gaia-x Hub Germany

Setting the course: Gaia-X and the future of data-centric government

Position paper of the domains

Geoinformation, Public Sector,

and Smart City / Smart Region

of the Gaia-X Hub Germany and Gaia-X Hub Austria

In collaboration with gaia-x Hub Austria

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About this paper

This position paper is the result of a collaboration between the Gaia-X Hub Germany and the Gaia-X Hub Austria, as well as three Gaia-X domains Geoinformation, Public Sector and Smart City / Smart Region.

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Summary

The digitization of local government has seen a growing trend towards data networking. Over the past 20 years, “smart cities” and “smart regions” have emerged as a key concept in this trend. Smart cities and smart regions are areas of settlement where highly integrated networking enables the regular use of (ecologically, economically, and socially) sustainable products, services, technologies, processes, and infrastructures. Of enormous importance are the next steps towards a networked, data-centric administration of cities and regions. On the one hand, the use of data-based systems will expand and improve public services and sovereignty over tasks. On the other hand, more and more public and private actors will be involved along the (digital) value chains. Furthermore, the growing need for sustainable and resilient administrations underscores the importance of developing digital tools and solutions for urban and regional development. Finally, these digital solutions will accelerate the transformation of the energy, transport, and infrastructure sectors.

This document aims to describe the concepts of data-centric government and the organizational and technical requirements necessary to achieve it. Section 1 provides a general introduction to data-centric government, addressing governance challenges and legal frameworks. Section 2 introduces the Gaia-X initiative, first in general terms and then as a tool to combine data sets and connect data services and facilitate the digital transformation of local government. Section 3 describes the technical aspects of digital transformation in government: from the current use of data to the technological and procedural tools available. The document concludes with four use cases illustrating the benefits of digitization and data orientation for governments.

10 Recommendations

These recommendations are intended to raise awareness of the importance of data and its management in government. They also promote practical steps to implement a modern, data-centric administration.

Cooperation with external players

To create synergies and social value through shared data spaces and projects, local authorities should intensify their collaboration with business, research, and civil society.

Commitment to open-source solutions and standards

To ensure interoperability, flexibility, and long-term sustainability, local governments should actively support open-source technologies and the adherence to standards.

Participation in the digital transformation

Public sector employees should be actively involved in the development and implementation of innovative solutions and processes that will drive the digital transformation of government.

Promotion of data literacy

To realize the full potential of data, public sector employees need support to continually develop their data management and analysis skills.

Development of an efficient data infrastructure

The administration should actively participate in building and maintaining a robust data infrastructure that enables secure and efficient data use.

Support for data integration across divisional boundaries

To overcome data silos, the administration should encourage the integrated use of data across departments.

Participation in the development and use of federated data spaces

To ensure secure, sovereign, and trusted data use, administrations should actively participate in the development of data spaces that meet Gaia-X standards.

Legal certainty and data governance

Local administration should be able to understand the legalities of data management and be aware of privacy and data security issues related to data handling.

Anchoring data excellence in the administration

Structures should be in place to ensure high data quality and efficiency.

Initiative for the active use and provision of data

To promote transparency and create value for the public, administrations should actively make data available to the public and other stakeholders.

1. Data-centric administration

1.1. The path to data-centric administration

Public administrations recognize more and more the importance of data and its potential to improve the quality of their work. Businesses have long collected, analysed, and used data to make better decisions. Data is used, for example, to improve customer service, develop new business models, and make forecasts. However, raw, unprocessed data adds no value on its own: it must be properly evaluated or contextualized with other data and information to generate decision-relevant information. Data visualization tools, such as dashboards, for example, aggregate information from different sources. So, these tools help evaluate possible alternatives in complex situations and make informed choices. Government decision-makers should consider how their areas of responsibility would benefit from a systematic use of data. Data-centric government contributes to faster and better public services, to quicker trend analysis, and better predictions about the future. Data and the insights they provide reveal opportunities for action, innovative business models, as well as ways to create value and save costs.

The term “digital public services” (*digitale Daseinvorsorge*) encompasses traditional areas of government, as well as specifically digital information and services (Digital-Gipfel, 2018). Because municipalities are directly responsible for providing many relevant goods and services for the public good, they play a crucial role. Using data, they unlock a wide range of analyses and applications, from the planning of heating systems to the reduction of air and water pollution, to the planning and management of transportation. Accurately assessing population trends in specific areas, local governments can determine the need for kindergartens or schools. During the Covid-19 pandemic, up-to-date information on infection and vaccination rates at local, regional, national, and international levels helped to take appropriate action to contain the spread of the disease. Satellite and aerial imagery can detect forest damage, for instance from drought, more reliably than human observation. Machine learning and artificial intelligence also supports pattern recognition and decision-making. These tools, for example, successfully detect credit card fraud and can also help the public sector to detect tax fraud. From these examples it becomes clear how much government can profit from widespread data use.

Data underpin and drive the digital transformation and enable high-quality digital services in cities and regions (Bundesministerium des Innern und für Heimat, 2023). Therefore, data expertise and effective governance structures in administrations are as important as powerful data infrastructures. Together, they make it possible to use data in a systematic, value-adding, and secure way.

1.2. Challenges in local administrations

A successful digitization of public administration relies on available data used across institutional boundaries. The shift to data-centric government requires both human and financial resources: to optimize administrative tasks as well as to implement and use complex forecasting and simulation systems. To achieve the latter, local governments in particular, need to be equipped with comprehensive data management schemes. All political tiers (EU, national and regional) agree that high-quality digital public services at the local level, require efficient and purposeful use of data (*Bundesministerium des Innern und für Heimat*, 2023; European Commission, 2020). This requires, beside data expertise and goal-oriented governance structures, high-performance data infrastructures that enable the systematic, value-adding, and secure use of data. While many already consider broadband infrastructure as part of digital public services, only funded projects have so far prioritized establishing and operating comprehensive data infrastructures.

Many suitable approaches already exist to promote data use in public administration. Several positive examples revolve around open data portals and smart city / smart region development. Key factors here are the anchoring of data excellence in government, the appointment of data stewards, or the deployment of dedicated processes and

responsibilities for data intelligence at the municipal level. These proven approaches deserve consistent promotion and dissemination.

Public administration at all levels faces complex challenges when it comes to the use of data:

Data is stored in department-specific silos instead of being shared

Government agencies at all levels hold significant amounts of high-quality data, which however remain underutilized and are not combined with data from external sources. Although data are often stored and used only within specialized silos, data generated by public administrations should serve the public good. On the one hand, businesses, start-ups, academia, and research should have access to them. On the other hand, a data-centric public administration can leverage data shared from the private sector for the public good.

From isolated solutions to shared approaches across municipalities, government levels, and sectors

Many current solutions address only isolated sectors or applications. The mindset needs to shift towards holistic, integrated, long-term approaches shared across municipalities, government levels, and sectors. Only then can local actions, actors and resources engage into a coherent whole. Interoperable digital infrastructures allow to link individual modular solutions and to unlock synergies and economies of scale.

