SmartCitiesWorld White paper

City data spaces:
A guide to building and operationalising data services

How data spaces are transforming data sharing, and establishing new frameworks to create data services to improve urban services and liveability

In association with

FIWARE

Written by

SmartCitiesWorld & FIWARE

with contributions from:

***SmartCitiesWorld* whitepapers examine emerging and growing trends in smart cities, highlighting progress so far and future potential, as well as spotlighting case studies from around the world.**

In this whitepaper, we present a guide to data spaces for cities, assessing how they can be built and operationalised, and asking industry leaders to identify real-world use cases and emerging trends in data spaces.

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Introduction

Our future digital life will gravitate more and more around data – data describing what is happening around us, when, where and why. Legacy IT systems are managing this data but are very often organised in silos. Data interfaces to partners, be it suppliers in a manufacturing supply chain, administrations in a smart city or partners in an energy grid, are often connected by a one-to-one interface. Such networks of one-to-one interfaces are time consuming to be created and to be maintained and they are very inflexible when the network of organisations is changing. Additionally, they are always created and operated between existing partners, so bringing new partners on board always requires the effort to create a new one-to-one interface.

Data spaces are paving the way for a new way to share data between different organisations and individuals. They are replacing the aforementioned one-to-one connections and enabling data-driven collaboration between different partners, while remaining very flexible for new partners who were not known before. This whitepaper illustrates the why, what and how of data spaces. This does not mean that the producer of data is losing control of the data or would not be able to create value out of the data.

The set of building blocks for the creation of interoperable data spaces in different application domains, to which FIWARE is contributing its technology, is providing exactly the functionality to enable interoperability by defined interfaces and data models. It also enables 'data sovereignty' which means that the producer of a set of data is able to determine and to technically enforce what someone is allowed and technically able to do with the data. This is finally the basis to be able to monetise data and to create value out of data.

Hereby it is important that the different data spaces are not creating another, larger silo for their ecosystem. Our world will be more and more connected in the future with the consequence that everything that can be connected will be connected, and everything that can be automated will be automated. This requires that data spaces in different domains will be interoperable. Imagine a smart city data space which would not be able to communicate and exchange data with a smart mobility, smart energy or smart building data space. The interoperability is the basis to create what is called 'multi-sided markets'. This is a description for the fact that data are very often creating their real value in a completely different environment or context compared to where they were created.

Join us in the endeavour of data spaces while reading this whitepaper.

Ulrich Ahle, CEO, FIWARE Foundation

SECTION ONE:

What are data spaces?

Data spaces have the potential to transform the way data is shared, operationalised and even monetised between different organisations, which given the complexity of the smart city ecosystem, will be critical to improving public services. But what are data spaces? How can they be established? What does best practice look like? Here, Juanjo Hierro, CTO of FIWARE, explains.

What are data spaces and how can they be established?

By Juanjo Hierro, CTO, FIWARE Foundation

At its core, a data space can be defined as a data ecosystem built around commonly agreed building blocks, enabling the effective and trusted sharing of data among participants for the creation of value. This is the definition of data spaces at their base level as given by the Data Spaces Business Alliance, created by FIWARE Foundation together with Gaia-X, the International Data spaces Association (IDSA) and the Big Data Value Association (BDVA), in its discussion document on data spaces.

As with other digital infrastructure, data spaces should be designed to work across sectors, with requirements and functions that are either similar or identical regardless of sector. With so many alternative standards available to create this foundation, it is not a technical challenge that stands in the way of the creation of data spaces but agreeing on the concrete standards that must be accepted by all participants in the data space.

Building blocks

Defining those building blocks is where FIWARE has been focused in data spaces for the last three years. One of FIWARE's first contributions to this was during the EU-funded Open DEI project, where experts from a wide range of organisations came together to reach a consensus on which building blocks would be necessary to create data spaces. Together, these experts identified a taxonomy of technical building blocks for creating data spaces, split into three pillars:

- **Data interoperability:** what are the protocols that participants will use in a data space for exchanging data? What is the vocabulary they will agree – the 'common lingua' – to ensure they understand each other, and create traceability in the exchange of data?

- **Data sovereignty and trust:** a commonly agreed technology framework is required to ensure participants can trust that the organisations they exchange with are who they say they are, have agreed to the overall data space governance rules and have valid credentials. How can that trust be built and the right level of identity management be achieved? What language for defining the policies for accessing data services and usage of data will be used, and what technology can be used to enforce those policies?

- **Data value creation:** what technologies will participants use to describe their data services and offerings around those services, especially if these are to be monetised? How can these services be promoted and published, for example, in data marketplaces?

The technical building blocks for data spaces must answer the questions that define these key pillars, but governance building blocks must also be defined that address non-technical matters as well, typically requiring definition of legal agreements every participant must sign and follow: business agreements, definition of governance bodies, or operational agreements. Altogether, technical and governance building blocks are elements that only those participating in the data space can define, but the adoption of common standards and agreements is essential at the outset.

