trust in the use of cloud and data processing services and makes it easier for companies to develop data-driven business models without losing control of their valuable information.

In addition, Gaia-X ***promotes effective collaboration*** and active knowledge transfer within the ecosystem from different locations. The Gaia-X framework enables companies, research organisations, and public institutions to collaborate on innovative projects without compromising their sovereignty over data and infrastructures. By being interoperable by design—at the level of descriptions, policies, and standards—it creates the basis for cross-sector learning and the exchange of best practices. This, in turn, supports the continuous improvement and adaptation of data-driven processes. This is particularly important in industries such as aerospace, where data-based innovations offer high synergy potential or where the production of individual parts and small batches takes place.

Another advantage of Gaia-X is the provision of an ***open and competitive cloud infrastructure*** that gives companies of all sizes access to advanced technologies. For SMEs in particular, this means the opportunity to benefit from technologies such as big data, artificial intelligence and machine learning without having to invest heavily in their own IT infrastructures. Large companies also benefit from the diversity and openness of the Gaia-X ecosystem by being able to choose the best solutions for their specific needs from a wide range of solutions. This diversity not only promotes competition but also enables companies to react flexibly to changing market requirements.

In addition, Gaia-X strengthens the ***global competitiveness*** of European companies by creating an open and interoperable infrastructure that can be used beyond Europe's borders. Through Gaia-X, European companies can enter into international collaborations while maintaining compliance with European values and regulations. This is particularly important for international industries such as aerospace. Gaia-X promotes internationalisation and drives the development of a sustainable European data economy that is an international role model for data protection and security.

Gaia-X offers the opportunity to build a European data economy that promotes openness, interoperability and security. It supports companies of all sizes and industries to develop innovative, data-driven business models, improve their data strategies and take full advantage of digital transformation. Data spaces based on common standards and open technologies offer clear benefits and form the basis for a competitive and innovative European aerospace industry. Gaia-X harmonises European regulations, supports SMEs and creates a competitive market for data-based services. Data is shared in a sovereign and controlled manner while fulfilling the requirements of the Data Act and other EU regulations. Gaia-X creates a sustainable and innovative data economy in Europe that offers multiple benefits to all market participants and strengthens Europe's digital sovereignty.

Statement from OHB[6]:"As OHB SE, we find answers to the complex questions of our time. Pioneering new technologies is part of our DNA. With Gaia-X, we are empowering future digital engineering, foster seamless collaboration across the value chain and facilitate digital business models for downstream services. We trust Gaia-X to strengthen European sovereignty, ensuring our data and intellectual property remains secure and innovation thrives within a trusted ecosystem."

[6] OHB SE is a European space and technology Group and one of the major independent forces in the aerospace industry. It has more than 40 years of experience in the development and implementation of innovative space systems and projects as well as its range of specific aerospace and telematics products.

3. Vision and positioning of the domain

The aerospace sector plays a key role in European industry. It is characterised by a high level of innovation and complex technological challenges that require secure, efficient and innovative handling of data. The rapid pace of technological development with new possibilities and the increasing number of crises are increasing the need for solutions such as data spaces that offer access to real-time data and the highest level of security at the same time.

In order to meet these demanding requirements and strengthen competitiveness, the Gaia-X aerospace domain is planning to lay the foundations for the development and utilisation of (interoperable) data spaces for the industry at the Gaia-X Hub Germany. This digital infrastructure should enable companies, research institutions and authorities to exchange, analyse and share data securely and confidently up to the end-users. Gaia-X conformity ensures that the highest standards in the areas of data protection, security and interoperability are met while ensuring compliancy with required data policy and regulation (e.g. export control).

Aerospace is an international engine for the global economy, so the domain endeavours to promote community building in Europe. It is important to think and constitute the domain in European terms, but also to intensify cooperation beyond Europe. A comprehensive data ecosystem and a common data space are intended to break down silos so that all organisations can cooperate better. The domain would like to work more closely with organisations such as the Gaia X Association, DSSC and IDSA. In their aerospace ecosystem, we want to find and strengthen the connection to European communities.

3.1 Common Data Space for Aeronautics and Space for Europe

The aerospace domain of the Gaia-X Hub Germany emphasises the need to simplify access to and exchange of data and to strengthen the development of shared and interoperable data spaces. This brings significant benefits and pursues several strategic goals. It supports the position of the Gaia-X Association (Gaia-X AISBL, 2021), takes up the recommendations and strives for a Europeanisation of cooperation.

Objectives of a shared data space

By setting up a shared data space, the aerospace domain is aiming to achieve several key objectives that promote digital collaboration and efficiency in the industry:

- ***Promoting effective collaboration***. A shared data space enables the location-independent, real-time exchange of data along the entire value chain - from suppliers to manufacturers and other partners. This eliminates isolated data silos and significantly improves collaboration between different players. This enables seamless integration and coordination of the companies involved, which speeds up product development and production processes and makes them more efficient.

- ***Preserving data sovereignty***. Data spaces ensure that each company retains full control over its data and can decide for itself who is authorised to access the data and how it is used. Clear standards and protocols ensure secure and transparent data exchange, which strengthens the trust of those involved and fulfils the legal requirements of the industry.