Lack of data competence in the administration

If government is to become a driving force in providing and using data, it must continually expand the offer for professional skill development. In this way, government employees will become more aware of the opportunities that data presents and more confident in their handling of data. Data literacy is essential to improving the availability and use of public sector data and overcoming existing limitations. Society as a whole needs to become more data literate and gain a basic understanding of how the data-driven economy works.

Legal uncertainties in handling personal data in particular

Numerous legal restrictions constrain the availability of public-sector data, particularly personal data. For example, the access is limited to specific purposes. The fragmented legal landscape on data protection poses additional obstacles. As a result, digitization projects suffer from legal uncertainty about what data can be used, shared, or published. Aggregating, anonymizing or pseudonymizing data offers good solutions to use personal data.

Quality, timeliness, and interoperability of data

Administrations at all federal levels have access to a wide range of data from a variety of fields, such as construction, environment, health, social affairs, and transportation. Data sources include specialized procedures, publicly available documents, statistical data, or raw data from deployed sensors. However, the quality or machine-readability of data is often insufficient. Furthermore, different agencies often collect the same data multiple times, causing inconsistencies and desynchronizations between organizations. In other cases, the lack of exchange standards lets agencies publish data in different formats, which makes merging different sources a considerable effort. The quality of data also depends on the knowledge and commitment of the administrative staff. Only those who appreciate the potential of data are willing to make them available. Demand should drive the opening of governmental data silos, making data generally available for digital use, in high quality, with open interfaces, but in compliance with the law. A culture of data sharing needs to be established.

Lack of technical infrastructure

Both the demand for and the supply of public sector data require appropriate infrastructures, as well as frameworks for data portability and interoperability. These infrastructures need to be developed and tested. Many stakeholders should be able to use them, without compromising the necessary data security and data protection requirements. Only then, will data become accessible across Germany, Europe and the world. The European Gaia-X initiative (see section 2) provides the first approaches for an interoperable, sovereign digital infrastructure.

Costs and financing

Interdepartmental data management is a major challenge for most government agencies. On the one hand, because of scarce expertise, human resources, as well as technical and organizational preconditions. On the other hand, viable concepts for data provisioning are little-known and too rarely receive priority and, therefore, funding. Building, operating, and developing high-performance, interoperable data infrastructures requires large initial investments, but entails also long-term costs. Strategic funding, budgeting, and provisioning approaches can cover these costs. In addition, various financing alternatives can fund the operation of digital infrastructures. Cooperative financing models in the community (and beyond) include, for example, cross-subsidization between loss-making and profitable applications.

Funded projects support the development and establishment of digital infrastructures. However, the national and European funding landscape is uncertain. Moreover, there is too seldom an effort to "turn lighthouses into a sea of lights" (Deutscher Städtetag, 2022) , i.e. to sustainably reuse already-developed solutions. Existing solutions are also not yet evaluated according to standardized criteria. To this end it would be useful to develop a portfolio for impact evaluation, providing quantitative and qualitative indicators, supplemented by concepts such as goals and key results, or "smart" goals that could make a first contribution here (Smart City Dialog, 2024).

1.3. Legal framework and data governance

The European Commission defined a fair and trustworthy data use as a policy priority in its agenda "A Europe fit for the digital age" and in the European Data Strategy (European Commission, 2020). In practice, this entails the creation and establishment of common European Data Spaces (see Section 2) in a cross-sectoral regulatory ecosystem. Part of this ecosystem already exists, while part of it is under development. In this ecosystem, data sovereignty is a key concept – especially in the context of strategic, sensitive, or personal data. Data sovereignty grants data providers full control over their data and digital identities, with the power to control who uses their data, for what purposes, and under what conditions.

Gaia-X is an international initiative that started in 2019 to create the framework for interoperable, open, and sovereign European data spaces. According to Gaia-X, data spaces are federated, open infrastructures for sovereign data sharing, based on common policies, rules and standards (Reiberg et al., 2022). In addition, the Digital Europe program of the Connecting Europe Facility and Horizon 2020 are also investing in the development of European data spaces.

Several regulatory measures at European level will flank the existing regulations that establish data spaces. This will promote the development of data spaces, while limiting possible negative developments – especially regarding large platforms. The Data Governance Act (DGA) creates uniform European requirements for data intermediaries. The DGA also promotes the fair re-use of data held by public authorities. In particular, it regulates providers of data intermediary services and the so-called data altruism. The latter is the voluntary donation of data by institutions, individuals, or organizations for public good purposes. The DGA shall thus facilitate data-based value creation and allow more data to be used for innovation. At the same time, however, it makes it easier for a wider range of stakeholders (including citizens) to gain control over the further use of the data they generate in different contexts. With the implementation of the DGA, local authorities will gain more and easier access to data to develop innovative services in the city (e.g. for mobility, climate change, and urban development).

The Data Act (DA) is intended to promote data sharing and facilitate access to data generated by connected devices. In particular, it allows device users to make data available to third parties. For example, the driver of a car can have the manufacturer make the data generated by the car available to an insurance company, a repair shop, or the local government. In addition, the DA contains provisions that allow public authorities to access private sector data for specific public interest purposes. For example, public authorities can request data they need to respond quickly and safely to a public emergency, with minimal burden on businesses.

2. How can Gaia-X help with data usage?

2.1. Gaia-X: a framework for open, sovereign, and federated data ecosystems

The European Gaia-X initiative aims to build an open and federated ecosystem for the sovereign exchange of data and digital services. Because the ecosystem is open, several data and service providers and users can participate. Because it is federated, participants can – instead of signing on to centralized platforms – use or create decentralized frameworks (such as data spaces), interconnected through standardized software components. Accredited authorities guarantee security by verifying the identity of the participants. Finally, digital sovereignty gives participants control over who uses their data, under what conditions, and for what purpose. This creates an open, secure, and transparent data infrastructure, in which participants can share, collect, and share data in a trusted manner (Gaia-X Association, 2022). Participants will thus be able to offer and receive data and digital services while retaining control over their data (Gaia-X Association, 2022).

Gaia-X provides a foundation for data spaces as an environment for trusted use of data. data spaces allow data from different sources, including sensitive data, to be shared and made available to different services. Data sovereignty ensures that data providers retain control over the use of the data. Figure 1 shows how an urban data space integrates data from multiple sources. Thanks to persistent connections, data remain accessible even if a source, for example, switches to a different cloud provider. Connected data is delivered according to agreed-upon rules and standards. The data space thus enables, for example, the creation of a digital twin of the city, which provides continuous information on the state of the city and reacts to problem situations. In addition, users can feed data into tools for visualization, analysis, and forecasting, as well as applications to support decision-making, for example AI-based ones. As the figure shows, data spaces represent overarching structures in respect to urban data platforms, rather than an alternative to them. Urban data platforms, in fact, can participate in data spaces as providers of urban and regional data.

