Winning with dataspaces like Catena-X: From Big Data to Better Data

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DEEP DIVE INTO DATA SPACES – #2

T Systems Let's power higher performance

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Intro

Business leaders and futurists, and stock markets, of course, agree on the importance of data-driven value creation. Automotive is a case in point. Figure 1 illustrates the shift in automotive from a hardware-centric business toward software & services, and how ultimately data rules with trillion-dollar market valuations. The big question is how to do it. How to get from analog products and legacy infrastructure to data-driven profitability? And how to get started quickly now, not tomorrow ... toward results with big numbers. And all of it, of course, in a quick succession of smaller steps from success to success instead of taking a big leap into the dark.

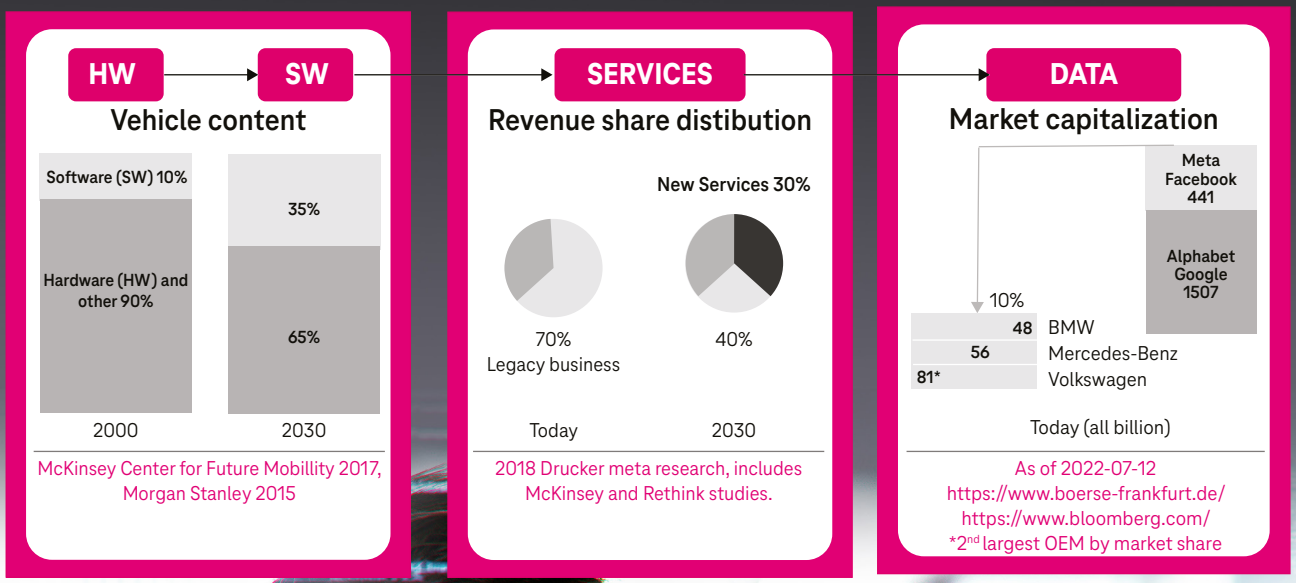


Figure 1: Auto power shift to services and data (update of Schlueter Langdon 2023)

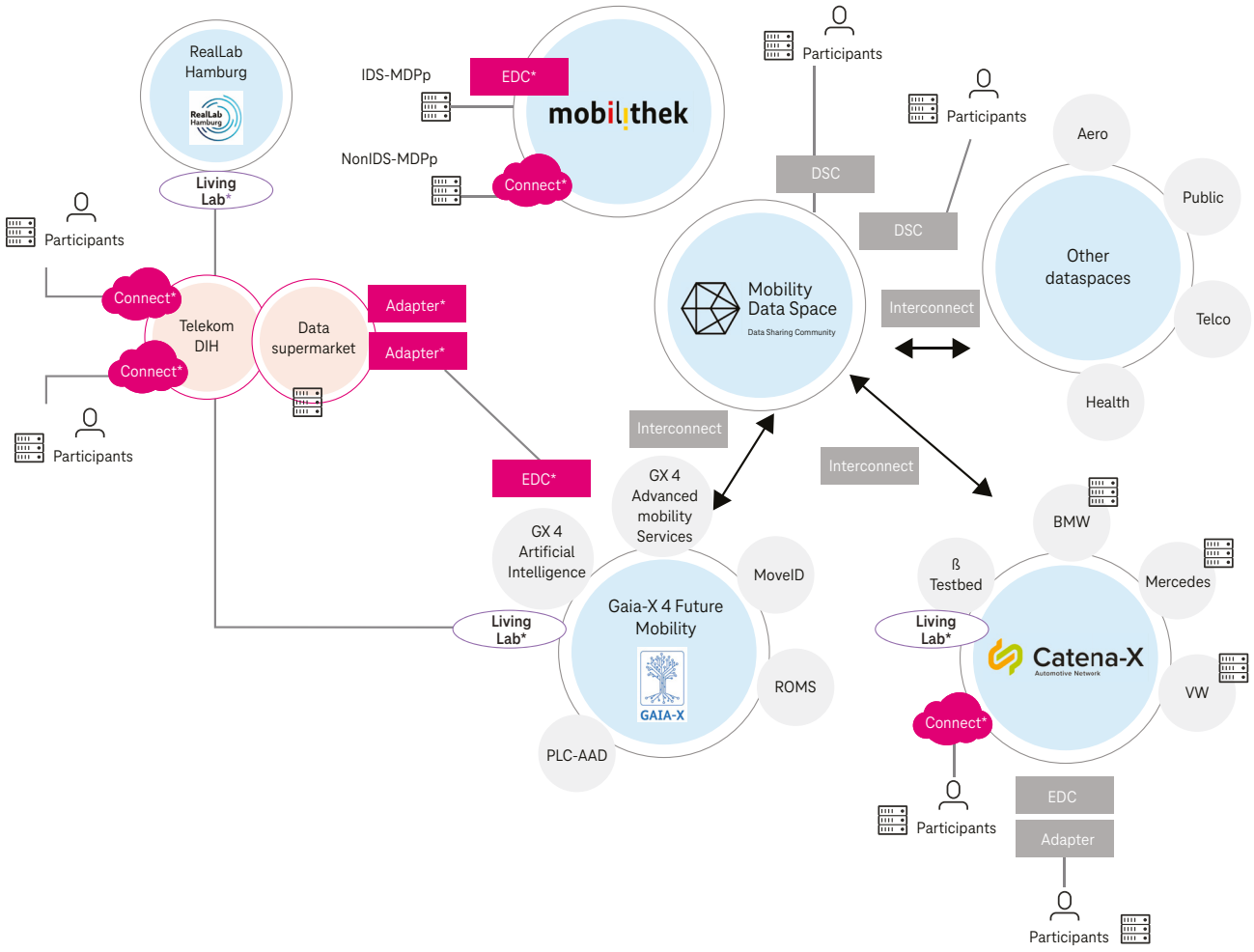
Recap: Three themes from part 1 – data product, factory, space

The good news: best practice has already emerged. In part 1 we presented three themes for a strategic response at an enterprise level. They didn't fall from the sky but, evolved from the acknowledgment that we as humans and highly visually oriented creatures are biologically challenged in dealing with data because we cannot see much. Hence, we called it the data iceberg. And to avoid a fatal collision, and your project becoming another Titanic, our themes suggest starting to apply tried-and-tested approaches to data:

1. **Treat data as a product** applying product management best practice
2. **Industrialize data products** using factory-style automation
3. **Build a data supply chain** for these factories using dataspaces

Instead of reinventing the wheel, we suggest applying some very traditional business best practice to data – as a starting point and to adjust going forward. For example, many of us are familiar with product management or even product development. So, to begin with, let's treat data as a product and apply the basics of product management. Part 1 provides suggestions. Furthermore, for step two, many of us know how to economize on production using factories and automation. If we know how to automate the production of a complex product like a car with its 30,000 parts, then it should be possible to create a data factory. Again, part 1 provides some guidance. While product management and process automation translate easily, data supply chains using dataspaces may be a stretch. We know supply chains as a key requirement for factory automation. Similarly, dataspaces allow for true data supply chains. So, what is a dataspace? Let's use **part 2** to dig deeper, and expand on part 1's three themes with **three consecutive ones**. While are our first three themes are strategic, the new ones present immediate action items for first results in the next quarter:

4. **Get connected:** Release the value in your data in a dataspace with sovereignty protection
5. **Create data chains:** Participate in the next IT revolution, build super-apps for your business
6. **Build on top:** Don't reinvent, start building on pioneering automotive dataspaces



- **CATENA-X** - German funding project for an open data eco-system driven by automotive industry.
- **EDC** - Eclipse dataspace connector
- **DSC** - International dataspace connector
- **GAIA-X 4 FUTURE MOBILITY** - Family of German funding projects for new mobility, headed by German Aerospace Center (DLR)
- **MDS** - Mobility dataspace created by German government with Acatech and Fraunhofer Institutes
- **MOBILITHEK** - German government's national access point and platform for mobility data as mandated by EU
- **REALLAB HAMBURG** - Award-winning German funding project for new mobility solutions in city of Hamburg

* Products by Telekom Data Intelligence Hub (DIH): All managed service offerings hosted in trusted cloud - from plain EDC to easy-to-use data upload services like Connect to Living Lab, a customizable, private dataspace

Figure 2: Mesh dataspaces for automotive triple (adapted from Drees et al. 2022)

4. Get connected: Release the value in your data in a dataspace with sovereignty protection

Dataspace is a novel concept and technology system. It is a radical departure, a U-turn from traditional data management. So, let's quickly recap a few basics - what it is - and then lay out how it originated and why it will be required. The German federal government's data strategy describes a data space as "a shared, trusted space for transactions with data [... and] based on shared standards (or values, technologies, interfaces), for example, that permit or promote transactions with data" (German Federal government 2021). It is furthermore "a decentralized infrastructure for trustworthy data sharing" according to the OpenDEI project (OpenDEI 2021, p. 23). The dataspace concept originated from a Fraunhofer research project funded by the German Federal Ministry of Education and Research ("German government and Fraunhofer drive forward plans to implement "Industrie 4.0" on an international scale," link) and is today promoted by the International Data Spaces Association (IDSA, link) with more than 120 members.

From voice dial-tone to video dial-tone to data dial-tone ... from e-commerce to metaverse

The IDSA initiative also created first software artifacts of key components, such as the connector (Otto et al. 2019; DIN SPEC 27070, link). The connector is the telephone of a dataspace-based data exchange or data dial-tone system. Figure 2 illustrates how the connector is an access device to a dataspace. A dataspace can be seen as the next step in the evolution of communication networks. In a previous shift triggered by the 1991 "video dialtone policy" ruling of the U.S. Federal Communication Commission (FCC), we upgraded from voice dial-tone communication to video dial-tone (Lazzareschi 1992; new "Telephone Company-Cable Television Cross-Ownership Rules" issued in 1991, link; finalized in 1995, link). Video dial-tone expanded the capability of voice calls switched from somewhere to anywhere else to include broadband video signals or multimedia (a term used in Europe to include different media format such as text, images, or video). Back then this upgrade gave birth to a big leap in business opportunities: the emergence of electronic commerce or e-commerce (Schlueter Langdon & Shaw 1997), which in turn gave rise to e-business and triggered a large-scale transformation of supply chains and channel systems (Schlueter Langdon & Shaw 2000). Lately, in June 2020, the German and French governments have embraced dataspaces and launched Gaia-X to establish a pan-European infrastructure to support it ("Peter Altmaier and Bruno Le Maire present the European data infrastructure project GAIA-X," link).

Regulation	Description	Focus	Business Impact	Telekom DIH advantage
Supply Chain Act since January 2023	Extend companies' responsibility along their entire supply chain to protect the rights of people who produce goods for the German market	Companies with employee · >3,000 (2023) · >1,000 (2024) ... are obliged to report fulfillment of due diligence obligations internationally	· Requires due diligence processes and transparency n core operations and within supply chain with focus on human rights and environmental risks · Establish effective risk management integrated into all relevant business processes	Our products, such as DIH Connect, have been designed to enables easy connection to dataspaces that provide access to cross-organizational data chains, digital product twins and material traceability applications (for example, Catena-X)
Digital Service Act since February 2023	Distribute responsibilities among digital service providers for online content and products to safeguard consumer interests	· Digital platforms and services · Mere conduit & caching providers · Hosting services · Online platforms and very large online platforms	· Obligation to remove illegal content (take and stay down) · Disclosure of core data from larger platforms (e.g. oversight used for search) · Disclosure of internal data and processes	Our cloud agnostic managed services are orchestrated and operated by Deutsche Telekom, the European communications leader, and T-Systems the leading information technology vendor and No 1 IT provider in German automotive industry
Digital Market Act applies 2023	Ensure fair digital markets to be open and contestable for everyone	Large online platforms fulfilling three criteria · Annual turnover>7.5 bn € in each of last three financial years · 45 mio end users per month · 10,000 business users per annum	· Allow 3rd parties to collaborate with their tools with large online platform · Require platform providers to grant access to hardware/ software of platform elements · Ensure business and end-user data portability · Examples: unbending, data portability, non-discriminatory access	Data sharing marketplace with trusted participants via Gaia-X conform verified credentials – DIH Digital.ID
Data Governance Act applies in September 2023	Create data intermediaries as a business model to enable trustworthy data exchange in EU (Public and private sectors)	Data intermediaries or exchange services	· Data intermediary is limited to data exchange, cannot manipulate data · Ensure access to public sector data · Facilitate data donations from citizens	· DIH as a facilitator of interconnections between different dataspaces or a dataspace mesh · Gaia-X compliant and IDSA certification in process
Data Act Draft issued February 2022 (first reading)	Foster access to and sharing of data in business to consumer/ business/ government settings. Rules for cloud switching and access to non-personal data	· Internet-of-Things (IoT) product manufactures · Cloud and service providers · Data holders and recipients · Public sector bodies	· Enable an easier change of cloud providers, enhance data portability rights (move of customer data to new provider) · Increase access to and sharing of data for end and business users	DIH as an active contributor to dataspace innovation, dataspace-as-a-service, such as in Gaia-X AISBL and IDSA, and dataspace open-source software, such as in the Eclipse Foundation AISBL

Figure 3: Data regulation overview and compliance requirements

Decentralization for (a) just-in-time data and (b) compute-to-data

Overall, a dataspace presents a U-turn from traditional, centralized data management to a distributed, federated structure like the Internet. Because of decentralization, it is also seen as part of the Web3 evolution of the World Wide Web (see Web3 foundation, link). Instead of warehousing data centrally or near different applications or pouring it all into a data lake, it is left at the source and only moved when needed to where it is needed. This is summarized as "just-in-time data" (see Databricks JIT data warehouse, link). If data is left where it is, and in addition not moved at all but the application instead, then it is called "compute-to-data" (see minimum viable Gaia-X, link). Both concepts have demonstrated superior economics and customer satisfaction in the physical world, such as just-in-time logistics in manufacturing and home delivery of consumer goods, which is complementing shopping at a supermarket. Both concepts help to digest the explosion of data. Sticking with our iceberg analogy from part 1 (Schlueter Langdon & Hort 2022), your ship won't hit an iceberg; your ship will face a monster wave. Figure 1 in part 1 illustrates the size of the wave. If you are already struggling today, at less than 2% of the next 15 years of data, then just-in-time data and compute-to-data may be prudent investments going forward.