- ***Promoting research and innovation***. Extensive, shared data sources facilitate the development of new technologies, for example in the field of autonomous flying, maintenance optimisation or increasing fuel efficiency. AI algorithms, which are trained on large data sets, enable more precise predictions and faster solutions. This accelerates the innovation process and opens up new business opportunities for the aerospace industry.

- ***Promoting interoperability and standardisation***. The smooth exchange of data between different systems and platforms reduces dependency on proprietary solutions, increases openness to technology and facilitates collaboration. This creates a dynamic and competitive ecosystem in the long term.

- ***Establishing a framework for security and trust.*** High security standards are essential, especially in the aerospace industry, where a lot of data is of business-critical importance, often affects national security interests and is subject to dual-use regulations. The development and use of robust security protocols that protect sensitive data from unauthorised access while ensuring transparency in the handling of this data form the basis for the development of a framework for trust.

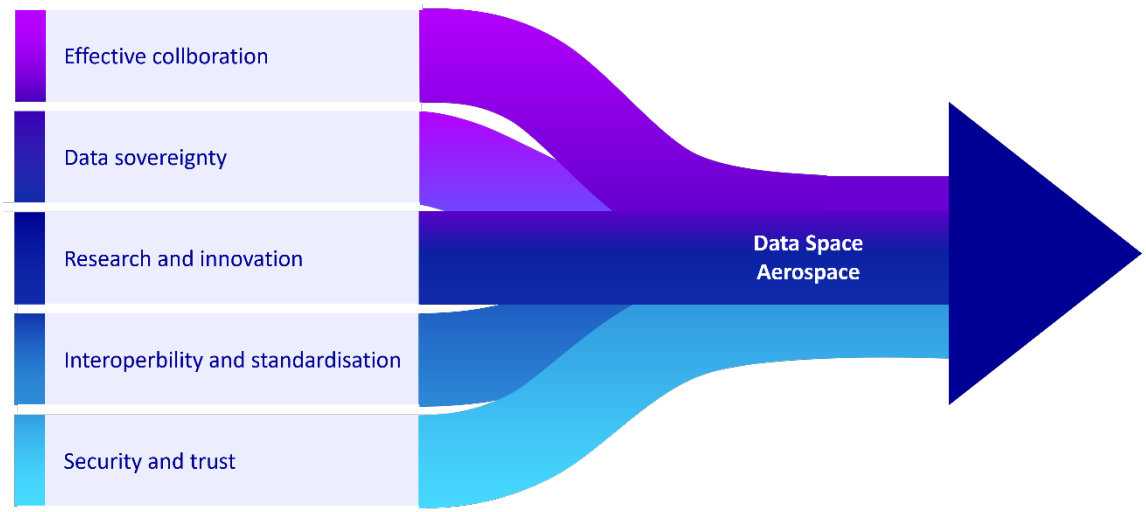


Illustration 4: Objectives of a common aerospace data space (own illustration)

Various projects and initiatives are already realising interoperable data spaces. They show how data spaces can work and contribute to the realisation of the objectives listed. For example, the ***COOPERANTS*** project is developing a Gaia-X-compliant data space for the aerospace industry in order to increase efficiency and innovative capacity through increased digitalisation. The ***Tellus project*** aims to enable hybrid cloud scenarios and create a secure, efficient data infrastructure. Other projects such as ***ACCURATE*** and ***Aerospace-X*** are driving the digitalisation of the aerospace industry by integrating technologies such as Manufacturing-as-a-Service (MaaS) and digital twins into the value chains, thus laying the foundations for a sustainable, resilient future. The decentralised digital ecosystem Pontus-X forms the technical basis for projects such as ACCURATE and COOPERANTS and enables the creation of an interoperable data space that promotes the secure, decentralised exchange and sovereign management of data. It is based on the compute-to-data principle, allowing data providers to retain control over their information by processing data locally without having to physically transfer it.

Potential of Gaia-X for the aerospace industry

The aerospace sector benefits significantly from Gaia-X. This highly technologized industry collects and processes large amounts of data and must comply with strict security requirements and dual-use regulations (EU 2021/821). Gaia-X provides the framework and the necessary infrastructure to master the complex challenges and at the same time open up new opportunities for data-driven business models.

- ***Gaia-X provides security standards*** that enable the secure exchange of dual-use relevant information and develop methods for handling technologies and goods that are used for both civilian and military purposes. The initiative offers solutions for trustworthy data exchange, enables interoperability for co-design and

technical data and simplifies distributed data models. This creates the basis for innovative collaboration within the industry.

- ***Gaia-X ensures access to an open data space infrastructure***. Companies and research organisations in the aerospace industry can network internationally while complying with the strict European requirements for data protection, security and data sovereignty. Secure and DGA-compliant trade is made possible, uses eIDAS and SSI and fulfils KYB (Know Your Business) and KYC (Know Your Customer) for both individual and bulk transactions. All data processing companies must fulfil this requirement. This offers advantages not only for industry, but also for science, which relies on the secure exchange of large volumes of data, for example in the research and development of new technologies. Gaia-X forms the basis for a sustainable and competitive future for the European aerospace industry and science in this field.

- ***Gaia-X facilitates collaboration by separating data collection and utilisation*** and strengthens trust in cloud services. Trust-based collaboration promotes the exchange between business models. Special attention is paid to trustworthy identity management, which forms the basis for all aerospace use cases and supports cyber security.