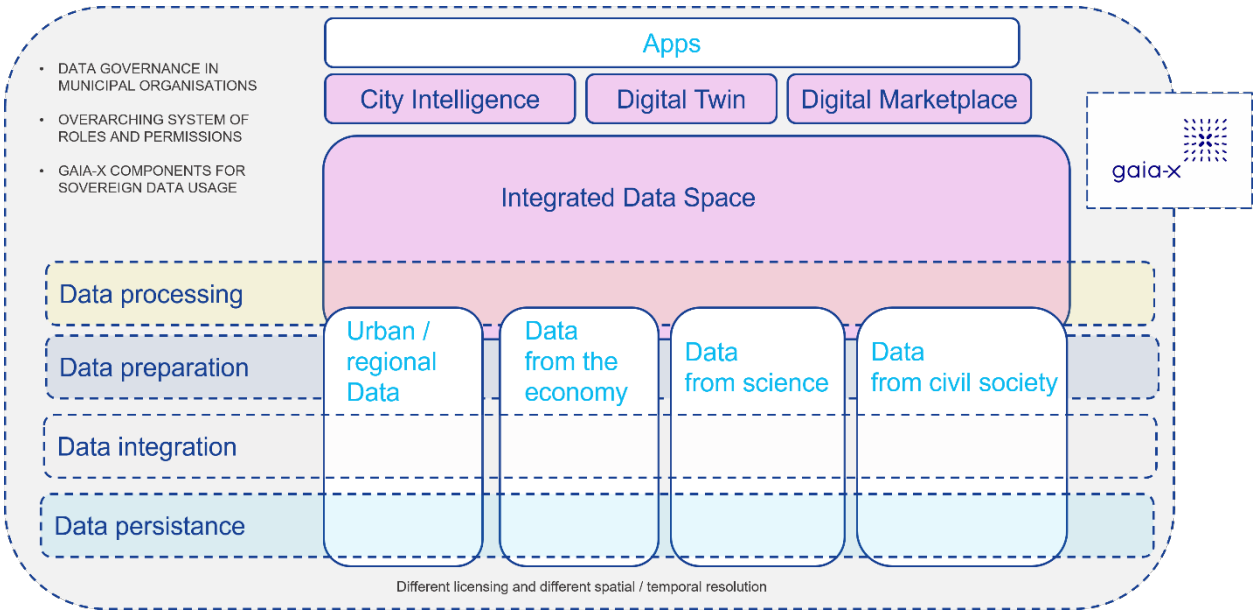

Figure 1: The vision of the urban / regional data space based on existing systems and components (Source: Dr.-Ing. Alanus von Radecki, own work).

Gaia-X is by design compliant with European laws and values of openness, transparency, and human-centeredness. The foundations for trust and interoperability are defined by the Gaia-X Policy Rules and the Gaia-X Trust Framework. The Gaia-X Policy Rules ensure that all participants in the data ecosystem adhere to the agreed policy rules. As a

result, every participant accepts and uses the common standard of rules and control mechanisms. The Gaia-X Trust Framework defines minimum requirements for transparency, contracts, identities, access, and data use.[1]

In addition, Gaia-X stands for simple, interoperable open-source components, which can be tailored to individual requirements. The standards for trusted data use and the interoperable components grant flexibility, including in terms of technology vendors. Data sharing fulfils its potential when providers and consumers exchange and orchestrate services seamlessly across data spaces, companies, and borders. In such an ecosystem, participants benefit from each other and fully exploit the value of their data and services (Kraemer et al., 2023). For example, when different cloud service providers and data owners connect using common standards. Government agencies can also share data with each other in a trusted environment through common data spaces[2] and securely consolidate data geographically dispersed across multiple storage locations.

2.2. Data spaces and Gaia-X in public administration

The organizational difficulties already described above and technical challenges, hinder the connection of data sources within a community or region. These challenges become even more complex when confidential or sensitive data is exchanged, or when the connection crosses administrative boundaries. Today's IT infrastructures are insufficiently equipped for this type of networking. A typical example would go as follows: a municipality needs a data platform for its municipal data environment and contracts the deployment of this infrastructure to a local public IT service provider. For security reasons, this local data infrastructure will allow, in most cases, little to no access from outside the local environment. The resulting platform cannot then interface with data platforms from other local authorities, other levels of government, or other IT service providers – or, when a connection is possible, it requires significant efforts.

A common, nationwide cloud solution would appear as a fast and economical solution to simplify data management for the public sector. However, even considering the municipal infrastructure alone reveals the limitations of this solution. The heterogeneous software deployed in around 11,000 municipalities in Germany or 2,093 municipalities and cities in Austria would have to be integrated in a single overall solution. This would be an almost impossible task in terms of both time and organization. The alternative is to build on existing solutions and connect them. Gaia-X provides a solution to this challenge with federated data spaces, which creates an ecosystem for trusted data use that preserves the digital sovereignty of all participants. Such a data ecosystem would fit the diverse data management landscape of smart cities and smart regions in Germany and Austria. It would also provide a blueprint to gradually connect urban data platforms with other data sources and services from business, science, and civil society.

Participating in a Gaia-X-based data space provides concrete incentives for local and regional governments. As shown in the use cases below, the efficiency of the administration increases enormously when different areas or stakeholders are able to share and use their data together. Moreover, public administrations can share their data with society without losing sovereignty. Conversely, private sector actors can make their data available to government. Combining data from these different private and public sources unlocks better services, while

[1] For more information on the Trust Framework, which provides the definitions for managing Gaia-X compliance, Gaia-X labels, and trust in the data ecosystem, see the architecture document, which also lists the technical implementation information: https://docs.gaia-x.eu/technical-committee/architecture-document/latest/context/

[2] The Data Space Support Center (DSSC) provides support for the establishment of Data Spaces. Among other things, the DSSC develops so-called "building blocks" that address the economic, legal, operational, technical and social aspects of Data Spaces. These are made available on a support platform (see www.dssc.eu).

guaranteeing citizens much more transparency about how their data is used. Depending on the use case, the added value can range from economic (resource savings and new business models) to environmental (e.g. energy savings).

Implementation needs people in government who can see these potential gains, think holistically about data management, connect domains, cross organizational boundaries, and open data silos. With further advances in Gaia-X and future testing of federation services, more untapped potential can be exploited. The use cases described below illustrate this potential and provide blueprints for practical implementations on the way to digitized smart cities and smart regions.