Building from openness

When we look at the technology building blocks, agreement among participants is critical – they must agree on the standards that the data space infrastructure is built upon and there are a lot of technology standards that must be agreed. The FIWARE mission is to build a sustainable open ecosystem around development of smart solutions in multiple sectors based on the adoption of common open software platform standards. Together with its members, FIWARE Foundation actively participates in relevant standard or industry bodies, contributing to the definition of open standard specifications when they do not exist, or the specifications of how existing standards can be integrated. These contributions are based on the experience gathered through the open source implementation of specifications.

Data spaces enable the next step in the digital transformation of any organisation: how smart applications that they host can exchange with smart applications at other organisations in a trusted and efficient manner for the creation of value. FIWARE Foundation believes that data space infrastructures must be based on open standards backed by open source implementations and has joined forces with Gaia-X, the International Data Spaces Association (IDSA) and the Big Data Value Association (BDVA), creating the Data Spaces Business Alliance (DSBA) where, among other things, they are building technical consensus on the standards to be adopted and how they can be integrated.

This consensus covers the three technology pillars mentioned before. Regarding data interoperability, ETSI NGSI-LD comes as the default API for exchange of digital twin data and the community-driven Smart Data Models initiative emerges as a strong reference for creation of vocabulary hubs that will facilitate interoperability, since the semantics and format representation of attributes describing digital twin entities (e.g., a building, a bus) have been agreed among participants. Bringing the necessary foundation to implement identity management and trust, the adoption of W3C standards for Decentralized IDentifiers (DID) and Verifiable Credentials (VCs) combined with the new generation of OpenID Connect protocols (SIOPv2, OIDC4VP, OIDC4VCI) has been agreed. Besides, an attribute-based policy enforcement framework has been defined based on the adoption of ODRL as base policy definition language. Covering the third pillar on data value creation, creation of catalogs and marketplaces for data services and their offerings described using verifiable credentials are based on the adoption of TM Forum standard recommendations. Last but not least, as important as the identification of standards to rely on, a significant outcome of this consensus is the definition of detailed specifications about how all these standards can be integrated together.

Returning to the beginning and the definition of data spaces, the aim is for the secure, effective and transparent exchange of data between different parties. To create an open system requires that the building blocks and technology of that system, and the processes by which they're agreed, must also be discussed and decided openly and collaboratively, as we are doing in the DSBA. These principles provide a clear path forward for the sharing of data and operationalisation of data services, with flexibility among partners built in. Anything less will see organisations continue to work in silos, and hold back the kind of necessary collaboration required to advance modern digital service provision. Fulfilling its mission, FIWARE Foundation is not only contributing to building consensus but supporting a fast adoption in the market by means of bringing a first open source implementation of components materialising data space building blocks that support most recent standards and commonly agreed specifications, therefore making data spaces happen.

SECTION TWO:

Exploring uses for data spaces in cities

For all that data spaces are still a somewhat emerging concept for smart cities, there are already a number of active use cases in the market today that demonstrate best practice for establishing, operationalising and even monetising them. Data spaces have the potential to revolutionise the way that cities and businesses work together to boost urban economies, tackle sustainability issues, transform urban mobility, and improve liveability for citizens by supporting the development of more inclusive and accessible public services. Here, we look at those in FIWARE's partner network who are already working with data spaces to achieve some of these goals.

Municipal data utility: sovereign data sharing for cities and regions of tomorrow

By Anne-Marie Pellegrin, Communications Manager, Data Competence Center for Cities and Regions (DKSR)

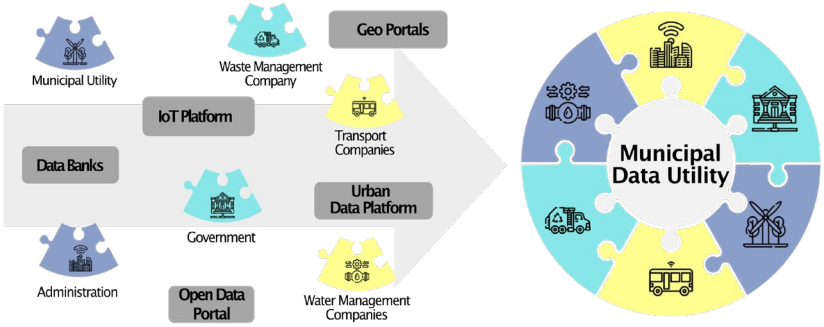
To make urban innovative measures evidence-based and sustainable, and turn cities into resilient environments in the long-term, cities and municipalities need to be able to exploit data, and not only data they own, but data coming from different organisations and sectors.

A hurdle for the broad transfer and availability of diverse and highly-qualitative data is the lack of infrastructure to share it safely between different organisations without participating stakeholders losing view and grasp of it. This is the case especially when it comes to restricted data. Data spaces enabling this kind of data sharing already exist for many areas, but for municipal stakeholders, a data sharing platform with determined roles and user rights that is easy to access and handle in a sovereign way is still lacking. A technical, organisational, and legal solution is needed to share data freely within a municipality and beyond its borders, at the same time providing the safety it needs for municipal stakeholders to exploit the full potential of urban data.