One-to-many data sharing with sovereignty … without running red lights

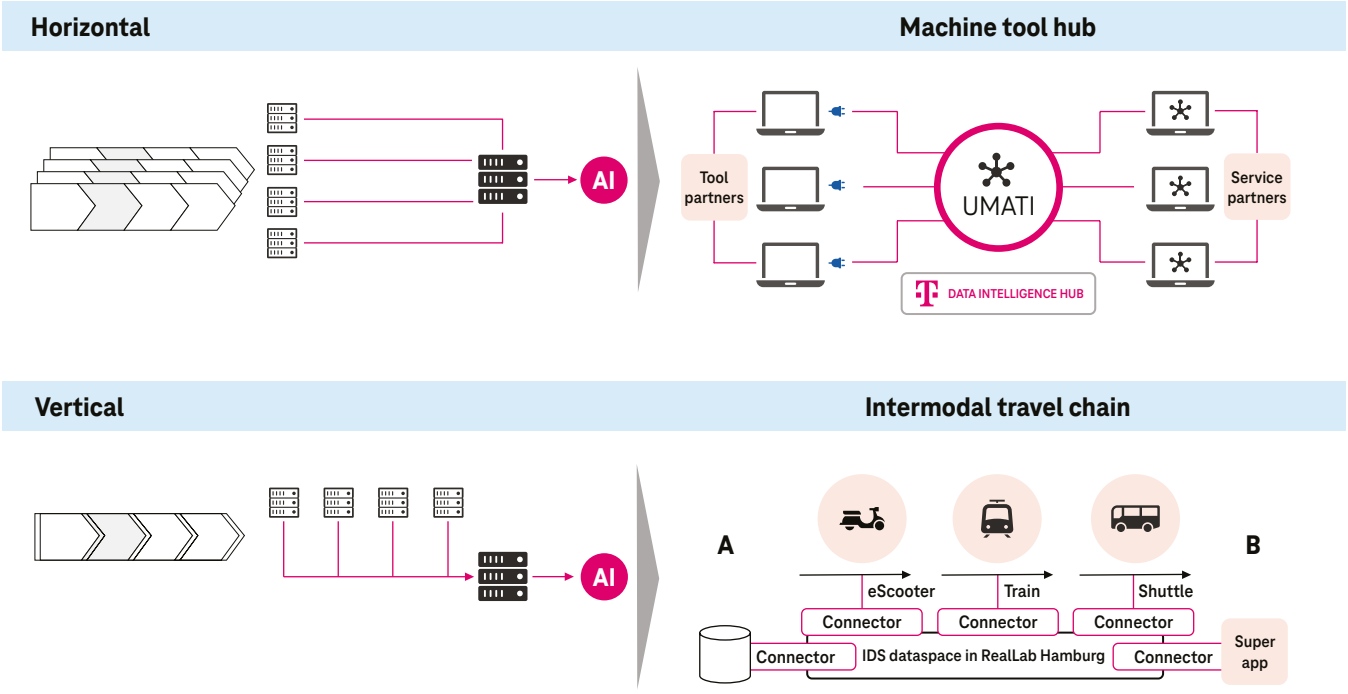
The other important tenant besides decentralization based on a common standard is rights management. Regulation continues to emerge to create rights to data, which in turn requires recognition of these rights and compliance with the new regulation. There have always been rights to data, and decision makers have always been keen to secure and protect those rights. Just think about military campaigns: Initially data is kept highly confidential and only leaders are privy to it; then sharing is expanded but kept restricted to a need-to-know basis, for example, and it may be kept classified and not made public for a long time. Lately, regulation continues to materialize that more clearly defines and expands data rights. Prominent examples include GDPR in the European Union and CCPA in the state of California in the United States (Schlueter Langdon & Sikora 2020). And more is on the way, such as the new European Data Governance Act (European Commission 2020) and Data Act (see Figure 3; please feel free to contact us for a more detailed overview of data regulation). Consequently, data processing must remain compliant. In other words, any time a data bit is touched, it is imperative to respect and obey the rights attached to it. If it says don't copy, then you won't be allowed to copy it. This dramatically increases the complexity of data management. More regulation, more complexity. This is where a dataspace comes in, again. At this point, you may wonder, how is this possible. How does it make data magically disappear? It looks nothing like a shredder or a powerful magnet. Well, think of it as a red traffic light that prevents us from crossing an intersection. We could run a red light, but we don't do it. Red traffic lights work because of transparency and consequence. Running a red light is transparent, and we personally face a consequence so that it discourages and deters us from breaking the law and committing an offense in the first place. There are intersections fitted with physical barriers to make crossing impossible (and similarly there is dataspace technology to enforce some usage restrictions). Railroad crossings come to mind. However, physical barriers are not practical and too costly in inner-city traffic, and fortunately, all of us have come to trust red lights as sufficient for protecting our lives and well-being. And occasionally, if a red light is not enough, traffic and speed cameras are installed. Similarly, a dataspace can provide different levels of protection thanks to contracts that include access controls (who can see my data offers) and usage controls based on usage policies (how can data be used). For super sensitive data legal enforcement will increasingly be complemented with technical policy enforcement involving blockchains, for example (see Hofmann 2022). In summary, a dataspace allows for data sovereignty protection, which is the power to protect one's rights to data (see Schlueter Langdon & Schweichhart 2022, for example): If I share a file with you and our usage policy says, "use it but do not copy it," you can then use it, but you will not copy it. The business implications are massive, a true game changer. For example, two parties who do not trust each other, such as competitors, can suddenly trust a data transaction, for example sharing data from a common customer. This could unlock win-win gains, allow for entirely new applications and products or even business models as the next theme and section illustrates.

In a nutshell a dataspace is a data distribution system that ...

- Leaves data decentralized, for example at the source, such as an IoT sensor
- Enables one-to-many data sharing with sovereignty: Keep power to control your rights to data

Find out more here on:

- Data sovereignty: Lauf et al. 2022, WI22 Best Paper Award, link
- Dataspace mesh and sovereignty: Drees et al. 2022, ITS Europe Congress, link



No data lake/ data warehouse required; data may or may not be persisted; peer-to-peer, real-time data transfer using a dataspace

AI: Artificial intelligence applicatio, for example

IDS: International data space technology

UMATI: Universal machine technology interface; open platform communications (OPC) companion for cross-industry machine builder/ opertaor interactions

Figure 4: Data chains (adapted from Schlueter Langdon & Schweichhart 2022)

5. Create data chains: Participate in the next IT revolution, build super-apps for your business

Data revolution! This is not Karl Marx speaking but the Frankfurter Allgemeine Zeitung, a leading German conservative daily newspaper, which summarized the confluence of new data regulation (see Figure 3) and data technology as a revolution in data markets (Kafsack 2022). For this revolution to be enduring, proof would have to be in profits. So, where are the profits coming from? Generally, process automation is the only way of generating profits from IT. And one last automation frontier are chains like business value chains (see Porter 1985) and, specifically, supply chains and channel systems (see Schlueter Langdon & Shaw 2002, for example).

Interoperability

Chains are tricky; they present interoperability barriers on multiple layers – technology, process, and business governance or strategy. For one thing, chains pose technology interoperability challenges like different data formats across tiers; for another thing, chains present legal and data protection challenges as they cut across different legal entities with different and possibly competing strategies. Untangling these interoperability barriers can unclog data flows, which can then fuel seamless automation of end-to-end transactions. This in turn enables entirely new business applications in B2B as well as B2C markets. Examples range from CO2 footprint calculations for more sustainable product offerings (B2B) to intermodal mobility "super-apps" for consumers (B2C). According to Free Now, a leading mobility platform, a "[super app] integrates sustainable micro-mobility options such as eScooters, eMopeds and eBikes as well as taxi, Private Hire Vehicle (PHV) and car sharing within the app"; (Free Now 2022, p. 3). Both use cases, CO2 footprint calculations and intermodal travel, are examples of vertical data chains. Other data chains can be horizontal. Figure 4 illustrates the difference between vertical and horizontal data chains (for details on these specific use cases see Schlueter Langdon & Schweichhart 2022). A typical horizontal application is machine monitoring across all machines of a particular type for operational optimization and predictive maintenance. For both directions, vertical and horizontal, a dataspace can overcome interoperability barriers as it provides standardized technology, common processes, and data rights protection or data sovereignty, which allows even competitors or different strategies to co-exist while sharing sensitive information.