2.3. Getting started: concrete use cases

Data spaces in public administration offer numerous benefits and contributions, as illustrated by the following use cases (described in more detail in Appendix 1). They cover various topics such as heating planning, mobility, and interdepartmental data use infrastructures. These use cases provide technical solutions for trusted, secure, and sovereign data use, as well as data standardization and quality assurance. They serve as a model for similar initiatives – or even directly help other agencies with similar problems. In summary, these examples demonstrate the transformative potential of data spaces in local government, as they allow organizations to overcome the challenges of using and sharing data, as well as complying with existing regulatory requirements. By fostering collaboration, innovation, and efficiency, data spaces contribute to positive change and lay the foundation for more efficient and sustainable cities and regions.

The first use case, the Energy Efficiency Data Portal, provides a national access point for energy-related data. It facilitates the integration of data from local governments and various stakeholders in the building and energy sectors. It demonstrates the implementation of data spaces in local government according to Gaia-X standards, ensuring the secure exchange of sensitive data. This use case improves the connection of different data sources and supports municipal heating planning, as it provides tools for graphical visualization and AI-based analysis.

The second use case, the Municipal Data Facility (*Kommunale Datenwerke*, KDW) initiative, revolves around sharing data and IT infrastructure in smart cities. This promotes cooperation between municipal actors and enables secure and trusted data use in an inter-municipal data space, with improved connections between different data sources and within a legally secure framework. The use case serves as a precedent for a broader integration of data ecosystems in local government and facilitates participation in decentralized data spaces such as the Mobilithek or the Mobility Data Space.

The third use case, the Smart City Vienna Municipal Data Space, facilitates the shared and trusted use of data between the City of Vienna and Vienna's municipal utilities. It establishes a system for these actors to efficiently collaborate and access each other's data. Using legal framework agreements and metadata catalogues, this data space forms the basis for better services and promotes data-driven decision making in the city administration.

The fourth use case, Mobility Data Standardization in Local Government, aims to unlock the full potential of mobility data by improving its quality and accessibility. Automating data standardization and ensuring data sovereignty through Gaia-X concepts simplifies data integration and improves the networking of different data sources. This initiative makes data more usable in several decision-making settings, such as urban planning and traffic management.

3. Technical requirements

3.1. Development and status quo

The development of the base of the technology can be described over the last 20-30 years as an evolutionary process. A process that resulted in the current fragmented, multipolar landscape of only partially interoperable technologies, software components and skills among the relevant urban actors. Although every case is different, the current status quo – and thus the building blocks of future urban and regional data spaces – usually fits in a historical development curve. Figure 2 shows such an abstracted development path for municipal data infrastructures (blue) and their application layer (yellow). Different municipalities are typically at different stages of development.

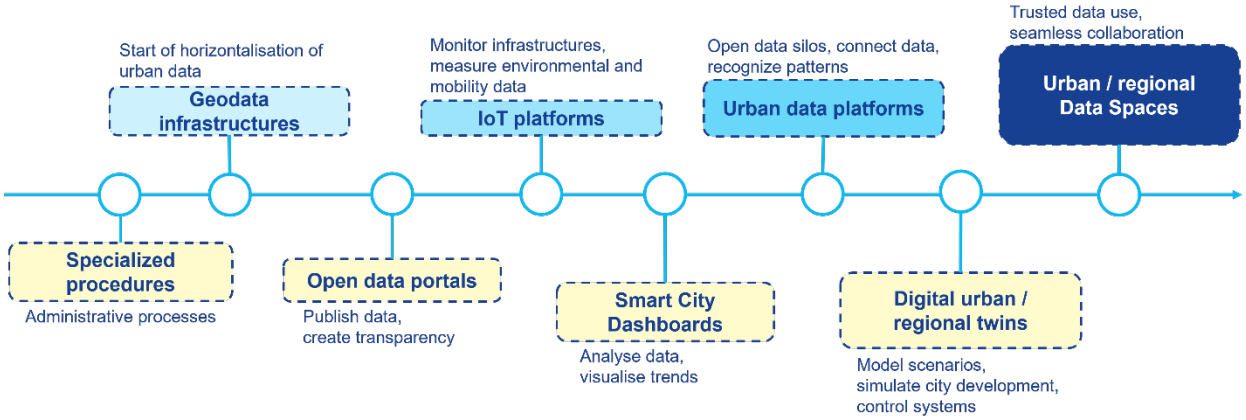

Figure 2: Figure 2: Development of specialized procedures for urban data spaces.

Spatial data infrastructures have been an integral part of municipal infrastructures for many years. They follow worldwide standards set by the Open Geospatial Consortium and ISO, and they comply with EU directives, EU regulations, as well as federal and state laws. As planning and operating infrastructure and the built city grows in complexity, municipalities, and districts rely more and more on data. Since around 2014, administrations have piloted solution on selected use cases, leveraging the exponential growth of (urban) data and the increasing availability of relevant third-party data (e.g. real-time information from shared vehicles, environmental sensors, charging infrastructure or parking management). For example, only few pioneering municipalities use city data platforms to analyse and manage multiple data streams or build digital city twins to simulate and model development scenarios. In most German cases, however, funded pilot projects still have to make the step to become integral parts of the urban infrastructure, with long-term management plans.

Moreover, most cities and regions in Germany and Austria are still far from harmonizing and integrating their data landscape across the board. In addition to the reasons mentioned above, costs and benefits for the development and operation of a city or regional data infrastructure must be re-evaluated, which few municipal decision makers adopt. As a result, administrations typically view data infrastructures as IT projects rather than what they really are – infrastructure endeavours.

While providing technology, organization, and expertise requires significant initial investments, a multitude of value creation opportunities offset the initial costs. In fact, multiple and distributed use creates value and, as the number of connected data sets and use cases increases, the return on investment is multiplied. Moreover, fewer services need to be outsourced and less time is spent on data searches and cleaning, which generates additional savings for the administration. There is also concrete added value for society, the environment, and the economy.

3.2. Standards and openness

Activities in recent years clearly reveal a growing technological convergence. A central element is the trend towards open-source solutions, with the following examples being particularly relevant for cities and regions:

- Systems such as the Masterportal or the Solingen App provide fully developed, tested, and refined open-source solutions for inter-municipal communities.
- A group of relatively new service providers (*DKSR*, 2022/2024; *FIWARE*, 2024) orchestrates and develops solutions for open-source urban platforms, like the FIWARE stack or Open UrbanPulse, used by a growing number of municipalities. In addition, many individual open-source building blocks can be used to individually operate city data platforms, as done for example in Hamburg or Munich.
- CKAN, Piveau, and InGrid are examples of open-source catalogue systems for the inventory, publishing, and managing distributed datasets (InGrid, 2024; *KSP-CKAN*, 2014/2024; *piveau*, 2024).

The convergence trend becomes even clearer when considering individual open-source components, for the listed systems and beyond. The same or very similar technologies play a prominent role in data processing in many open and proprietary systems.

In addition, many established and emerging software solutions for data connectivity, data processing, data analysis, or visualization can be integrated into data spaces as needed.