This is why a project between the Data Competence Center for Cities and Regions (DKSR) and the municipal utilities of the City of Mainz, Germany, is now developing a blueprint for municipal data utilities as a data Space. The project, funded by the German mFUND research initiative, aims to provide municipal stakeholders with a data sharing platform addressing legal, technical, and organisational aspects.

The consortium consists of partners from the relevant areas of expertise, who will coordinate the project according to the requirements of municipal stakeholders (e.g. administration, municipal utilities) taking part in the process. The proof of concept will be delivered in terms of a use case in the area of mobility by combining (partly) restricted data from several sources, based on open-source technology and open standards. FIWARE open-source technologies implementing relevant standards for data spaces will therefore be instrumental in making data spaces happen.

The full potential of data is not yet reached, and the need for intermunicipal data sharing platforms to shape cities in innovative and sustainable ways has only become more urgent. Open-source technology and open standards can pave the way to municipal data utilities as data spaces for cities of the future.



Credit: DKSR

Satellite data spaces for urban sustainability

By Gaetano Volpe, CEO, and Mauro Manente, COO, Latitudo 40

The challenge for sustainability must be met in cities (75 per cent of the world's population will live in urban areas in 2030), and data-driven planning combined with action models can help to achieve this goal. Building analysis models in urban areas is complex, and acquiring data for urban sustainability programmes can be challenging due to the limited availability of reliable data, poor data quality, and the difficulty of integrating data from multiple sources.

In response to these challenges, Latitudo 40 developed a new platform – an operating system for urban sustainability – based on data from space, analysed and processed with innovative artificial intelligence algorithms and integrated, thanks to FIWARE technologies, with urban open data and data from IoT sensors in the field.

Remote sensing can provide valuable data for European cities as part of the European Data Space Strategy. This data can be used to support a range of applications, including urban planning, climate adaptation and environmental monitoring. The Latitudo 40 platform enables the tracking of changes in urban areas over time, such as land consumption, the evolution of green spaces and their quality, and the presence of urban heat islands. In addition to identifying and monitoring environmental risks, Latitudo 40 offers a range of mitigation tools, mainly through nature-based solutions and simulation of the future effects of current choices.

Within the European SPOTTED (Satellite Open Data for Smart City Services Development) and BeOpen projects, Latitudo 40 had the opportunity to integrate information extracted from satellite remote sensing images with FIWARE to provide a new 'data space from space' to promote urban sustainability. The datasets generated by Latitudo 40 can be shared with a zero-code approach within data spaces for data sharing, using FIWARE data space technologies, this way designing the future of cities by learning from the past and monitoring the present.

Latitudo 40 offers cities a range of multi-temporal datasets to support sustainability strategies, including:

1. Land use changes (e.g. land cover and land use) at high resolution
2. Evolution of urban green space (quantity and quality) and tree cover density
3. Land surface temperature evolution at 10mt resolution.

Latitudo 40's cloud platform then allows these datasets to be combined to create complex products, providing:

1. Heatwave risk potential in cities, integrating datasets with urban population distribution
2. Microclimatic performance of urban greenery
3. Beneficial effects of urban parks on heat mitigation (park cool islands).

These products, validated in the cities of Naples and Milan, offer additional datasets useful for making informed decisions on urban investment. In particular, the combination of the products makes it possible to create urban vulnerability indices and to identify the areas with the highest priority for intervention, optimising the use of resources and maximising the social ROI of the mitigation actions put in place. FIWARE data spaces technologies can make these product services, as well as data they generate, accessible from cities and citizens in a trustworthy and efficient manner.

Making data spaces work for everyone

By Jim Craig, Senior Product Manager, Global Public Sector, Red Hat

Even with the support of technology like FIWARE, smart city deployments can be complex, time consuming, and costly. The biggest challenge is to effectively gather and process data at a very large scale while, at the same time, building an easy-to-deploy solution that is scalable and secure.

A multi-disciplinary combined team of experts from Red Hat Open Innovation Labs, FIWARE Foundation, and Human Oriented Products (HOPU) – a Libelium company and one of the most active solution providers in the FIWARE ecosystem – collaborated over six weeks to facilitate the implementation of an easy-to-deploy, highly-scalable, production-ready, cloud-native, open source smart city platform powered by FIWARE, using Red Hat® OpenShift®. This platform does not only include base FIWARE platform components but modules designed to improve liveability and environmental sustainability based on air quality monitoring. It was tested with real data from the cities of Cartagena, Las Rozas and Molina de Segura, in Spain but was designed for easy deployment in many other cities worldwide.

As a provider of infrastructure software, the value of Red Hat is often hidden to the end user and is realised most by systems administrators, operators and developers. Therefore, what we have done is make the act of deploying FIWARE much easier and quicker for everyone deploying future FIWARE platforms, as the insights and enhancements realised during the 6 weeks workshop have been included in the source code.

Juanjo Hierro, FIWARE CTO, summarised: “We have transitioned from a complex process of deployment that takes days into a more automatic process that takes just minutes. Solutions that were previously only available to large cities will now be available for any city in the world, thanks to the combination of FIWARE technologies and Red Hat solutions.”