- ***Gaia-X reduces the effort and time involved in the certification process***, as the identities of the participants are already verified. This enables continuous management of airworthiness and safety over long product lifecycles. Companies also benefit in the area of aircraft operation, maintenance, repair and overhaul through the trustworthy exchange of operational data, which increases efficiency and enables the development of new business models.

- ***The aerospace industry can act as a central industry within the Gaia-X ecosystem*** and utilise its global reach and comprehensive supply chains to support other sectors such as Industry 4.0 and mobility. This creates synergies that lead to value creation and innovation not only within the industry, but also beyond.

A common aerospace data space will serve as an important catalyst for innovation and growth. It will enable the industry to organise its global supply chains more efficiently, develop new technologies faster, and secure its international competitiveness in the long term.

3.2 Strategic alliances for Europe

Strategic alliances and long-term partnerships between companies, research institutes and governments not only ensure the continued existence but also promote the further development of the European aerospace industry: Cooperations enable access to new technologies such as digital twins, AI-supported maintenance and automated manufacturing. Strategic alliances are crucial to protecting European interests in aerospace through secure, interoperable, and sovereign data spaces, ensuring European sovereignty and strengthening Europe's competitiveness in the global market.

Gaia-X as a key initiative

Gaia-X promotes the establishment of a sovereign European data space, which is particularly aimed at safety-critical industries and thus fully meets the requirements and needs of the aerospace industry. In addition to the technical standards for an open, secure and transparent data infrastructure, Gaia-X also specifies regulatory frameworks (see 1.3 Legal framework, S.7) and ensures compliance with security standards and data protection (cf. Appendix, S.26). Gaia-X thus forms the ***basis for trust and transparency*** and ***strengthens strategic alliances*** and long-term partnerships between European countries, organisations and companies in important sectors. Projects such as COOPERANTS or Aerospace-X show the potential that lies in strategic alliances and strong partnerships. ***Financing***

the digital infrastructure for the development of data spaces is a major challenge. No single player is in a position to bear the costs alone. In addition to the establishment of governance structures and strategic alliances, close political support and co-financing will also be required to enable the establishment and continued existence of a common data space.

A common data space for aerospace not only strengthens the innovative power of the industry but also creates synergies with Gaia-X data spaces in other sectors, such as those for geoinformation systems, Industry 4.0 or mobility. This cross-sector collaboration promotes the exchange of data and knowledge, which enables new applications and business models. For example, geodata from aerospace can be used to create more precise analyses and forecasts in the fields of logistics, traffic control or agriculture. In addition, data spaces from other domains can also benefit from aerospace-specific security, compliance and sovereignty features that can also be used as best practices in other sectors. For example, high standards in encryption and secure data transmission that are established in the aerospace sector can be adapted in other data spaces from the Gaia-X environment to increase security there, which in turn promotes competitiveness and strengthens trust in data-based collaborations. The aerospace domain therefore endeavours ***to exchange and collaborate with other data space projects and Gaia-X domains***. Such an exchange is not only important at European level, but also in an international context. Due to the global nature of the aerospace industry in particular, a cross-border flow of data is essential to promote international cooperation and ensure that European companies and research institutions remain competitive. Due to the international nature of the domain in particular, a European exchange is of great importance here, as it contributes to the harmonisation of standards and the development of interoperable solutions that can be used worldwide.

Strong partnerships

Alliances also play a central role beyond sector-specific data spaces. Close cooperation and harmonisation with other data infrastructures are particularly crucial in order to strengthen competitiveness.

The *Data Spaces Business Alliance* (DSBA) brings together expertise and experience to accelerate the digital transformation in the data economy and thus makes an important contribution to the development of data spaces in the aerospace industry. The organisations have different delivery objects: While Gaia-X provides a trust framework that forms the organisational-regulatory framework for the interaction of distributed systems, the IDSA develops technical standards and reference architectures that enable trustworthy and secure data exchange. This is particularly important in sensitive industries such as aerospace, where the protection of critical data is a top priority. At the same time, the FIWARE Foundation promotes open standards and technologies in the area of the Internet of Things (IoT) and Smart Cities. Its platform offers a wide range of interoperable components that can be used in data spaces to facilitate the exchange of sensor data and other IoT information. This is of particular interest in the field of connected aviation, where more and more data from different sources, such as drones, aeroplanes and satellites, need to be collected and processed. The DSBA works closely with the *Data Spaces Support Centre* (DSSC), which coordinates the harmonisation of the various initiatives on behalf of the EU and bundles their activities.

This cooperation is crucial to prevent fragmentation of the European data landscape and to ensure that companies in all sectors can benefit from a standardised and interoperable infrastructure. The interaction of all these initiatives creates the ***conditions for a European data economy based on open and standardised technologies***. The aim is not to build new European silos in the cooperation, but to consider international connectivity.

The aerospace domain strives for an exchange between different Data Spaces initiatives. Based on the Gaia-X experience and with the Trust Framework as an important Gaia--X building block, future data spaces in the domain should be interoperable with other initiatives. Other technical building blocks from these initiatives will also be kept in mind so that they can be integrated into the domain-specific data spaces if required.

4. Outlook of the domain

Over the next few years, the aerospace industry must not only lay the technological foundations but also promote a culture of collaboration and openness and establish new business areas. Data spaces offer the opportunity to future-proof the industry through data-driven innovation, trust-based structures and technological progress. They enable more efficient processes, optimised business models and new collaborations. The aerospace domain has formulated specific recommendations for the next steps.