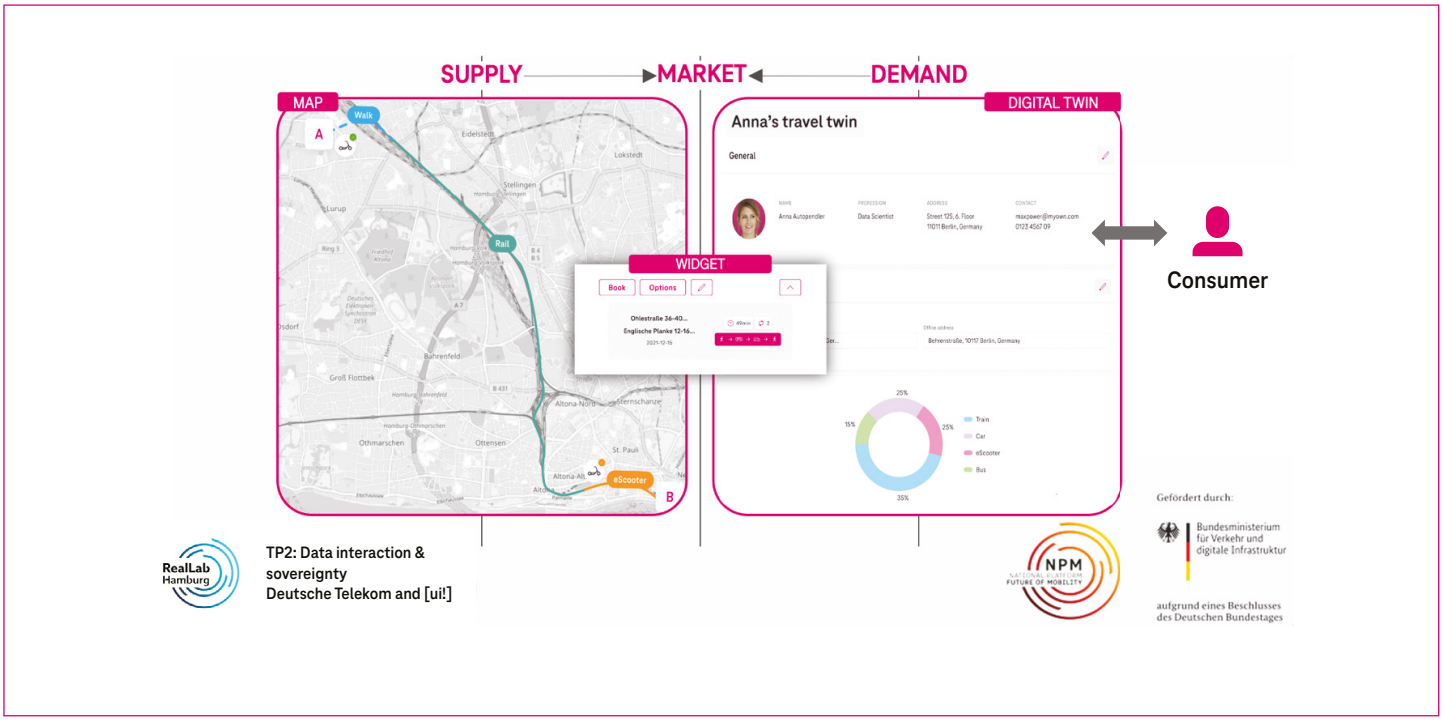


Figure 5: Super-app user interfaces (UIs) of personal twin, recommendation widget, and map

Data chains for mobility chains: The RealLab Hamburg dataspace case study

Let's quickly use a real-world example of intermodal travel to highlight why data chains are a revolution, "a radical, complete change" or "a changeover" (Merriam-Webster 2022, link).

The problem. Urban travel is a good example because it's easy to relate to. Most of us are likely affected, at least twice a day, commuting back and forth to work, and many of us are stuck in traffic. So, we know it is taking longer and longer to get from point A to point B – and we are all paying the price: drivers, commuters, cities, the public, and the environment (Schlueter Langdon 2020c). While motorized individual transport has liberated citizens around the world, progress has now shifted into reverse in many urban areas. One possible solution is intermodal travel with integrated public transport, the linking of public transport (a bus or subway is affordable and means you don't have to park your car) with micromobility, such as electric scooters and on-demand shuttles (which brings the bus stop or train station closer to us). It would be a game changer for urban traffic because intermodal traffic is a better product for consumers – it's faster, can be more comfortable, and possibly cheaper – and, therefore, causes the behavioral change required for a modal shift from personal car trips to travel with public and shared modes of transportation (Schlueter Langdon et al. 2021, Schlueter Langdon & Oehrlein 2021, Schlueter Langdon 2021b). This has been tested in RealLab Hamburg, recipient of the 2022 Innovation Prize for Real Laboratories by the German Federal Ministry of Economic Affairs and Climate Action (BMWK, link[in German]).

Award-winning RealLab Hamburg. The German National Platform Future of Mobility (NPM, link) kicked off RealLab Hamburg to explore, probe, and test new mobility solutions in a controlled but real-life setting in the port city of Hamburg, Germany's second largest city. The lab received funding from the German Federal Ministry of Transport and Digital Infrastructure (BMVI), with Hamburger Hochbahn (HHA), one of the largest transportation companies in Germany, as project and consortium leader ("Startschuss für das Reallabor Digitale Mobilität Hamburg – mit Bundesminister Scheuer," link [in German]). The project included eight subprojects with a total of 32 partners, including BMW, Continental, Deutsche Bahn, Sixt, and other mobility experts. Deutsche Telekom's Data Intelligence Hub unit (DIH, link) and the Urban Software Institute (UI, link) teamed up in a subproject on "Data Interaction & Sovereignty" to investigate how dataspace technology can enable data chains for novel mobility chains such as intermodal travel.

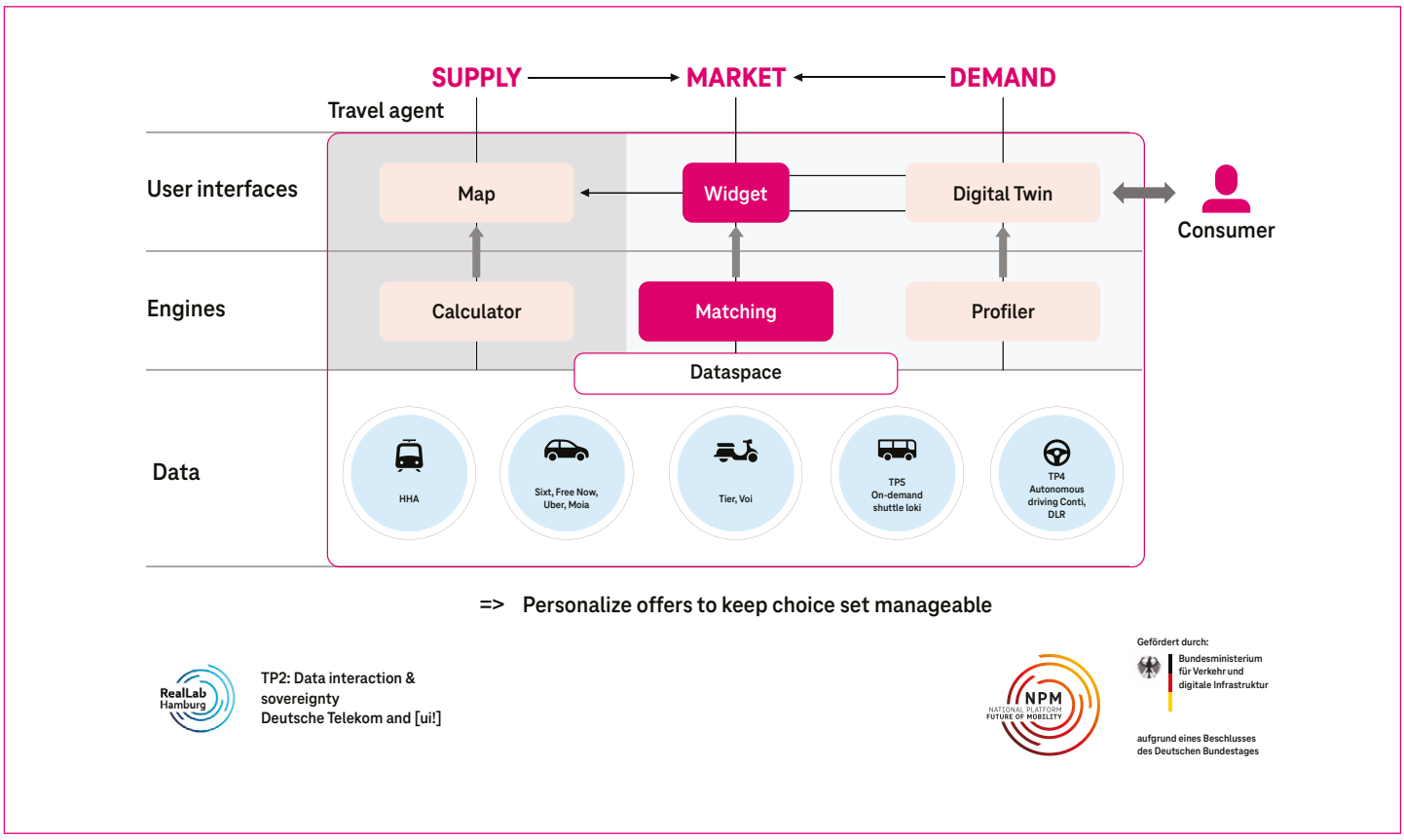


Figure 6: Super-app architecture and key engine building blocks (adapted from RealLab Hamburg 2022)