Meanwhile, David Zamorano, Engagement Lead, Open Innovation Labs, observed: “This is not a purely technological project, thanks to working on culture, processes, and technology. And, thanks to putting engineers, business people, and the cities themselves in the same room, we manage to encourage these cities to become more ecological and sustainable.”

Collaboration is key for the future success of data spaces, between the various data owners, business and technical stakeholders. FIWARE will bring open source technologies helping smart cities to join data spaces and become major contributors of the data economy, offering data and services that may fuel development of innovative services or integrating data and services from other organisations which help to improve services offered to citizens. All in a trusted and effective manner.

Red Hat can contribute with tools that will help to reduce the complexity associated with the deployment of FIWARE technologies for data spaces, helping to materialise data spaces. Widening the lens beyond a purely technological focus, Red Hat may also contribute to creation of an open culture in the implementation of processes linked to data spaces, bringing technical and business people together for the creation of greater efficiencies, plus reduced time and costs to development and deployment. In this way, we can realise overall higher levels of satisfaction and value for employees, users, businesses and partners of organisations involved in the creation of data spaces.

Data for innovative, sustainable and user-friendly mobility solutions

By Dr. Andreas Heindl, Project Leader, Mobility Data Space, acatech – National Academy of Science and Engineering

Mobility Data Space

Data sharing is an answer to challenges of future mobility

The Mobility Data Space offers solutions to many challenges, such as the mobility shift or more affordable, convenient and available mobility solutions – and it is an answer to strengthening competitiveness and innovation in Europe. The Mobility Data Space is the data sharing community for anyone who wants to make mobility more eco- and user-friendly, safer, and fairer. The Mobility Data Space brings together companies, organisations and institutions who want to monetise their data or need data for innovative mobility solutions.

Trust and cooperation are the key for sovereign data sharing

For the Mobility Data Space to work, it is necessary, that a neutral and trustworthy institution such as acatech – the National Academy of Science and Engineering – which is accepted by all stakeholders, takes responsibility. On the other hand, it is important for a contributing community that as many key players as possible participate – car manufacturers, public transport, mobility service providers, municipalities, small and large companies, and start-ups.

The Mobility Data Space is offering a technical and organisational solution to incentivise the sharing of data based on European values and standards. The challenge is not a lack of data but a lack of data sovereignty as basis for data sharing on equal footing.

Decentralised infrastructure is a game changer

The Mobility Data Space is a marketplace which is providing a level playing field for all players. Fundamental features of the Mobility Data Space are based on the framework of Gaia-X and the International Data Spaces Association (IDSA). The Data Spaces Business Alliance set up by these two organisations together with FIWARE Foundation and the Big Data Value Association (BDVA) is called to play a central role in accelerating the development of data spaces.

This means that centralised structures are avoided in favour of decentralised solutions. In addition, the principles of federation and interoperability promote the interaction of actors within a data space as well as across data space borders. The decentralised infrastructure is the prerequisite for sovereignty over one's own data and its use.

Trust is essential for data exchange: technologies and control mechanisms help to create trustworthy relations. In addition, transparency is promoted via digital identities and the trackability of transactions but not of the data itself.

As the driving force behind the data spaces movement, the FIWARE Community is contributing to the definition and implementation of DSBA Technical Convergence recommendations, hence supporting creation of an open, standard-based, mobility data space.

The Mobility Data Space provides learnings for other domains

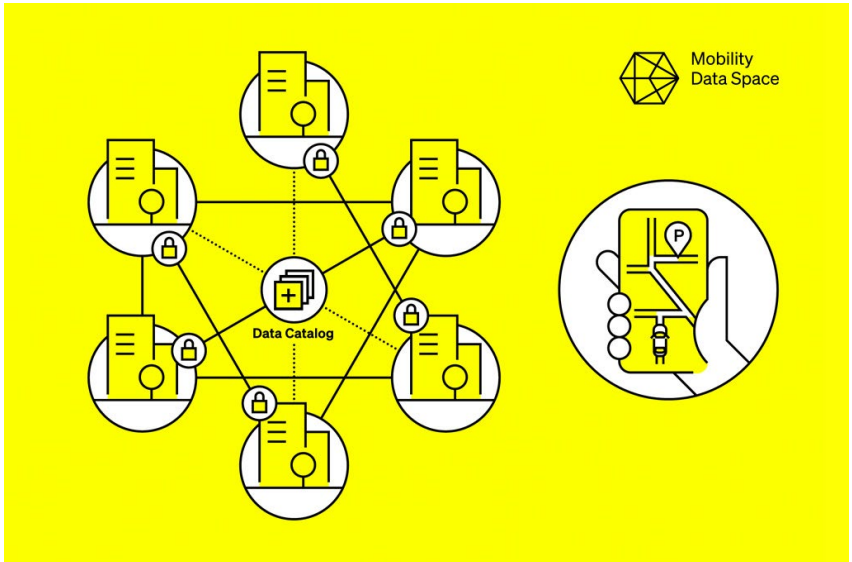
From the beginning, the focus was on use cases: the first use case in March 2021 was a collaboration between FREENOW and the German Weather Service to provide weather-dependent recommendations for the choice of mode of travel.