The white paper “Building a dataspace: Technical overview” by the Gaia-X Hub Austria (Siska et al., 2023) is intended to introduce the common terminology, the current state of the art, and the existing software applications in the rapidly progressing field of data spaces.

Beside open-source components, standards should play a central role in the municipal sector. Standards are the central technical factor for sustainability in social (ethics and values), environmental (resource use and energy consumption), economic (investment security and business models) and technical (interoperability and vendor independence) terms. Numerous efforts in the smart city sector therefore aim at identifying requirements for norms and standards. Some such efforts have already produced the first documents with the support of local authorities, research, and industry, among others. The national DIN SPEC series 913x7 and 916x7, in particular focuses on the topic of smart cities.

So-called "Minimum Interoperable Mechanisms" (MIMs) are another important standardization tool. MIMs are a type of minimum standard, designed to support the flow of data between organizations that use different standards or proprietary solutions to collect and process data. Rather than requiring all organizations to change their existing practices and share standards, MIMs suggest simpler changes that allow for “sufficient” interoperability. MIMs address different aspects of data use, such as data models and security. The European initiative “Living-in.EU[3]” will combine all existing MIMs into one toolkit, called MIMs Plus. MIMs Plus and other future MIMs will facilitate the digital transformation of municipalities and the development of an interoperable Europe.

In addition to the technical components for urban and regional data spaces, the elements involved in digital value creation are essential. Indeed, a city or region can only gain the intended added value if all stakeholders make coordinated use of data, systems, and tools. The international standards series ISO/IEC 10746 (Open Distributed Processing) provides a suitable framework and orchestrates the individual steps to develop distributed systems. The Smart District Data Infrastructure Framework (SDDI) of the Technical University of Munich provides an example implementation of this standard for the design digital city twins (Deigele et al., 2020). The SDDI structures the development of data-based applications into five successive “viewpoints” (depicted in Figure 3), each considering

[3] For more information see: https://living-in.eu

the development of the use case from a different perspective. The SDDI thus provides a framework to develop and operate value-added applications, based on who the participants are, what roles they take, and what interests they have. This development framework emphasizes interoperability, security, and scalability as key features. Although user interface and usability optimization for users and citizens are central elements of the development, the Open Distributed Processing considers them only to a very limited extent. Figure 3 illustrates the five perspectives and provides examples of the components and processes involved in each one. The design of a data-driven use case in a distributed system (e.g., a city) moves step-by-step from the Enterprise Viewpoint to the Technology Viewpoint. Once all levels are completed, the implementation takes place.

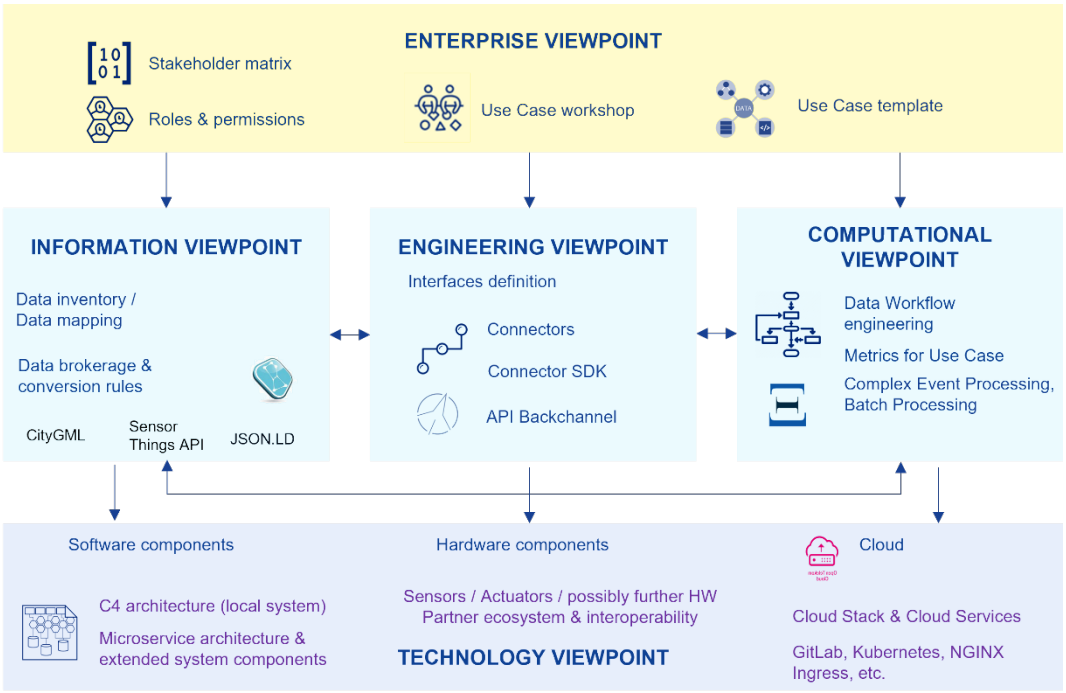

Figure 3: Open Distribution Processing for the development of distributed systems as a reference process for the data space (Source: DKSR, 2023).

In summary, most of the necessary building blocks for integrated urban data spaces – and therefore for easy, seamless data use between participants organizations – already exist. Moreover, the current development of many reference projects demonstrates how these elements can be productively integrated.

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Appendix 1: Use cases

Use case 1: Energy efficiency data portal as a national access point for energy-relevant data: First application to support municipal heating planning

Brief Description

An energy efficiency data portal is being developed, which will serve as a national access point for energy-related data. By integrating data from different actors in the building, energy, and public administration sectors, the portal will enable visualization and AI-based analysis of energy consumption data. The project aims to provide a trusted, secure, and confidential data use. The exchange will follow Gaia-X standards, enabling data providers and data holders to share their data in a trustworthy way. The trusted environment will also incentivize governments and other providers of sensitive data to participate in the data economy. As a first use case, the Energy Efficiency Data Portal aims to effectively support municipal heat planning.

Relevant Domains

The use case deals with issues related to services of general interest, energy, urban planning, and the environment. It is therefore mainly focused on the Public Sector domain, but it is also relevant to other domains, especially Smart City / Smart Region, Planning / Construction / Operations and Geoinformation.

Participants

- Materna Information & Communications SE
- Gesellschaft für Siedlungs- und Wohnungsbau Baden-Württemberg mbH
- wowiconsult GmbH
- Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI)

Overarching goals

This use case aims to provide and visualize data for heating planning in a user-friendly way, as well as to allow a trusted, secure, and sovereign data use via a data space based on Gaia-X.

Presenting and combining partly sensitive data from authorities, housing associations, energy suppliers, and citizens themselves presents a particular challenge, as the usage data of heating, hot water and electricity consuming devices of citizens require special protection. Interlocking connectors ensure the necessary security, as they grant access to the data space only to trustworthy actors (who themselves meet the Gaia-X criteria). This use case, in particular, deploys the well-proven Eclipse Dataspace Components (EDC). Through the resulting data space, all relevant actors will have all energy-relevant data available in their respective systems. The data space will be further connected to the SmartLivingNEXT data space (SmartLivingNEXT, 2024), providing a national access point for heating planning.