Super app as minimal viable demonstrator (MVD). To this end, the Telekom DIH built a minimal viable demonstrator of a travel planning application. The app allows for Hamburg residents to plan an A-to-B, door-to-door trip using different modes of transportation including public transport, shuttle services, and micromobility all in one "super app." Figure 5 shows the three user interfaces (UIs) of the app: a traditional map, a novel recommendation widget, and a digital personal travel twin. From an end-user perspective, interaction with the super app is very straightforward and intuitive. The app facilitates two use cases – an active and a passive case: A user can either (a) initiate trip planning (via the personal Twin UI – the active case) or (b) be notified of an upcoming trip (by the recommendation Widget UI popping up – the passive scenario). In case of (a) trip planning, a user opens the app, which will display a user's digital travel twin (see "Anna's travel twin" on the right of Figure 5). The twin stores all relevant personal travel data – it's the one travel profile as opposed to the many profiles, one for every travel app you want to use. It allows manual entry of: starting point A, destination B, as well as starting time or arrival time. Results will be displayed on the widget, which closes the twin and pops up together with a map view. Whereas the widget is part of the twin, the map could come from any provider connected with the super app. In the passive scenario (b) the user doesn't do any planning; instead, the widget will pop up to notify the user of an upcoming trip together with three routing suggestions based on the user's twin profile with travel preferences and history. From an implementation perspective super app is borrowing from two concepts: (a) an agent system concept (see Schlueter Langdon 2020b, for example) and (b) the dataspace concept and technology (see Drees et al. 2021). Figure 6 reveals the key intestines of the travel super app: agent elements and dataspace. The agent calculates possible route offers (Calculator) and matches them with individual user preferences or profiles (Profiler) to recommend a short, digestible list of the top three personalized recommendations (Matching). All data is provided either from test files or a dataspace setup, which is connected to test and live data sources from partners like Deutsche Bahn, Sixt, Tier Mobility and UI.

Data chains enabled by sovereignty protection. Data sharing is imperative for planning and booking to be a one-stop shopping experience and for the travel experience itself to be seamless. The intermodal travel chain requires a corresponding data chain across participating mobility providers and including the end user. And this data chain is not limited to integration of user interfaces (shown in Figure 5). This challenge is an excellent example of the data iceberg metaphor introduced in part 1 (see Figure 1 of part 1). The true challenge of this use case and app lurks beneath the surface. The linking of different providers into a single app interface is only part of the story, and the easy one – or the tip of the iceberg only. For a travel super app to be attractive for end users the app must also recognize a user's existing relationships and advantages with these providers: Why use the app if it doesn't know about our subscriptions and discounts with all providers included in a travel solution. It doesn't make sense to lose discounts and pay more in the super app, for example. For it to work, all providers would need to share sensitive customer data in the super app. This has not happened so far. The providers don't trust each other, and they don't trust the data sharing transaction.

Welcome to the club … and metaverse. Today, no longer than that. A dataspace built on IDS technology would be a solution because it can protect data sovereignty (for an implementation see Drees et al. 2021). While providers will continue to mistrust each other, because they remain competitors, they can trust the data transaction due to data sovereignty protection. The person doing the sharing maintains the power to control data rights and prevent misuse after sharing. Also, data sharing in a dataspace can scale up beautifully. For the frequent flyers among us: think of a dataspace as a club or airline network like Star Alliance. Your gold status and privileges, like lounge access, with one provider will be recognized by all other members. Similarly, a usage policy attached to your data offer can be valid for all dataspace members. Now it is easy to see how this setup can suddenly make lots of data available for entirely new offerings with more business for everyone, as demonstrated with our super app demonstrator at the ITS World Congress in Hamburg. It is a bit like a domino effect: Toppling the first piece in line creates a chain reaction with one domino falling into the next and so forth, to create a domino run. Furthermore, it is easy to see now how this new, distributed, federated data infrastructure with data sovereignty protection is also a key enabler of the metaverse. While its outlines remain fluid "our working definition positions the metaverse as the next iteration of the internet that seamlessly combines our digital and physical lives [… that will] include interoperability across platforms and devices [… and] concurrency with thousands of people interacting simultaneously "(McKinsey 2022, p. 11). A human digital twin, such as Anna's travel twin (see Figure 5) is a first symptom of such interlinking of digital and physical lives (Schlueter Langdon 2020a).

- "Everyone's a winner": Win-win outcomes for all participants; with intermodal travel consumers are faster, providers profit from higher usage and capacity utilization, and cities cut CO2 emissions and save space
- Novel data chains allow for super-apps (think WeChat) with new business configurations today and in the emerging metaverse with virtual channel intermediaries like "travel agent" and consumer digital twins or "avatars"

Find out more here on:

- Intermodal travel is better: Schlueter Langdon et al. 2021, Technical Paper, link
- Building a mobility super-app: Schlueter Langdon & Eckert 2022, Scientific Paper, link

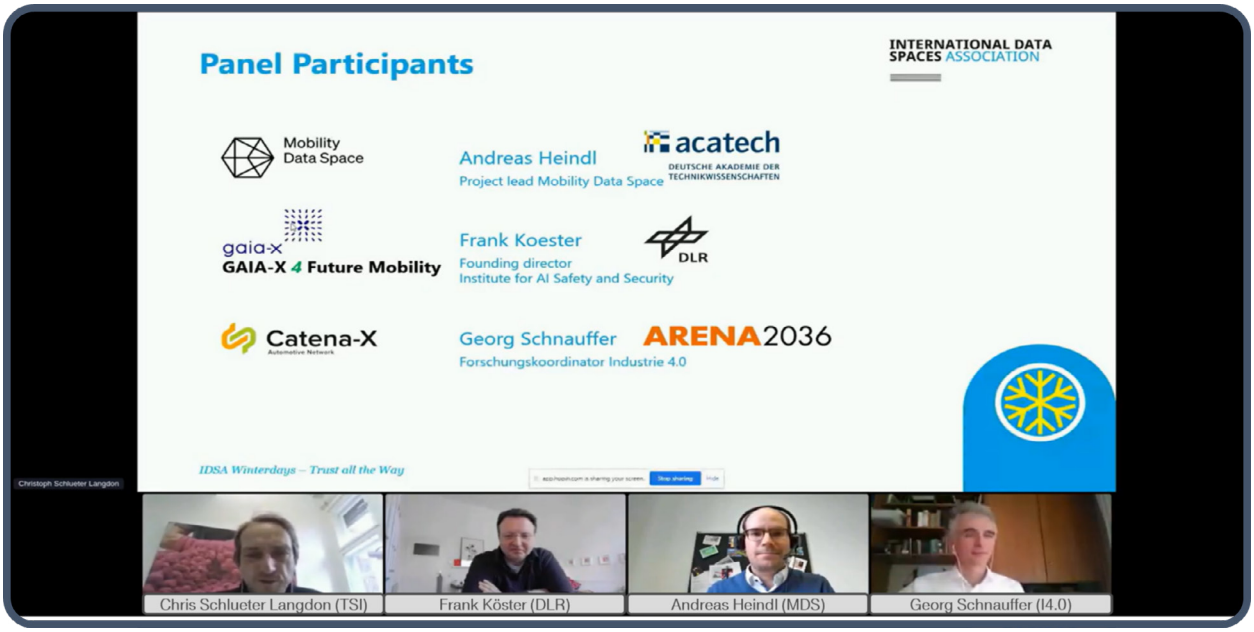


Figure 7: Lessons learned from our "triple win": Top three automotive data spaces (link)

6. Build on top: Don't reinvent, start building on pioneering automotive dataspaces

T-Systems International (TSI) and particularly its Telekom Data Intelligence Hub (DIH, link) is shaping development in all three top dataspaces in automotive and mobility – our "triple win" (see Figure 7):

- **Mobilithek** (link), the German national access point for mobility data, attached to the **Mobility Data Space** (MDS, link), is a front-runner, a first dataspace, built on the first available dataspace technology from the International Data Space Association (IDSA RAM 3.0, link) by TSI for the Federal Highway Research Institute (BASt, link) of Federal Ministry for Digital and Transport (BMDV, link). Deutsche Telekom provides in the IDSA the deputy chair of the executive board, and co-lead of the IDS Mobility Community (link) as of 2022.