Today, the focus is on exchange and collaboration between the different stakeholders within the community, for example in improving the data quality of the charging station infrastructure, connecting other data spaces to the Mobility Data Space, or cooperation with other domains such as the insurance sector.

With that background, lessons for other domains and data sharing can be derived from the experience of the Mobility Data Space. Currently, acatech – National Academy of Science and Engineering is setting up further data spaces in other domains.

Data spaces offer added value for citizens, companies and society

On the one hand, sharing data via the Mobility Data Space offers concrete added value for individual citizens by enabling innovative, affordable, and convenient mobility solutions. On the other hand, companies can improve products and services and offer new mobility services through data-driven business models. Finally, society as a whole benefits by strengthening competitiveness, sustainability and mobility.



Credit: Mobility Data Space

Data space for smart cities: an application in Italy powered by FIWARE

By Lanfranco Marasso,
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Carmelo Bonaccorso, Manager,
MUNICIPIA SPA – Engineering Group

Data space refers to a type of data relationship between trusted partners who adhere to the same high-level standards and guidelines in relation to data storage and sharing within one or many vertical ecosystems. If we consider data space as the sum of all its participants (data and service providers, citizens, public administration, private companies), this seems to be the perfect solution for a complex environment such as a smart city, where a common ground for different urban ecosystems is required.

In delivering smart city solutions we need to foster public data spaces, leveraging AI applications and the re-use and combination of open public data across the EU, to improve G2B and G2C services. In the smart city domain, data sovereignty and trust are essential for data spaces to work and support relationships among participants: the Reference Architecture Model for data exchange published by the International Data Spaces Association (IDSA) is a first archetypal to look at and main ideas are now incorporated into Data Space Business Alliance (DSBA) Technical Convergence recommendations.

The European Commission promotes the release of High Value Datasets held by the public sector for the creation of data products and services and for their use by the participants in the common European Data Spaces. The Implementing Act on High Value Datasets mandates public sector bodies to publish open, machine-readable data belonging to specific thematic categories.

In this context, Engineering has delivered the first smart city application project that we can label as 'data space ready'. The aim is to implement remote control of public lighting, enable efficient energy consumption, monitor pollution thresholds and, consequently, free up economic resources

to enable new public and business services. The project, developed by Municipia within an Italian Public Private Partnership (more than 40 municipalities and several private companies in Sicily, Italy) provided an IoT solution, based on the Digital Enabler, powered by FIWARE. It is a scalable, cloud-native, multi-tenant platform used to remotely control and command streetlights and power meters provided by different vendors, who adopt heterogeneous protocols.

The project supports cost optimisation and energy waste reduction, thus improving the efficiency of street lighting. By moving "from street lighting to smart lighting to smart cities", it enables the municipalities to use lighting only where and when necessary.

The solution is connected and integrated with different infrastructures deployed in 40 cities (sensors and a wide range of IoT and devices), which can remotely detect, monitor and manage information received from the urban ecosystem, including the functionality of sending alarms to plant maintenance technicians whenever unusual energy consumption occurs.

Historical information on energy consumption is stored in the platform data lake as time series, and harmonised in data models. The readiness towards data spaces is ensured by the FIWARE TRUE Connector, integrated with the Digital Enabler.

By increasing the information flow, the data spaces approach enables better decision-making for stakeholders and, by providing foundational datasets, it allows the development of innovative services at reduced marginal costs. It makes available more data for the economy and society, ensuring control for those who generate it and, at the same time, facilitating its sharing. This creates a positive impact on citizens' lives and instils trust in businesses and public administrations.

"In delivering smart city solutions we need to foster public data spaces, leveraging AI applications and the re-use and combination of open public data across the EU"

SECTION THREE:

Identifying trends for the future of data spaces

Having now explored the existing use cases for data spaces for cities and urban environments, we look ahead at where this technology can take us moving forward, to make data spaces more common and continue to develop trust between parties within data spaces, while examining the role that FIWARE is playing in this process.

Understanding minimum viable data spaces (MVDS)

By Sabine Gerdon, Business Development Manager Data Sharing and Innovation, and Syrine Souissi, Business Development Manager Data Sharing and Innovation, Amazon Web Services (AWS)

Data spaces are a rapidly evolving technology concept. Various data spaces use cases have been identified. For example, a data space can support cities in tracking their progress and inform action to achieve Europe's Green Deal goals. Cities are key contributors to the ambitions to reach the target of reducing emissions by 60 per cent by 2030 in the building sector and achieve climate neutrality by 2050. To meet these targets, data spaces can foster data exchange on energy consumption, energy-related greenhouse gas emission and smart meter data to drive and evaluate climate action. The basis for achieving those outcomes are comprehensive data strategies which enable sharing data within an organisation (intraorganisational data sharing) and across organisations (interorganisational data sharing).

As a first step, intraorganisational data sharing needs to be enabled. For example, the Smart Territory Framework (STF) is an open-source framework that makes it easier and faster to create and operate interoperable platforms, in line with global industry standards and compatible with the open-source offering of the FIWARE ecosystem. By implementing the STF and leveraging the FIWARE open-source technologies, cities break data silos and are able to share data within their own organisations.