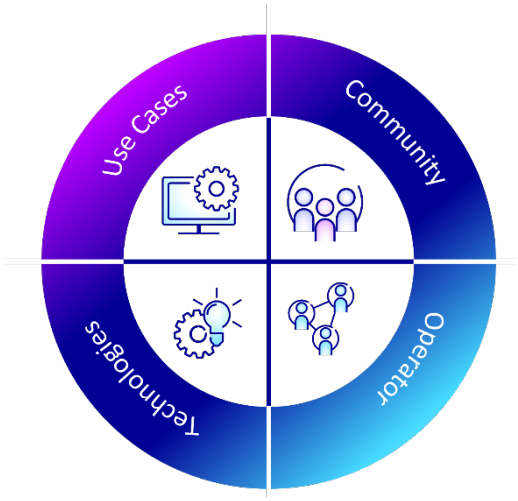


Illustration 5: Action areas for establishing a common data space (own illustration)

4.1 Community

Data spaces not only need data but also depend on various players. The aerospace community comprises a broad *spectrum of players:* research institutions and government organisations (national and international), industry (large-scale integration, operators, hardware and software suppliers), space data users (public and private) and aviation users. These include agencies, Ground/Earth Station Operation Centres (G/E-SOC), ministries, airlines and existing portals. Together, these players shape an ecosystem and take on various *roles in the data space*: data provider, data user, service provider, service user and operator.

The main goal of the aerospace domain in the Gaia-X Hub Germany is to create a common understanding and build an ***active user community*** in the various roles of a data space. Various strategies are being pursued to achieve this goal:

1. ***Communication and networking:*** To increase awareness and acceptance of Gaia-X in the aerospace industry, partnerships will be established with key national and international organisations and associations and communication and information campaigns will be carried out. This will help to build the community.

2. ***Information infrastructure:*** A shared and easily accessible information environment—comparable in function to platforms like ResearchGate—pools and provides essential information. It serves as the first point of contact for interested parties and potential members as well as a source of information for the existing community. This is where the Gaia-X Hub Germany can provide support as the domain's administrative centre. A standardised and easily accessible exchange format will be necessary to enable efficient communication and data exchange within the data space and between participants. This requires easy accessibility.

3. ***Knowledge sharing and collaboration:*** One potential approach is to set up working groups that work on specific technical standards in topic-specific workshops and hackathons in order to increase trust and efficiency in the data infrastructure. The exchange of best practices and the development of concrete use cases promote cross-industry synergies. Active participation in other domains utilises experience from other sectors.

4. ***Community activities:*** In order to establish a lively community, personal exchange and networking should be strengthened and face-to-face events offered. This is particularly important for building trust and relevant for matchmaking participation. Community calls should provide information on current funding projects and funds and present opportunities for data and service offerings. Regular newsletters should provide information on current developments in use cases and opportunities. Success stories will be presented to provide inspiration for further projects.

These diverse approaches aim to create a vibrant community that pursues common goals and drives digitalcollaboration in the aerospace industry. The governance of the data space for the aerospace domain could take place through a collaborative and participatory structure within the Gaia-X community that emphasises transparency and co-determination.

4.2 Technologies

Data spaces are based on a complex technical infrastructure. The Gaia-X ecosystem is based on a federated structure of different actors (federators) that operate certain Gaia-X services. This structure also promotes collaboration across different data spaces. To ensure the security, trustworthiness and efficiency of the services, the actors use technologies such as interoperability standards, usage rights control and smart contracts, cryptographic technologies, auditing technologies and Gaia-X Federation Services. A long-term goal of the domain is to further develop the ***technologies*** for data spaces. Three central task areas have been crystallised in the process:

1. ***User-friendliness and accessibility***: In order to establish and successfully operate a data space, it is essential to reduce technological complexity and establish simple onboarding processes. This also includes intuitive service provision and the use of open-source solutions to promote software trust, which are of central importance here.

2. ***Data protection and sovereignty:*** Security is essential. This includes ensuring data sovereignty (including the control of data storage by country and organisation), the protection of design knowledge and the implementation of smart contracting for data usage agreements (personal data, NDA, security/PSI). Security aspects play a key role here, particularly in the accreditation of participants based on defined criteria and identity verification as well as return management during data exchange and ecosystem operation.

3. ***European values and interoperability***: Gaia-X is based on European values and rules, which are reflected in the Trust Framework and Compliance Document and should also be incorporated into the technological solutions. The aim is to create a common data space that is interoperable with European ecosystems. This includes the introduction of an electronic currency, compatible payment processes and browser-based solutions for LSI (Large Scale Integration).

In order to overcome these challenges, intensive cooperation between users, operators and developers will be essential in the coming months. This cooperation is to be promoted and structured through various formats such as user forums, working groups and workshops within the domain in order to develop innovative and practical solutions.

The COOPERANTS project is a concrete example of the success of such collaborations: one consortium partner became the Gaia-X Digital Clearing House (GXDCH). GXDCHs address the aforementioned challenges: They provide a ***user-friendliness*** solution by offering standardised, easily accessible services that make it easier for SMEs in particular to enter the data economy. They check and certify the compliance of participants and services with the

Gaia-X framework - from basic compliance to advanced security labels, which take into account additional aspects such as the protection of personal data, cyber security requirements and secure data traffic within the European legal area, thus making an important contribution to ***data protection and sovereignty***. The added value lies in building trust: they validate compliance with Gaia-X guidelines and thus create the basis for secure, cross-industry data collaboration. In this way, they support the Gaia-X vision of a trustworthy, secure and ***interoperable data space based on European values*** across different application areas. This role is particularly important in the aerospace domain, where the highest security standards and strict compliance with conformity requirements are essential. The solutions developed here are also to be transferred to other sectors.