- **Gaia-X 4 Future Mobility** (GX4FM) is a project family (link) funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK), run by the German Aerospace Center (DLR, link), using technology such as Gaia-X Federation Services (link) developed for Gaia-X AISBL (link). Deutsche Telekom is a founding partner and provides the Chairman of the Board of Directors as well as Chief Operating Officer as of 2022. In GX4FM the Telekom Data Intelligence Hub (DIH) team is focused on dataspace development as overall project lead in one project and dataspace work package lead in another project (see GAIA-X 4 AMS, link)

- **Catena-X Automotive Network** (link) project is also funded by BMWK but driven by the automotive industry with 28 partners including BMW, Mercedes, VW, leading Tier 1s, and technology experts such as SAP and Deutsche Telekom; it is expanding use of technology from the IDSA (see Mobilithek, link), Gaia-X (see GX4FM, link), as well as introducing new software from Eclipse Foundation (link). The Telekom Data Intelligence Hub team is part of the strategic portfolio level and lead of management of dataspace technology at the operational level. Another TSI team is driving digital twin development.

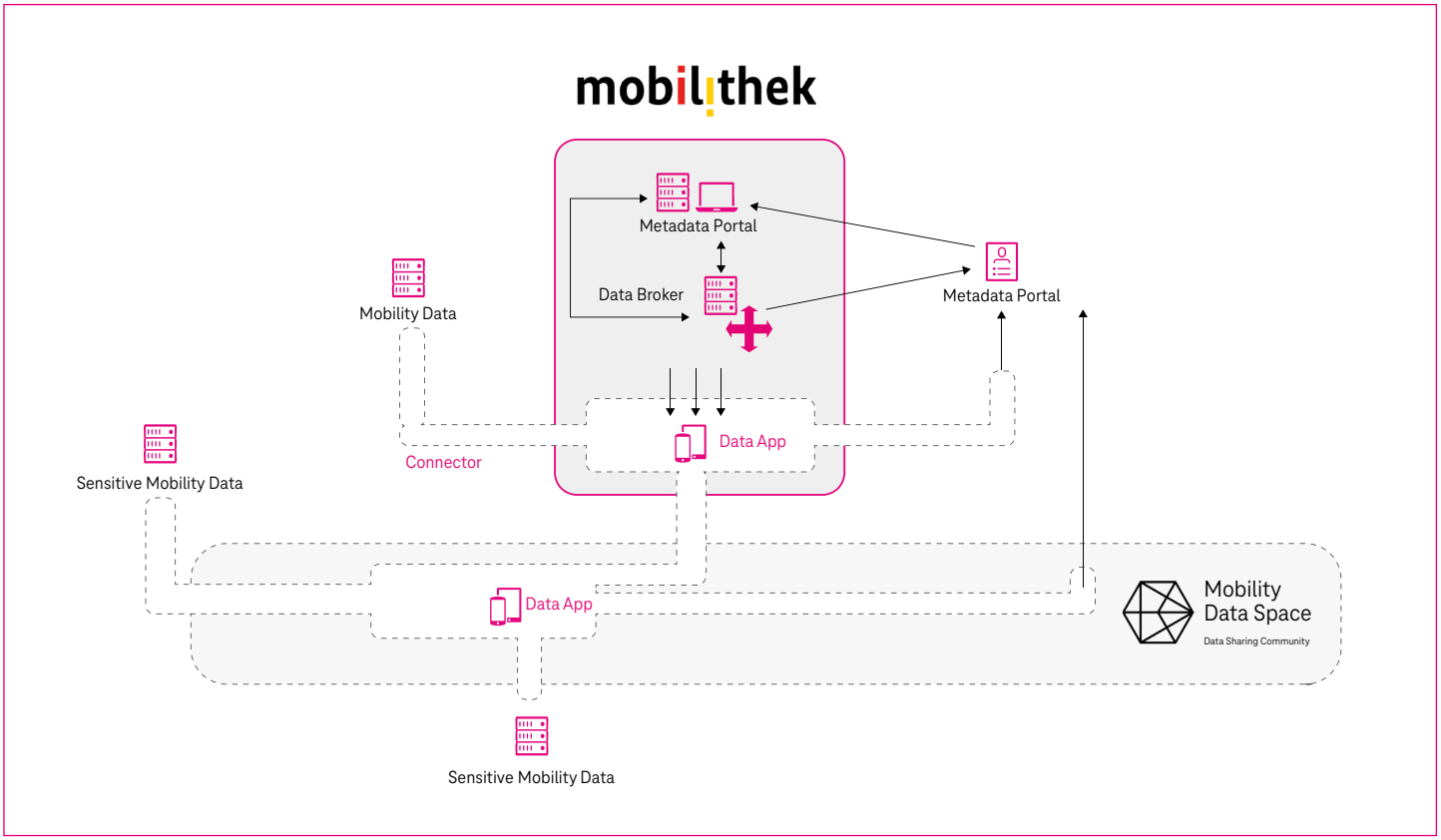


Figure 8: Mobilithek architecture concept

Mobilithek and MDS: First mover data ecosystem based on IDS technology

In 2021 T-Systems won the tender to port the first generation of the German national access point for mobility data onto new dataspace technology and implement requirements from delegated regulations on the European ITS Directive and the amended Carriage of Passengers Act (BMDV 2022, link). This new platform is called Mobilithek and is built on International Data Spaces Association (IDSA) standards and IDS technology for data sharing with data sovereignty protection (see Figure 8 for a high-level architecture overview). As a national access point, Mobilithek is the first dataspace for mobility and will play a key role in a comprehensive mobility data ecosystem for mobility providers, infrastructure managers, transport authorities and information providers to share digital information, including timetable data, real-time traffic information or rental bike locations. In future, all the information needed to plan a trip and travel throughout Germany can be accessed there from a single source and integrated into information services. Through its cloud-based infrastructure with a web portal, high-performance support for real-time data exchange and a digital space for developing data-based apps, it will cooperate closely and share data with the Mobility Data Space or MDS. The latter was announced by former German Chancellor Angela Merkel during the Automotive Summit in October 2020 (Delhaes 2020, link), its implementation orchestrated by the German National Academy of Science and Engineering, Acatech, ("Datenraum Mobilität," link [in German]) with support from Fraunhofer, and officially launched during the 2021 ITS World Congress in Hamburg. MDS is also based on IDS technology to facilitate close cooperation with Mobilithek.