When it comes to interorganisational data sharing, a key trend we have observed related to data spaces is to move from theory to practice with the help of Minimum Viable Data spaces (MVDS). The MVDS is a small-scale practical deployment of a data space based on the FIWARE building blocks. The MVDS shows organisations the benefits of a data space with small time and financial investment. The MVDS not only allows organisations to test different data space technologies, but – more importantly – it enables them to try out different data governance set ups. This includes organising elements of trust, identity and access management policies to enable safe and secure data sharing at scale.

FIWARE data space technology building blocks are well suited to create MVDS. These building blocks are the first to comply with technical convergence recommendations defined under the umbrella of the Data Spaces Business Alliance (DSBA) launched by FIWARE Foundation together with Gaia-X, the International Data spaces Association (IDSA) and the Big Data Value Association (BDVA). Their tested modular approach allows for integration with existing solutions and the flexibility to add new capabilities over time. The initial focus for MVDS is to ensure data interoperability and create data sovereignty and trust based on the FIWARE data space framework. Building blocks of this framework that participants of the MVDS have to use can be deployed on AWS and integrated with the AWS STF, building the concept of AWS STF Data Space Connector enabling cities to expand their applications and share data with other organisations (ports, logistic operators, car manufacturers, etc) in a secure and trusted manner.

> *"Data spaces solve the challenge of federated data sharing but their main purpose is to free up data to solve major challenges that smart city stakeholders face, and allow for the creation of new and innovative solutions"*

Requirements and participant characteristics for impactful MVDS

Our experience from testing and implementing data spaces show that meeting three requirements and participant characteristics listed below allow cities to quickly demonstrate the benefits of data spaces.

Three requirements that accelerate the success of MVDS are:

1. A clear business case for data sharing for all participating parties, for example: a) by sharing their data to meet shared requirements (e.g. compliance, process efficiency, transparency) every member saves money and time by sharing the burden; b) by working together to accelerate innovation through granting wider access to data; c) by bringing together the public and private sectors to work towards achieving a common goal, such as climate action.

2. One key point of contact for the cross-sectorial/cross-organisational project with decision making responsibility that can also facilitate discussions for the organisational set-up of the data space including governance structures and decision-making processes.

3. Trusted technology partners that have tested and implemented data spaces in the past.

Three characteristics of MVDS participants that can benefit most from data spaces:

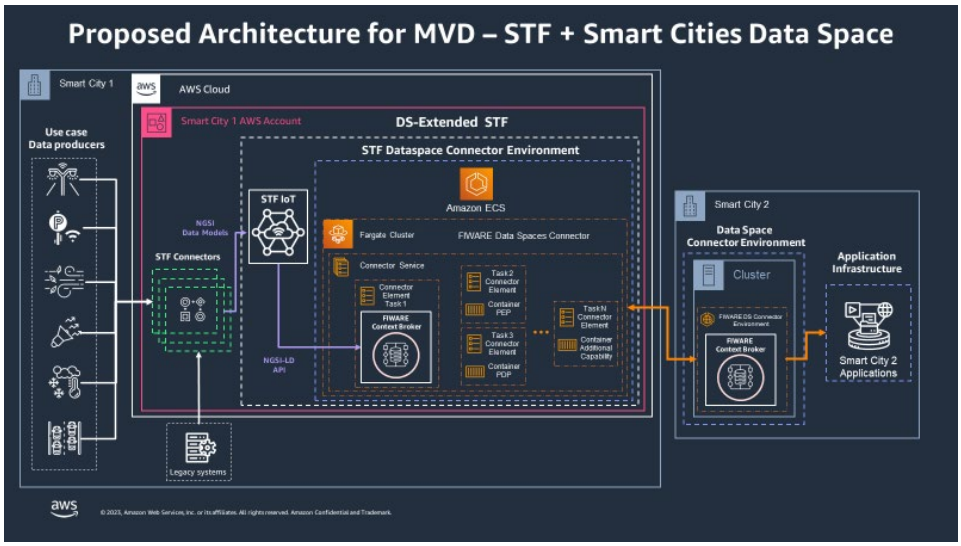
1. Parties that do not regularly share data but have complementary data that would provide useful insights if linked

2. Parties that are reluctant to create a joint data platform due to trust, user identity management, competition issues or other regulatory concerns