4.3 Operator

Data ecosystems are diverse and are based on different business and administrative processes as well as alternative creation processes. They can be based on established value chains with key players as orchestrators or can emerge in less organised structures without a key player being able to coordinate the players.

The ***business models*** in data ecosystems aim to open up new value creation opportunities through multilateral data sharing. This can result in collaborative business models based on the joint development of new use cases. Other opportunities include increasing efficiency through process optimisation, data monetisation, new data-based services and innovations through the use of shared data pools. The ***operator model,*** on the other hand, is about the organisational and technical structure that enables and secures the operation of a data space and regulates the cooperation and interaction between the players involved. It defines how a data space is managed and operated, where the responsibilities lie, and which governance mechanisms apply. Monetisation can take place via various payment models, such as subscription models, pay-per-use models or onboarding fees. Possible operator models can be divided into three main models: in *centralised models*, a single player orchestrates and operates the data space; in *decentralised (federated) models*, several players operate the data space together; and in *marketplace models*, the data space functions as an open marketplace for data providers and users.

Gaia-X pursues a decentralised, federated model to balance control and collaboration: Several players operate the data space together, all participants retain control over their data and decide on data exchange themselves. This model promotes data sovereignty and trust between the players. Data spaces can be operated with or without their own legal personality. Without legal personality, they offer flexibility and a project-orientated structure through founding agreements, whereby resources and ownership remain with the members. This enables rapid implementation, but harbours risks for long-term stability. With their own legal personality, data spaces can act independently, conclude contracts and hold ownership rights, but require clear governance structures such as a general assembly or a board of directors to ensure independence and dynamism in the long term (DSSC, 2024). Examples of operational management are the limited liability company (GmbH), as in the case of the Mobility Data Space (MDS), and the registered association (e.V.), which Catena-X has chosen (Reiberg et al., 2024). The Airbus Skywise ecosystem demonstrates a platform model in which participants commit to providing data in order to use the platform. The choice of operator model depends on factors such as industry, participant structure and data protection requirements. The ***governance structure***, which regulates the relationships between the players in the community and influences the development and sustainability of the data space and its organisation, is central to its success. Regardless of the chosen legal form, it is essential to create a ***comprehensive rulebook*** that defines both technical specifications (e.g. APIs, data licences) and internal guidelines and procedures (e.g. dispute resolution mechanisms). Ideally, this set of rules should be available in a human- and machine-readable format (DSSC, 2024). Trust plays a key role in successful interactions between participants. A neutral orchestrator can ensure impartial control and is an important building block for the success of the data space. (Brousseau et al., 2024). Future developments could also include hybrid models that combine elements of different operator models to maximise flexibility and scalability. The integration of technologies such as blockchain for improved transparency and traceability could also further evolve operator models.

The aim of the domain is to ***develop business and operator models***, provide information about their possibilities and attract ***interested parties for the federative operation*** of data spaces. An operational data space as a future goal of the domain will only become a reality if one or more operators can be found. For long-term success, it is also crucial to consider the appropriate legal form and governance structure at an early stage, as subsequent adjustments can be complex and costly.

4.4 Development of use cases and new projects

The ***development of use cases*** and their ***successful integration*** is crucial for the success of data spaces in the aerospace industry. In order to fully utilise their potential, concrete use cases must be developed that generate economic, technological and social benefits. Data spaces offer the aerospace industry enormous opportunities along the entire supply chain: use cases can range from the production and maintenance of aircraft to specialised areas such as satellite-based airspace monitoring or the coordination of space projects. Access to data from a wide variety of sources such as sensors, production systems or traffic management services provides valuable insights that lead to the optimisation of processes and the development of new innovations. One example of this is the development of "simulation as a service" applications, in which digital twins of aircraft components are created and shared in a data space in order to shorten the development cycles of new models while reducing the costs of physical testing. Such approaches can significantly increase the efficiency of the aviation industry and ensure competitiveness.

In aerospace and defence, the initial use cases are focusing on supply chain management and sustainability for commercial programmes. From this starting base, the data space will gradually host more restricted data for use cases from the defence sector.

For information, the set of first use cases:

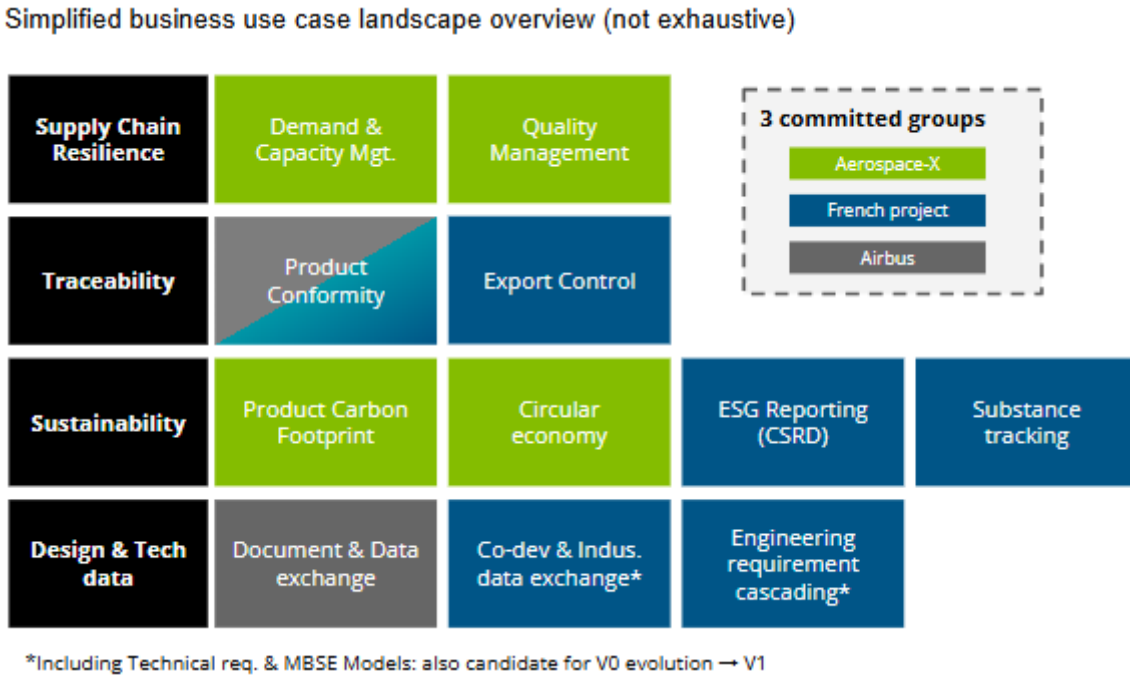


Illustration 6: Simplified business use case landscape overview (Aerospace-X)

The development process for use cases comprises three steps: ***Identification, refinement and implementation*** (DSSC, 2024b). New use cases are created by observing specific needs resulting from technological developments, changing

market conditions or regulatory requirements. Analysing the needs of existing and potential participants in the data space plays an important role in identifying potential use case scenarios. Industry-specific challenges, such as the optimisation of maintenance through predictive analyses or the improvement of flight safety through real-time data, can be tackled with data-driven approaches. Data spaces facilitate the ***identification of synergies*** by bringing together players with complementary data or skills. This structured approach would be difficult to implement without common data standards and interoperability. Identification is followed by refinement, in which the use case scenario is worked out in detail, an orchestrator coordinates the players, defines data flows and harmonises roles and responsibilities. The final step is implementation, in which the use case is realised technically and organisationally. In complex cases, a step-by-step implementation can be useful, in which a "minimum viable use case" is implemented first and then gradually expanded.

Data spaces offer the aerospace industry advantages in the development and implementation of use cases. They create a structured and trustworthy environment in which new use cases can be efficiently developed and realised. This benefits not only aviation-specific players, but also other industries with similar data processing and security requirements, such as the automotive industry, logistics companies and the energy sector. ***The systematic approach*** promotes innovation, optimises processes, and increases the value of data spaces in the long term, making the industry more competitive. In order to realise this potential, the industry must actively establish, further develop and efficiently use data spaces. ***Collaboration with other sectors*** can also create valuable synergies that promote cross-industry solutions. Companies need to work more closely together to develop common standards for data exchange, interoperability and security mechanisms. In addition, the industry must proactively identify and prioritise promising use cases that create clear added value through the use of data spaces. Use cases in maintenance, production, and logistics that promise efficiency gains or cost savings should be quickly and specifically implemented as "minimum viable use cases" and later expanded. At the same time, such use cases can serve as models that can be transferred to other sectors, such as the optimisation of production processes in the automotive industry or improved logistics management in retail. Another important field of action is the systematic utilisation of use case matching, in which suitable players are brought together in a targeted manner in order to jointly develop use cases. Mechanisms that facilitate this partnering ensure that data and technology suppliers cooperate efficiently with users and drive innovation. This applies not only to aerospace, but also to other industries that can benefit from similar challenges and opportunities in the area of data-driven innovation.

Equally important is the ***creation of clear governance structures*** that ensure the sustainable operation of data spaces. Mechanisms must ensure that all participants work according to the same rules, exchange their data securely and have confidence in the processes, for example through coordination by the central orchestrator. Finally, it is crucial to provide comprehensive training for all stakeholders in order to promote ***understanding and skills for the effective use of data spaces***. This requires targeted education and awareness-raising activities, which ideally should also be organised across sectors to ensure that both aerospace-specific and cross-sector stakeholders can develop a better understanding of the benefits of data-based collaboration. The aerospace domain can draw on knowledge from a large number of already advanced projects and use cases and thus take on a pioneering role and serve as an example for other industries of how data-driven innovation can be successfully scaled and implemented.

By consistently implementing the measures, the aerospace industry can play a pioneering role in the utilisation of data spaces and thus strengthen its global competitive position. Cross-industry collaboration and the exchange of best practices will benefit not only the aerospace industry, but the entire European data economy.