- Government sponsored national anchor provider of mobility data including public transport
- Real-time data delivery platform based on IDS technology

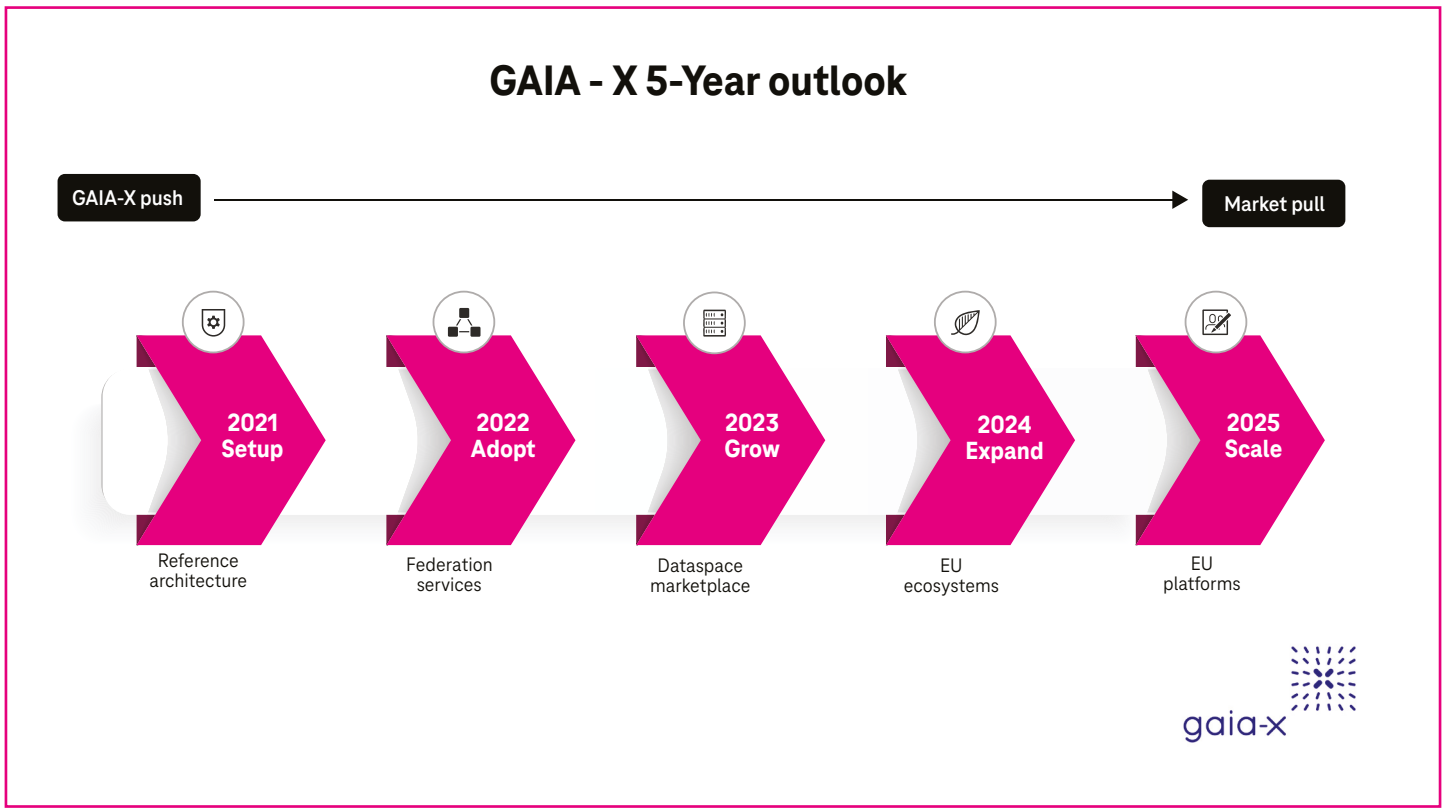


Figure 9: Gaia-X AISBL 5-year plan (Bonfiglio 2021, p. 14)

Gaia-X 4 Future Mobility (GX4FM): Gaia-X technology and dataspace mesh

GAIA-X 4 Future Mobility is a family of projects located in the domain "Mobility" of the Gaia-X Hub Germany with funding from the Federal Ministry for Economic Affairs and Climate Action (BMWK, link). The family is focused on creating an open, transparent, and secure data and application sharing ecosystem to enable future mobility services. This includes important transformational trends, such as the software-defined car, and, of course, automated, and autonomous driving using some everything-to-vehicle communications with supreme latency and quality assurance requirements, for example. "US companies currently have a huge lead with driving data thanks to their tests on the roads, which can be reduced by data sharing across companies, concludes Christoph Schlueter Langdon, who is responsible at Deutsche Telekom for the development of the software for data exchange within the framework of Gaia-X 4 Artificial Intelligence," the family's lead project (Johann 2021). Accordingly, a wide variety of partners including manufacturers, suppliers, and service providers from various fields within the automotive sector and related areas are involved. All together around 80 partners from business and science have teamed up in this family. This initiative exhibits at least two key advantages.

Science power. The first advantage of the family is strong participation of leading scientific and R&D institutions. Their capabilities will be in great demand at this early market stage of data ecosystem formation because first Gaia-X software artifacts, such as Gaia-X Federation Services, are under development as an external Gaia-X technology project and will only emerge in 2022 (Figure 9 outlines the Gaia-X roadmap based on Bonfiglio 2021). Furthermore, Gaia-X software will be open source, and will therefore require a community of expert volunteer contributors for refinement and further development. Overall project lead is with the German Aerospace Center (DLR) where the family is orchestrated and led by Frank Koester.

Family benefits. Another key advantage is in the family structure of the initiative. It lends itself to broadening the scope of dataspace development from an intra-space view to an inter-space perspective, addressing the issue of interoperability between and across multiple dataspaces. Figure 2 shows the emerging landscape of dataspaces in automotive and mobility. This configuration of dataspace mesh is already an issue with a need for interconnection and roaming solutions not unlike in voice dial-tone networks (Drees et al. 2022). The family has launched with GAIA-X 4 AI (Artificial Intelligence, link), GAIA-X 4 AMS (Advanced Mobility Services), GAIA-X 4 ROMS (Support and Remote-Ops for automated and connected mobility services), GAIA-X 4 moveID (Decentralized digital identity and data sharing) and GAIA-X 4 PLC-AAD (Production, After Sales and Product-Life Cycle, link) [see for full details here]

Engagement of Deutsche Telekom has been orchestrated and organized by the team from the Telekom Data Intelligence Hub under tribe lead Sven Loeffler and with Prof. Dr. Chris Schlueter Langdon as project lead of GX 4 AMS and lead of the dataspace work package in GX 4 AI.

- Next generation applications, and data quality and assurance services for automated and autonomous driving
- Strong scientific and R&D capabilities for shaping the implementation and emulation of Gaia-X federation services software

Figure 10: German Federal Minister Robert Habeck on importance of creating data chains

Catena-X Automotive Network: Data chain-based applications and new Eclipse technology

In December 2020, Bloomberg News announced that some of the biggest German companies had joined forces to build a German auto alliance (Wilkes 2020). In May 2021, the founders of the network including BMW, Deutsche Telekom, Robert Bosch, SAP, Siemens, and ZF Friedrichshafen created Catena-X Automotive Alliance Association ("the association", link). In quick succession additional companies joined the initiative including Mercedes-Benz AG, BASF SE, Henkel AG & Co. KGaA, Schaeffler AG, German Edge Cloud GmbH & Co. KG, ISTOS GmbH, SupplyOn AG, the German Aerospace Center (DLR, link), Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., and ARENA2036 as well as several small and medium-sized companies (SMEs; see Bergmann 2021). In a second step, a total of 28 partners pledged to cooperate jointly to build an open and collaborative data ecosystem and data network operating system in a project funded by the German Federal Ministry of Economic Affairs and Climate Change (BMWK), which in August 2021 became the Catena-X Automotive Network Consortium ("the funding project", Schlueter Langdon 2021a; see Figure 11 for a first show at the Hannover Messe 2022). This consortium is seen as the incubator and "workbench" of Catena-X, charged with building the core network operating system and first novel business applications. In the video in Figure 10 German Federal Minister Mr. Habeck underlines how new dataspace technology enables data chains to support in turn much needed applications like CO2 footprint calculation and circular economy – very specific examples of our theme #5 "Create Data Chains" to unlock a "data revolution" (FAZ). In order to provide the flexibility and agility needed to orchestrate 28 partners, and to leverage open but evolving technology and moving targets like IDS and Gaia-X, an agile first project management approach following the SAFe method has been implemented.