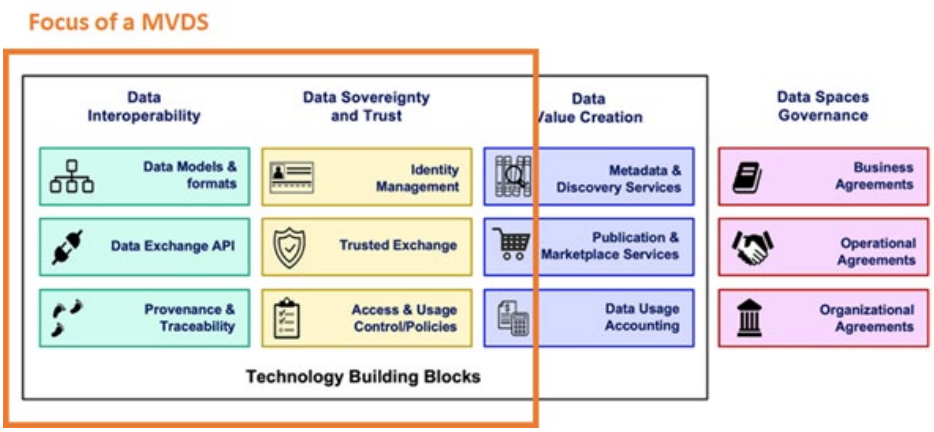
3. Parties that are keen to only share specific data assets/parts of the metadata rather than full datasets.

What's next?

Data spaces provide significant benefits to cities, including improved resource efficiency and better decision-making in order to meet, for example, sustainability goals through the implementation of a comprehensive data strategy that expands the frontiers of the organisation. To trial this, cities can implement a minimum viable data space (MVDS) using an AWS STF Data Space Connector, including the FIWARE data space technology building blocks. AWS and the AWS Partner Network have the technical expertise to support their customers in doing so, thus enabling cities to break down data silos, and unlock the full potential of data spaces.



Credit: AWS



Credit: FIWARE

Unlocking the power of data spaces: building the ecosystem for the digital economy

By Hugo Serra, Tech Senior Manager, and Ricardo Martins, Associate Partner, Deloitte

Deloitte.

Data spaces can excel in the creation of a decentralised ecosystem, where the industrial sectors are not an isolated phenomenon but rather part of a broader transition towards a digital economy. In a smart community context, data sharing as a local effort will no longer be sufficient in a medium-term context given the demands to drive value from data and analytics. Instead, they must recognise data sharing as a key driver to accelerate access to advanced technologies and strategic data reuse, while boosting the power of local digital twins and driving innovation and improved outcomes.

The power of data spaces derives from proper and well-architected data integration and correlation processes. Data models and standard interoperability mechanisms are crucial to ensure that different parties of the data space ecosystem are linked and understand a shared 'common lingua'. Interoperable data spaces will overcome existing legal and technical barriers to data sharing and enable it in a trustworthy and secure manner.

From Deloitte's perspective, there are several emerging trends in data spaces that are worth sharing:

Digital twins data exchange in smart cities

The information gathered from different sources within a city or community represented by local digital twins allows the creation of service performance and operational dashboards to enable a powerful visualization of advanced data maps. The power of sharing these data assets across multiple organisations globally can be leveraged and strengthened by data spaces. Digital twin data exchange ensures that cities can benefit from inputs provided by each other, facilitating modelling, simulations, and predictions, which can foster citizens' quality of life and improve city operations.

Distributed ledger technologies

Data spaces foresee a hyper-connected future built on interconnected devices and platforms exchanging data and value. Distributed ledger technology will ensure a network of nodes replicating, sharing, and synchronising digital data and value spread across decentralised entities. In that sense, these technologies guarantee a fully trustworthy environment, where all transactions are conducted using safe cryptographic encryptions, with no central administrator, creating the possibility to enable the trustful auditing of data transactions.

Sustainability and climate

Cities and organisations need to disclose their exposure to carbon-intensive activities and assets that may experience risks resulting from climate change. More rules will be published proposing that public companies be required to report certain climate-related data in open standards promoting data sharing and enabling it in a trustworthy and secure manner in the data space ecosystem.

Health data space

More and more health data are being collected and used within healthcare. The use of this data still leaves much to be desired and should become a (legal) framework for the use of health data through regulations and standards. It also must contain tools for managing the data models. The aim is to give individuals more control over their health data, stimulate the healthcare ICT market, and enable the secondary use of data for health research, personalised medicine, and innovation in a secure way. To guarantee privacy in the secondary use of data space, obligations have been included to anonymise that data and, where this is not possible, to pseudonymise it.

In this context, FIWARE technologies play a crucial role in shaping the future of data spaces. With the exponential growth of data in various domains, including energy, health, and mobility, there is a pressing need for effective management, integration, and utilisation of this vast amount of information. FIWARE, with its open-source platform and standardised APIs, provides a powerful framework for building scalable and interoperable solutions.

Trends in the development and adoption of mobility data spaces

By Dr. Gadi Lenz, Chief Scientist, Urban Software Institute, and Jason Warwick, Director, [ui!] UK

Mobility data spaces – the data spaces focused on mobility data, for both passenger and goods mobility – have seen some of the most significant research and development activities. Projects funded by the German government resulted in the implementation of IDSA (International Data Spaces Association) components for mobility use cases. The Mobility Data Space (MDS) showcased a large number of use cases, one of which (Optipark) [ui!] were proud to contribute.

MDS is now an entity operated by a neutral non-profit organisation, of which both FIWARE and [ui!] are active participants – and part of a rapidly growing international list. Similar developments are taking place at the European level as can be witnessed by Horizon Europe and Digital Europe – projects funded by the European Commission (EC). FIWARE and [ui!] are partners in both programmes currently running mobility data space projects in addition to those that have been submitted.