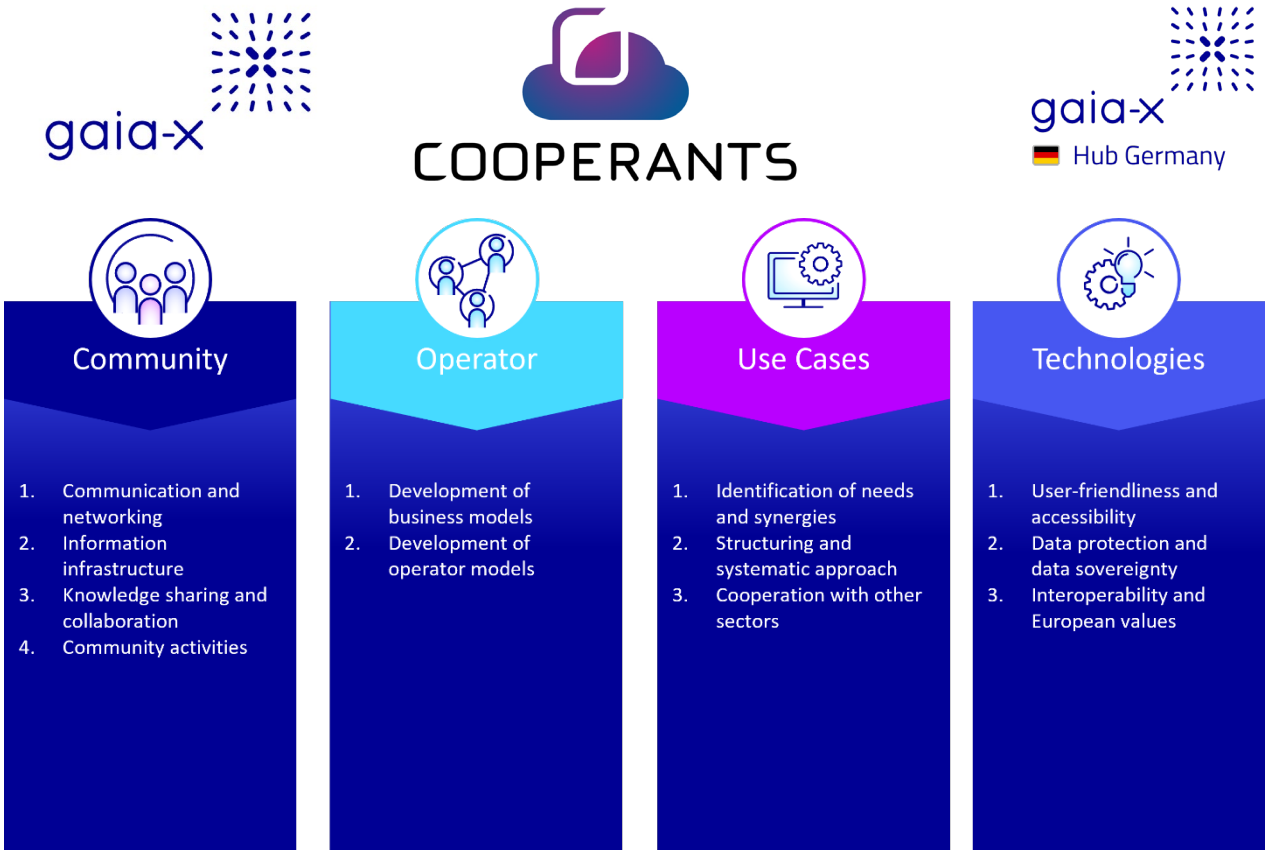


Illustration 7: Summary of the recommendations for action

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Further information

Gaia-X Hub Germany	https://gaia-x-hub.de/
Gaia-X Hub France	https://www.gaia-x-hub.fr
Gaia-X Association	https://gaia-x.eu/
Gaia-X Lighthouse Projects	https://gaia-x.eu/community/lighthouse-projects/
Overview GXDCH:	https://gaia-x.eu/services-deliverables/digital-clearing-house/
	https://docs.gaia-x.eu/framework/?tab=clearing-house
GXDCH Neusta Aerospace	https://aerospace-digital-exchange.eu/
COOPERANTS Website	https://cooperants.de/
COOPERANTS Portal	https://federator.cooperants.info/marketplace
Pontus-X Website	https://www.pontus-x.eu/
Pontus-X Portal	https://portal.pontus-x.eu/#
ACCURATE Website	https://accurateproject.eu/
ACCURATE Portal	https://accurate.pontus-x.eu/
Manufactoring-X	https://www.plattform-i40.de/IP/Navigation/DE/Manufacturing-X/Initiative/initiative-manufacturing-x.html
Aerospace-X	https://www.isst.fraunhofer.de/en/departments/industrial-manufacturing/projects/aerospace-x.html