Challenges and Solutions

The revised Building Energy Act and the Heat Planning Act will officially come into force in Germany on January 1, 2024. According to these regulations, all of Germany's approximately 11,000 municipalities must have a heat planning system in place by mid-2028 at the latest. High-quality data are crucial for such plans, starting with master data for buildings, consumption, demand, and potential for heat and electricity.

Data producers (e.g. utilities, housing associations, chimney sweeps, etc.) currently hold much of these data, which remain unrecorded, and must be requested by the municipalities. Additionally, the quality and formats of the available information is very heterogeneous, so municipalities have to invest much time and effort to merge and process the data (Stadt Oldenburg, 2024).

The Energy Efficiency Data Portal, based on the Gaia-X-compliant SmartLivingNEXT Dataspace, will serve as a focal point where different relevant stakeholders can come together to exchange data in a secure and trustworthy way. The portal provides an effective monitoring tool to evaluate the success of heating planning measures. The Energy Efficiency Data Portal benefits not only the public administration, but also all stakeholders involved. Housing associations strive to carefully integrate their comprehensive building data into heating plans. Utilities benefit from improved planning of energy demand and consumption thanks to planning data that can be shared with municipalities and municipal utilities. In addition, software and service companies can obtain data for smart services through the platform. To this end, a domain-specific data and service offerings catalogue of data, connected to a Gaia-X federated catalogue, could be an option. Offered services could include, for example, simulating potential savings from using photovoltaics, or from renovating of building elements, such as walls and windows. The win-win situation encourages continuous development and cooperation between the parties involved.

Maturity level

The development of the use case started with the launch of the ForeSightNEXT research project in August 2023. Parallel to the development of the data space components, a prototype of this use case is being developed to illustrate the vision and look and feel of the energy efficiency data portal. Automated pipelines are also being developed to process grid-critical equipment and building data efficiently and automatically. The Energy Efficiency Data Portal is expected to go live in the fall of 2026.

Use Case 2: Municipal Data Facility

Brief Description

The Municipal Data Facility (*Kommunale Datenwerke*, KDW) was developed as an easily accessible introduction to the topic of municipal data. The accessibility makes data use more attractive for municipal stakeholders. The KDW is a technically easy-to-use solution that provides a legally secure framework for municipalities and municipal utility companies. This creates trust and enables high-quality data collection at the municipal level. The resulting data space also facilitates the participation of cities and municipal utility companies to national platforms such as the Mobilithek or other data spaces such as the Mobility Data Space.

Relevant Domains

The Municipal Data Facility addresses fundamental cross-cutting issues, namely IT infrastructure and data sharing. It is therefore relevant for the Public Sector as well as for Smart City / Smart Region and many others.

Participants

- DKSR GmbH
- Mainzer Stadtwerke
- Fraunhofer FOKUS

Overarching goals

The goal of the use case is to enable all municipal stakeholders (city administration, politicians, and municipal utility companies) to exchange data securely, by establishing an inter-municipal data space. This will make it possible to investigate how to organize and use data spaces of municipal or regional relevance. Special attention will be given to developing a legally secure framework to share data between different stakeholders. Furthermore, the project will provide insights into the benefits of such data spaces, which are central to their further development and design.

Challenges and Solutions

Current solutions for municipal data management are typically limited to the exchange of specific data for specific use cases – for example, sharing via open data portals, publishing geospatial data, or providing real-time data via IoT platforms. Few platforms can perform all these functions simultaneously, with different access rights, data types, and data formats, which is necessary to securely share sensitive or high-value data. At the same time, sharing these data would offer municipalities enormous potential for efficient digital public services. Any such platform solution has to be first and foremost secure under municipal law.

The KDW aims to enable municipalities to participate in decentralized data spaces such as Gaia-X, Mobility Data Space or the Mobilithek. So far, local authorities do not have the appropriate technical or legal solutions to participate in such initiatives. The KDW pioneering effort will strengthen the participation of municipalities in decentralized data spaces, both in terms of data volume and data quality.

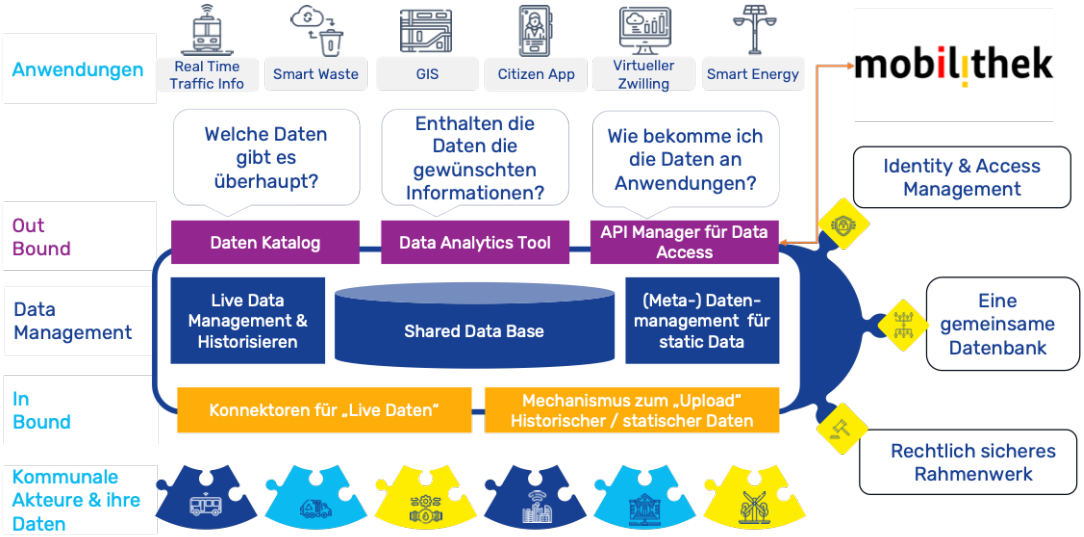

Figure 4: Sketch of the architecture of a municipal database for static and dynamic data (Source: DKSR GmbH, 2024).

Maturity level

A prototype is currently being implemented. A proof of concept (expected end of July 2024) will demonstrate and validate the underlying technology in real-world scenarios. For the most part, established open-source technologies will be used, which will need to be integrated and connected in a new framework. The goal is to quickly reach a high product maturity: a finished product is expected by early 2025.