The rapid development of mobility data spaces is not surprising and is in some ways related to the development of new smart mobility concepts over the last few years. In the passenger mobility arena, public transit has been joined by shared mobility, micromobility, mobility on demand, etc, and Mobility-as-a Service (MaaS) is now starting to be deployed at various levels in many cities. All of these require significant mobility-related data in order to offer new services. In one project (together with partner T-Systems) we demonstrated intermodal journey planning (an important application for a MaaS platform), which also included IDS connectors. It included not only connection to data from public transit and shared mobility operators, but also used parking data that [ui!] generated from floating car data (FCD) in conjunction with AI-based forecasting.

Mobility data is therefore expanding together with the new innovative services that are evolving, which already include much more than public transit schedules (e.g. parking, EV charging, real-time traffic information). As more data sources are made available, both public data from NAPs (national access points), for example, and from private data (possibly associated with commercial terms), new services are enabled. This creates a virtuous circle with new services driving the need for more data and new data leading to new value add services.

It is also not surprising that the automotive industry is now participating in these efforts. Modern vehicles generate massive amounts of data that enable infotainment and navigation services for the driver but also data that is of interest to many potential stakeholders (e.g. smart cities with their urban data platforms, insurance companies). As the automotive industry transitions to electric vehicles (EVs) and autonomous

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vehicles (AVs) even more data will be generated to enable AV use cases and connection to energy data spaces related to the EV charging infrastructure. [ui!] are currently partners in a project that is developing and then demonstrating cloud-to-edge (the edge being the vehicle) capability and use cases based on Gaia-X data space infrastructure. Some of the use cases have future AV applications as a longer-term target.

Finally, the EC is currently funding multiple mobility data space projects. The Digital Europe programme has data spaces as one of its core themes (driven by the EC's data strategy). Together with FIWARE and several other partners, we are currently participating in a preparatory action on mobility data spaces to be followed by a deployment action focused on sustainable urban mobility including multiple European cities. Many other data spaces in such domains as smart cities and regions, energy, tourism, water, and others are also being funded by the EC, all driven by its overall data strategy, demonstrating that data spaces are a fast-growing trend, and the mobility sector is one of the leading sectors.

Mobility is one of the infrastructure pillars of our society in urban, suburban, regional and rural areas – in fact, data platforms (not unlike data spaces) are already being represented as a utility, such as the Flemish Data Utility Company.

Undoubtedly, the vision for national and international mobility data spaces are to become part of our digital fabric for data exchange, much as the internet has become the fabric for information exchange. Technical Convergence recommendations coming from the Data Space Business Alliance (DSBA) launched by FIWARE Foundation together with other relevant actors such as IDSA, Gaia-X or BDVA bring to light the standard technical components to incorporate in the creation of data spaces.

Summary

Data spaces have the potential to pervade essentially every vertical within the smart city ecosystem, from mobility to energy – and not before time. Since the emergence of the smart city concept and the transition to more digital solutions, which brought with it the swathes of data cities and their partners now generate and collect every day, there has been a significant question mark over how to securely share that information between parties in a way that isn't disruptive to business practices or privacy. Data spaces are the answer to this question.

Data spaces reinforce the idea that data sharing is about sharing and begin to strip away the notion that organisations in data sharing agreements are giving something up. With the right building blocks in, the establishment of data spaces that are occupied by different sectors puts the focus on the advantages of having the right data shared between the right people at the right time, and the benefits this brings to cities and citizens alike.

With organisations like FIWARE taking responsibility for pushing the data spaces agenda forward, with foundations in openness and transparency, the concept of establishing data spaces to create data services between the public and private sectors should only become more attractive – particularly as the use cases continue to grow and diversify.

With greater data control and sovereignty, data spaces address a number of significant pain points in how organisations collaborate on data services, and this will be a key theme during FIWARE's Global Summit on 12-13 June in Vienna, among its three core themes: open source, open standards, and open community.

For more information and to get involved, visit the official Summit website.

About FIWARE

Together with its members and partners, FIWARE Foundation drives the definition – and the Open Source implementation – of key open standards that enable the development of portable and interoperable smart solutions in a faster, easier and affordable way, avoiding vendor lock-in scenarios, whilst also nurturing FIWARE as a sustainable and innovation-driven business ecosystem. Serving diverse domains, FIWARE is today the world leading Open Source technology for the digitisation of smart cities and regions.

The foundation achieves this through its offering of reference architectures, standard building blocks, roughly 1,200 Smart Data Models, a standard API, its 33 Innovation Hubs (iHubs), the FIWARE Marketplace, and the support of its fast-growing global community that shares a common vision and combines their efforts toward making FIWARE the Open Source technology of choice for industries, governments, universities and associations to reach their full potential and scale up their activities, thereby, entering new markets and growing their businesses. Founded in 2016, the foundation has Madinah City, Atos, AWS, Engineering, NEC, Red Hat, and Telefónica among its 600+ members. For further information, visit fiware.org and follow the organisation on Twitter, LinkedIn, and YouTube.