- Driven by data chain-based applications mostly in traditional automotive including vehicle development and production
- New and complementary dataspace technology, such as Eclipse Dataspace Connector (EDC, link), at a high technology readiness level (TRL, link)

Figure 11: Telekom with Catena-X contributors at Hannover Messe 2022

Executive summary: From lessons learned to next steps

Dataspace benefits

On the one hand, new European regulation of data rights and rules, such as the European Data Act (see Figure 3), is asking companies to recognize and enforce data sovereignty. On the other hand, new technology, such as dataspace standards and software, is emerging that (1) can address compliance with new data rules and at the same time may allow for (2) significant cost savings as well as (3) entirely new applications with strategic implications, such as cross-organizational data chains for supply chain transparency:

01 Compliance and implementation of data governance: Data transactions in a data space with access controls, usage policies, and transparency rules can help companies comply with new regulation in Europe, such as the European Data Act or the German Act on Corporate Due Diligence Obligations in Supply Chains (Lieferkettensorgfaltspflichtengesetz - LkSG, link).

02 Cost and scaling advantages due to a shift from a 1:1 connection (e.g., one OEM with one Tier 1 supplier) to 1-to-many relationships (e.g., one OEM with its entire supply chain), and possibly industry-wide solutions (like a club membership). Furthermore, data can be kept at the source and made available just-in-time to save the cost and confusion of duplication. In addition, the decentralized architecture and open, international standards help to avoid costly lock-ins.

03 New growth and revenue: Novel data chains create new value orchestration and intermediary opportunities as illustrated by “travel agent” (see Figure 5). Anna’s digital travel twin is also a symptom of the arrival of the metaverse (see McKinsey 2022, for example). While the outlines of the metaverse remain fluid it is widely seen as the next iteration of the internet that intertwines our physical with digital lives. Our intermodal travel demonstrator illustrates how a dataspace happens to be a key infrastructure enabler.

Roadmap

This White Paper dissected in two parts how data sovereignty is emerging to enable a data-driven future of automotive in which data fuels software-defined cars and personalized mobility services.

Part 1 started laying out three **strategic, enterprise level initiatives** to ensure making the right turn long term:

1. **Treat data as a product** applying product management best practice
2. **Industrialize data products** using factory-style automation
3. **Build a data supply chain** for these factories using dataspaces

Part 2 continued with a deep dive into novel dataspaces with very specific **action items for quick results** starting next quarter:

4. **Get connected:** Release the value in your data in a dataspace with sovereignty protection
5. **Create data chains:** Participate in the next IT revolution, build super-apps for your business
6. **Build on top:** Don't reinvent, start building on pioneering automotive dataspaces

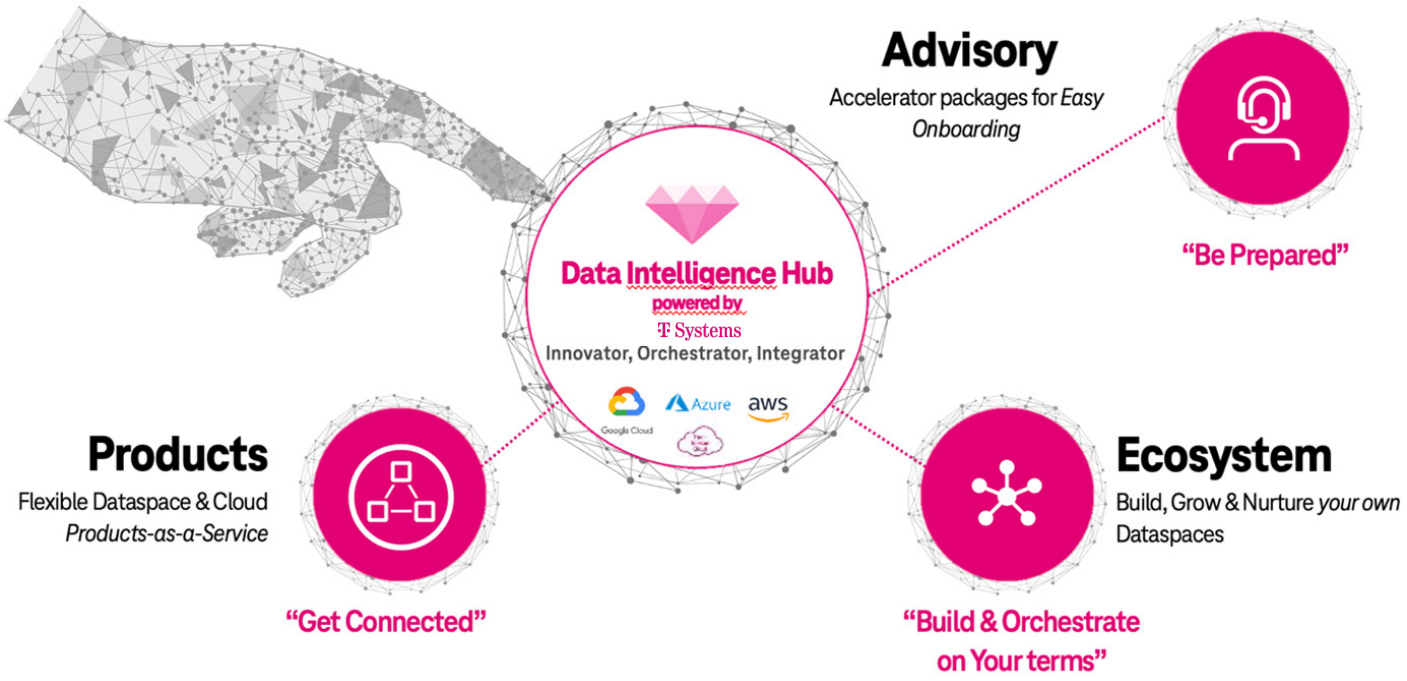


Figure 12: Telekom Data Intelligence Hub offerings

> **“Be prepared, get connected, build & orchestrate on your terms”**

In order to profit from dataspace benefits at this early market formation stage, first movers have to navigate multiple technologies and initiatives that are jockeying for position, including standards from the International Data Spaces Association (IDSA), Gaia-X federated services (GXFS) software, and Catena-X, which is influencing Gaia-X compliance and promoting new technology, such as the Eclipse Dataspace Connector (EDC). As a solution, TSI has fused lessons learned from (a) theory, our thought leadership research and standardization involvement (see “Publications”, link), with (b) early adopter practice, the “doing“ in our “triple win“ engagements, and translated insights into a carefully crafted 3-step enablement offering to avoid a big leap into the unknown but allow any client to “think big, start small, and scale fast“ (see Figure 12):

1. **“Be Prepared” - Advisory**
2. **“Get Connected” - Products**
3. **“Build & Orchestrate on Your Terms” - Ecosystem**

“Be Prepared” - Advisory: We design customized advisory solutions based on a suite of standardized, and therefore, cost-efficient dataspace onboarding packages. This suite is composed of packages organized into the two phases of “Investigate & Understand” and “Implement & Scale.”

Once prepared, the second offering following “Advisory” is “Get Connected – Products”, which includes products “Connect” (“Telefonanschluss”) and “Space” (“Telefon- und Nebenstellenanlagen”) – all easy-to-use and conveniently delivered as a managed service in the cloud that shields you from evolving technology under the hood.

Our third offering is “Build & Orchestrate on Your Terms – Ecosystems”, which allows clients to build out, grow, and nurture their own data ecosystem complete with dataspace setup and configuration. One innovation here is our first-of-kind sovereign stack or “sovereign-all-the-way” solution, which creates a sandwich so to speak of data sovereign exchange with our Connect product on top of the T-Systems Sovereign Cloud powered by Google Cloud (link). This allows for data to be persisted and processed in a sovereign way before being exchanged in a sovereign manner. Furthermore, T-Systems is offering a first service, the Gaia-X Clearing House Service (link), to provide verified credentials for dataspaces. For example, it will verify the credentials of participating company identities within the Catena-X data ecosystem.

All this innovation and pragmatic next step solutions are from a company known as a neutral and trusted partner backed by Deutsche Telekom, the leading communication carrier in Europe and, with T-Mobile, also the largest 5G network in America.

Our pioneering and deep “triple win” dataspace involvement in automotive ensures that our products encapsulate the complexities of a rapidly evolving technology so that clients can focus on their core competence and speed to be “the early bird that catches the worm.”

Further readings

Keep up to date on our latest dataspace applications and solutions:

- Telekom Data Intelligence Hub (DIH), link
- T-Systems Sovereign Cloud powered by Google Cloud, link
- T-Systems Automotive Data Sovereignty White Paper part 1, link

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