Use Case 3: Urban Data Space Smart City Vienna

Brief description

The Smart City Vienna data space enables the shared and trusted use of data between the City of Vienna and the municipal utility companies (Wiener Stadtwerke Group). Until now, data have been stored in separate systems (so-called "data silos"), of the agencies or departments that generated them (see Figure 5). Trusted data use occurs on an individual agreement basis. In a data space, data from different sources will become available more quickly and easily, while ensuring security and trust between the parties involved. Using existing data from other departments of the City of Vienna will not only accelerate internal processes, but also provide more convenient services for citizens.

Relevant Domains

The use case covers several domains: Smart City / Smart Region, Design / Construction / Operations, Public Sector, Energy, Geoinformation and Mobility.

Participants

- Stadt Wien
- Wiener Stadtwerke

Overarching goals

The goal of the Urban Data Space Smart City Vienna is to create the legal, organizational, and technical framework for an efficient, data-based cooperation among city actors. We want to shift the paradigm of data use: Away from individual data silos towards a connected data ecosystem (see Figure 5) based on Gaia-X principles.

Currently, both the organizational and technical connections are set up individually for each project and data set. Therefore, new agreements must be reached and signed for each new project involving data sharing data, leading to high organizational costs. The Smart City Vienna Data Space will bring these individual solutions together through a framework agreement for data use and a metadata catalogue, thus simplifying technical data access. Gaia-X provides support for the creation of a secure and trustworthy data infrastructure. The data remains stored by the respective providers, which maintain ownership, responsibility, and sovereignty and ensure that data is always up to date. The metadata catalogue provides a transparent view of who provides what data, in what form, and under what conditions. The data provider retains control over access and terms, such as access duration, costs, or purpose specification. Standards greatly simplify the technical connection to the data sources.

In the first phase, only the City of Vienna and the Wiener Stadtwerke Group will participate in the data space. In the next phases, other municipal companies of the City of Vienna, as well as businesses, research institutions, and citizens will be involved.

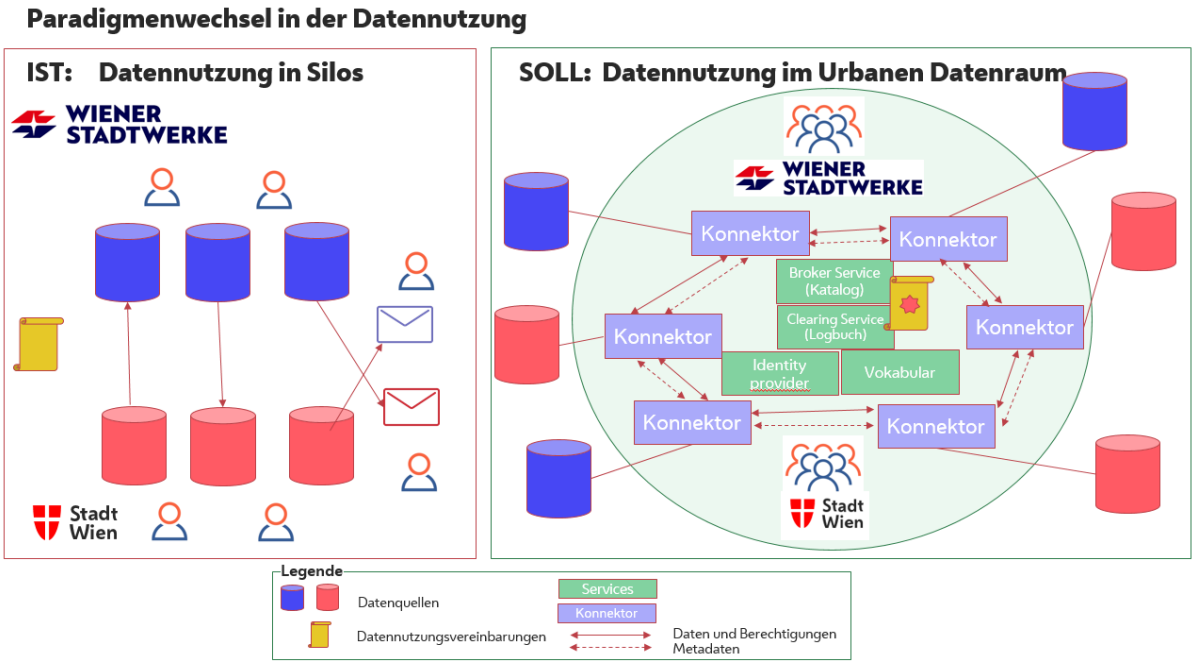

Figure 5: Paradigm shift in data usage, City of Vienna and Vienna Public Utilities (Source: City of Vienna).

Challenges and Solutions

The City of Vienna identified five areas that can benefit from the first phase of the Smart City Vienna Urban Data Space:

- Infrastructure: Sharing data on city infrastructure (e.g., central line register, road information system, rail and bus stop maps, IoT sensor data from the city data platform, etc.).
- Planning: Providing all relevant planning data in the public space (e.g. graphical data from the construction site information system, thermal compatibility, airborne laser scanning data, thermal flight, as-built plans for construction and facility management, orthophoto including infrared channel, planned tree planting, etc.).
- Smart Mobility in Vienna: Temporal and local over- and under-utilization of public space and infrastructure (e.g. analysing and predicting movement flows, occupancy of sights and museums, calculating road closures, etc.).
- Energy Dashboard: Use of near real-time data on energy consumption in Vienna (e.g. energy consumption of own buildings and facilities, breakdown by energy source, consolidation of electricity, heat, and gas demand, etc.).
- Coroner's inquest: Digital recording and processing of mortuary data without media discontinuity and provision for morticians (Vienna Funeral Service and others).

These five areas share similar challenges: data access is impossible or very limited, and the legal basis for possible uses unclear. Different projects currently share data in different ways across these thematic areas. Outside of the projects, data usage needs to be more transparent, as the uncertainty reduces reusability. The simultaneous need to define and organize compliance, governance, and technology poses the main challenge.

The main components of the solution are building know-how and gaining experience with the principles of a data space. It must become possible to use a common metadata catalogue, and the necessary data sources must be available. This requires a unified governance. The Smart City Vienna Data Space can fulfil the guiding principles of the Vienna Data Excellence Strategy (Stadt Wien, 2023), which reflects the Gaia-X principles.

Maturity level

The development of this use case is currently in the prototype phase. As this is the first data space of the City of Vienna, there is currently no interaction with other data spaces. However, connections with other Gaia-X compliant data spaces will be achieved in the future, thanks to interoperable standards.

Use case 4: Standardization of data / data formats through the use of a digital twin for mobility data in municipal administration

Brief description

This use case enables local government to automatically standardize mobility data. Mobility data currently exists in a variety of formats and standards, which increases the complexity for data providers, users, and public agencies. By automatically standardizing data, this use case reduces the variety of formats, simplifies data integration, and expands access to multiple data sources. A standardized view of mobility data provides local and regional governments with a better basis for decision-making and improves the efficiency of mobility services and infrastructure. This is particularly important in rural areas, where gaining an overview on mobility, poses major challenges.