Appendix

Overview of Gaia-X and European law

Legal framework	Specifications	Gaia-X provides support through the following measures:
Data Act (DA)	**Unfair contract terms (Chapter IV Article 13 DA)** The Data Act aims to prevent unfair contractual terms that deviate significantly from good commercial practice. This applies in particular to contractual clauses that distort competitive conditions or unreasonably restrict the rights of contractual partners.	**Federated catalogue and partner selection:** Gaia-X enables selection from a large number of providers through a federated catalogue. This promotes market transparency and gives companies the opportunity to choose alternative providers and thus avoid unfair contract conditions.
		Increased transparency: Gaia-X creates the possibility to directly compare different data providers and services through standardised and transparent data offers. This helps companies to identify and negotiate fair contract terms.
		Simplified contract models: Gaia-X promotes the use of standardised and simplified contract models that are based on fair clauses and thus meet the requirements of the Data Act.
	Switching between data processing services (Chapter VI Articles 23-26 DA) The Data Act calls for the removal of barriers to switching between providers of data processing services. These barriers can be of a commercial, technical, contractual or organisational nature. Measures are required to enable seamless switching, such as minimum requirements for support and data retrieval as well as clear provisions in the contractual terms.	**Seamless switching as a design principle:** Gaia-X is designed to enable smooth switching between different data processing services. This includes technical interoperability and support for data migration.
		Standardised interfaces and protocols: Gaia-X relies on standardised APIs and protocols that make it easier to switch between different providers and support the minimum requirements stipulated in the Data Act.
		Switching support: Gaia-X enables data to be migrated efficiently between providers through transparent and interoperable systems, which realises seamless switching between services.
	Interoperability (Chapter VII, Articles 33-36 DA) The Data Act places great emphasis on interoperability, particularly in the context of data spaces and data sharing in the EU. Specifically, it requires that datasets, data structures, formats and technical access (such as APIs) are clearly described and available in machine-readable form to enable the automatic use and sharing of data. In	**Transparent data and service offerings:** Gaia-X provides a high level of transparency about the data and services offered, supported by a federated catalogue that ensures clear description and accessibility of datasets.
		Harmonisation of standards: Gaia-X promotes the use of harmonised data formats and classification schemes, such as W3C standards and ODRL (Open Digital

	particular, **Article 33(1)(a)-(c)** contains requirements for the description of data sets, data structures and the technical means of data utilisation. The specifications should be provided in a publicly accessible and consistent manner to ensure interoperability.	Rights Language), to ensure interoperability between different services and platforms. **Existing standards and technologies:** Gaia-X builds on established technologies and standards that enable a seamless transition to interoperable data solutions and support the requirements of the DA.
Data Governance Act (DGA)	**Promotion of interoperability (Article 12(i) DGA)** In Article 12(i) the DGA requires that providers of data intermediation services take measures to ensure interoperability with other services.	**Open standards and technical specifications:** Gaia-X utilises open standards and uniform technical specifications within its data spaces to promote interoperability. This enables smooth and cross-sector data exchange, which facilitates compliance with the legal requirements.
	Ensuring security and fraud prevention (Article 12(g) DGA) Article 12(g) of the DGA requires data intermediary services to implement procedures to prevent fraudulent or abusive practices.	**Gaia-X Federation Services (GXFS):** The "Identity & Trust" work package offers functions for the secure management of decentralised identities. For this purpose, there are services for authentication/authorisation, authentication managers and trust services that contain a wealth of functions. This makes it more difficult for fraud attempts to be made in Gaia-X using a false identity - and if fraud attempts can only be made using a clear identity, this should make it easier to prosecute and reduce the number of cases. Although the GXFS do not yet guarantee conformity with the DGA, they help to prevent fraud, making it easier for companies to implement the necessary security precautions in accordance with the DGA.
	Transparency and non-discrimination (Article 12 lit. f) DGA) The DGA calls for fair, transparent and non-discriminatory conditions for access to data switching services.	**Open ecosystem**: The openness of the Gaia-X ecosystem prevents discrimination, as no actors are excluded from participation per se. **Gaia-X Labelling Framework:** The Gaia-X Labelling Framework from the "Regulatory Compliance" work package of the GXFS discloses the legal requirements with which services and data spaces are compliant. For the highest level three, immunity from non-European access, which could be a threat under the US Cloud Act, for example, must be guaranteed. In Gaia-X, these and other requirements strengthen trustworthiness and reduce barriers to data sharing - and also contribute to compliance with Art. 12 lit. f) DGA.
General Data Protection Regulation (GDPR)	**Strengthening data security (Article 32 GDPR)** Article 32 of the GDPR requires appropriate	**Secure data spaces and standardised security protocols:** The Gaia-X Federation Services (GXFS), in particular the "Identity & Trust" work package, offer functions for

	technical and organisational measures to protect personal data.	secure authentication and authorisation that help to effectively implement the requirements of Article 32 GDPR.
	Promotion of data minimisation and purpose limitation (Article 5 No. 1 lit. c) and lit. b) GDPR) In Article 5, the GDPR emphasises that personal data may only be collected to the extent necessary for the purposes for which they are processed (data minimisation) and that they may only be used for specified, explicit and legitimate purposes (purpose limitation).	**Transparent data processing:** Gaia-X promotes transparent data processing within its data spaces, where only necessary data is shared and used. This is made possible by standardised data flows that support the principles of data minimisation and purpose limitation.
	Transparency and traceability of data processing (Article 15 GDPR) Article 15 of the GDPR grants data subjects the right to information about the processing of their personal data.	**Labelling Framework:** The Gaia-X Labelling Framework provides an overview of which services and data spaces comply with the legal requirements. This makes it easier for companies to comply with the GDPR regulations on the obligation to provide information.
	Ensuring consent and data subjects' rights (Article 7 and Articles 12-22 GDPR) The GDPR requires organisations to clearly obtain consent for data processing and respect the rights of data subjects. Gaia-X provides a transparent and controlled environment in which consent and the exercise of data subjects' rights can be effectively managed, helping companies to fulfil their obligations under the GDPR more easily.	