Relevant Domains

The use case covers topics from several domains: Smart City / Smart Region, Public Sector, Geoinformation and Mobility.

Participants

- BU Road & Mobility
- Data Intelligence Hub

Overarching goals

The goal of this use case is to provide administrations with better and more usable mobility data. The automated standardization of data and formats expands the potential for application of the data. This use case reduces the variety of formats, quality, and standards of mobility data. This facilitates the connection between different city platforms and different data sources. This approach simplifies data management for providers, users, and public institutions and enables the full use of mobility data.

Municipalities will thus be able to connect their own data to existing platforms (e.g. Mobilithek) and data spaces such as the Mobility Data Space, Catena-X and the Data Space for Smart and Sustainable Cities and Communities, which is currently under construction.

Challenges and Solutions

Data is only valuable if it can be turned into information, a step which often presents practical challenges. Most raw data need to be “refined” or pre-processed before it can be used by an algorithm or software. This problem also affects mobility data, because of their complexity. Gaia-X based data spaces solve many problems for data providers by guaranteeing sovereignty. This use case addresses the other side of the equation, as it reduces complexity for data users through backend standardization, which can be implemented independently of the data space used.

This use case is based on the standardization processes of the Catena-X project. Catena-X is the first comprehensive implementation of Gaia-X and implements the Supply Chain Act in the automotive industry. In Catena-X, the delivered data is standardized using backend integration patterns. Using similar processes, this use case analyses the following data:

- Motion Data
- Timetables
- Geoinformation and Traffic Sign Cadastre
- Airport delay/cancellation data
- Dynamic traffic information (road works, traffic jams)
- Data on parking spaces
- Weather data
- V2X (Vehicle to X data, especially for autonomous driving)
- Mobility as a Service (MaaS) data, such as no-parking zones or location data

In some of these cases, providers have legal obligations to share data. Other data providers, unaffected by such legal mandates, often have concerns about their rights. This is where the Gaia-X concepts of data sovereignty come in (see section 2). Technological advances drive this development, which has already been tested in practice in Catena-X, but the development also applies in principle to other Gaia-X data spaces. The use case will use Catena-X as a reference architecture and advance it technologically.

An integrated database will allow local administrations a consolidated view of mobility in their region (a major challenge, especially in rural areas). This will contribute to the creation or improvement of so-called digital twins of

municipalities. It will also allow to evaluate (traffic) safety and to derive appropriate measures. In addition, local administrations will better understand and control traffic flows, optimize Mobility-as-a-Service applications and improve their planning (e.g. of roads, of bus routes, etc.).

Maturity level

This use case exists as a concept. Partial prototype implementations are part of Catena-X. Of these, connectors, simple cloud-agnostic services, and security and credential management solutions can be reused. This use case needs political support to be realized.

Appendix 2: The Gaia-X Hubs

The European Gaia-X project currently consists of 21 Hubs worldwide, 16 of which are in Europe. Gaia-X Hubs are the national contact and guidance points in the Gaia-X ecosystem for interested companies, administrations, initiatives, and organizations.

The Gaia-X Hub Germany

Since its foundation in 2020, the Gaia-X Hub Germany has been working to inform German companies, administrations, and organizations about the economic opportunities and benefits of the emerging Gaia-X ecosystem. The Federal Ministry of Economics and Climate Protection (BMWK) is responsible for the initiative to establish an interoperable digital infrastructure that stands for data sovereignty, data security and compliance with European data protection standards.

The Gaia-X Hub Germany is the national contact point for all social actors who want to engage in trusted use of data within open data ecosystems. The aim is to support the development of an international data economy in line with European values and economic structures. The Hub promotes the development and use of Gaia-X in Germany. To this end, it brings together representatives from science, business, politics, and civil society to exchange experiences, gain insights and jointly bring this knowledge into practice. The Hub uses the experience and know-how of its community to implement as many Gaia-X-based business and value creation models as possible. By participating in the Hub, members and interested parties learn how to implement their own projects in the ecosystem as efficiently and cost-effectively as possible, and what they need to consider when doing so.

For more information see: https://gaia-x-hub.de/en/

Working methods and goals of the Gaia-X Hub Germany

To date, the members of the Hub are organized in 15 domains (Agriculture, Aeronautics and Aerospace, Culture / Creative Industries, Education, Energy, Finance, Geoinformation, Healthcare, Industry 4.0, Logistics, Mobility, Public Sector, Planning / Construction / Operation, Smart City / Smart Region and Smart Living). To make the knowledge transfer as practical as possible, the Hub offers various exchange formats, such as regular domain meetings and workshops on relevant topics, from technology to law, to interdisciplinary topics. In this way, SMEs, organizations, and administrations benefit from the community synergies to develop their own application examples or business models, for example by applying existing solutions or by networking, exchanging, and jointly working on solutions. The Coordination Team is also responsible for the scientific support of eleven Gaia-X projects, funded by the BMWK for up to three years to develop pilot applications.

The Gaia-X Hub Austria

The Austrian Gaia-X Hub was initiated by the Federal Ministry of Finance (BMF), the State Secretariat for Digitalization and the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK). As the national Gaia-X contact point for companies, public institutions, and initiatives, the Hub ensures the implementation of the Gaia-X strategy in Austria and thus guarantees data sovereignty as a prerequisite for sustainable economic growth and social justice.

The Digital Austria Act[4] presents the federal government's digital work program, comprising a total of 36 digitization principles and 117 measures to reshape digitization in Austria. In the area of smart government, the Gaia-X Hub Austria is intended to actively participate in the European project. The Gaia-X Hub Austria consists of a Management Board, which works on a voluntary basis, and an Advisory Board, which provides support and acts as a multiplier. Working groups are responsible for the operational activities of the Hub.

For more information see: https://www.gaia-x.at/en/gaia-x-austria/

Working methods and goals of the Gaia-X Hub Austria

The Gaia-X Hub Austria aims to ensure that Austria as a business location does not waste any time in this essential phase of the digital transformation, and instead lets politics, science and research, business, administration, and civil society organizations actively participate in the European Gaia-X initiative and take a leading role in some areas.

To support the Gaia-X vision effectively, visibly and sustainably, the Gaia-X Hub Austria has pursued the following four strategic fields of action, for all participating or interested Austrian organizations and individuals in recent years:

- Provide information to build trust.
- Make it easier to get started and help build business.
- Join forces for greater impact.
- Network internationally to increase visibility.

If you are interested in becoming a member of the German or Austrian Gaia-X Hub, you can find more information on the respective websites.

[4] For more information see: https://www.digitalaustria.gv.at/Strategien/Digital-Austria-Act---das-digitale-Arbeitsprogramm-der-Bundesregierung/Einblicke-in-den-Digital-Austria-Act/Smart-Government-der-Zukunft.html