INTERNATIONAL DATA SPACES ASSOCIATION

Position Paper | Version 1.0 | November 2024

Data Spaces Business Models

- [x] Position Paper of members of the IDS Association
- [ ] Position Paper of bodies of the IDS Association
- [ ] Position Paper of the IDS Association
- [ ] White Paper of the IDS Association

Publisher

International Data Spaces Association
Emil-Figge-Straße 80
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Germany

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Cite as

Verbrugge, S. et al., Data Spaces Business Models, International Data Spaces Association, 2024
https://doi.org/10.5281/zenodo.14101303

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Management Summary

A business model explains how an organization creates, delivers, and captures value, always from the perspective of the actor offering the value proposition. This foundational concept becomes more complex in the case of data spaces, which are distributed systems involving various actors. However, it is often unclear whose perspective is considered when discussing the business model of a data space. Generally, a distinction must be made between the overarching business model of the data space itself – such as that of the infrastructure provider or data space authority – and the individual business models of participants and their specific use cases.

The concept of data spaces necessitates re-thinking value generation in data economies. It is essential to include data valuation concepts early to build a solid foundation for engagement among participants. Additionally, the collaborative nature of a data space business model means that the models of the different actors must be aligned for success. Moreover, a data space business model is multi-sided: the value grows as more data providers and consumers join the initiative, creating mutually enforcing benefits ('positive feedback loops'). Importantly, the model is also evolving, with characteristics like public funding changing over time.

A key insight is that a singular data space business model does not exist. Instead, the business model depends on the perspective being taken. To understand what works in practice, we looked at examples from the real-world. Therefore, three case studies were selected which provide practical insights:

- **Mobility Data Space (MDS)** is a German initiative focused on creating a sustainable data space for innovative mobility solutions, heavily supported by public-private collaboration. Despite the tasks associated with developing a sustainable business model, it emphasizes community building and technical facilitation.
- **Catena-X** highlights the regulatory challenges of building a data space while striving for economic sustainability in the automotive sector. Success will depend on the development of innovative pricing models that balance regulatory compliance with financial viability.
- **Smart Connected Suppliers Network (SCSN)** demonstrates how a coordinated effort can create a scalable model for data sharing in manufacturing supply chains for high-tech equipment in the Netherlands. Its success shows the potential for data spaces to drive efficiency and innovation.

The goal of this paper is to foster a shared understanding that allows all stakeholders to communicate effectively. Value creation is not just about monetization; societal benefits are often a primary goal of many data space initiatives. Furthermore, any effective data space business model must be both collaborative and multi-sided to thrive in complex value networks.

1. Introduction and motivation

The International Data Space Association (IDSA) was established 2016 and ever since then follows the goal to bring data sovereignty, interoperability, and trust to data ecosystems by creating the IDS Reference Architecture Model (IDS RAM)[1] for data spaces, as well as giving guidance on the required governance and legal perspectives when data is shared (cf. the IDSA Rulebook[2]). It was always clear that business models and in general a business-driven view on the topic of data spaces will make the difference between a theoretical concept and the adoption of data spaces by the market. Companies do not buy into a novel approach because they like the idea, but they need hard evidence for a concrete return on investment, like higher productivity, a rise in robustness, etc. Finally, there will be calculations that pave the way for the adoption of data spaces and not technical concepts or vague descriptions of underlying value propositions.

In the past years a plethora of projects have started to adopt the IDS RAM to build data spaces for different sectors and purposes. The Data Spaces Radar[3] is a witness to the progression of this topic and can be used to get an overview of the current situation. Figure 1 shows an overview of the current state of play with some examples of data space projects and initiatives. We are still in an early market when it comes to the adoption of data spaces and currently face the market of early adopters which joins the group of innovators who co-created the foundational work. The group of early adopters is steadily growing and soon will trigger the early majority. Still, this requires not only up and running data spaces, but it also needs to make business benefits visible to the early majority. To facilitate the process of creating convincing business models for the existing and future projects, this paper will provide comprehensive insight into this topic.

It may be surprising that, despite the strong value of data spaces, they have yet to provide clear answers on what successful business models might look like. At the same time, it underlines the fact that we are still looking at an early market.

This position paper aims to shed some light on the apparent paradox between the intrinsic value and the lacking business models. The objectives of the paper include the following:

- Define clear terminology to enhance communication on the topic of business models, starting with general concepts and then focusing on the specific context of data spaces. Common understanding of the relevant concepts can help to avoid confusion and improve the way people communicate about business models for data spaces.
- Provide a clear definition of a business model and what elements it consists of. Apply this definition in the data space context, illustrating the complexity of multi-stakeholder collaboration.
- Highlight the difference between the business model for data space participants and the business model for the data space itself.

[1] IDS Reference Architecture Model (IDS-RAM) 4.0: https://docs.internationaldataspaces.org/ids-knowledgebase/ids-ram-4
[2] IDSA Rulebook: https://docs.internationaldataspaces.org/ids-knowledgebase/idsa-rulebook/idsa-rulebook/1_introduction
[3] Data Spaces Radar: https://www.dataspaces-radar.org/

- Sketching a range of possible business models in a data space context, including different levels of public funding versus more sustainable revenues based on different pricing schemes.
- Provide inspiration from real-life cases reflecting on the perspective of three examples from the group of innovators.

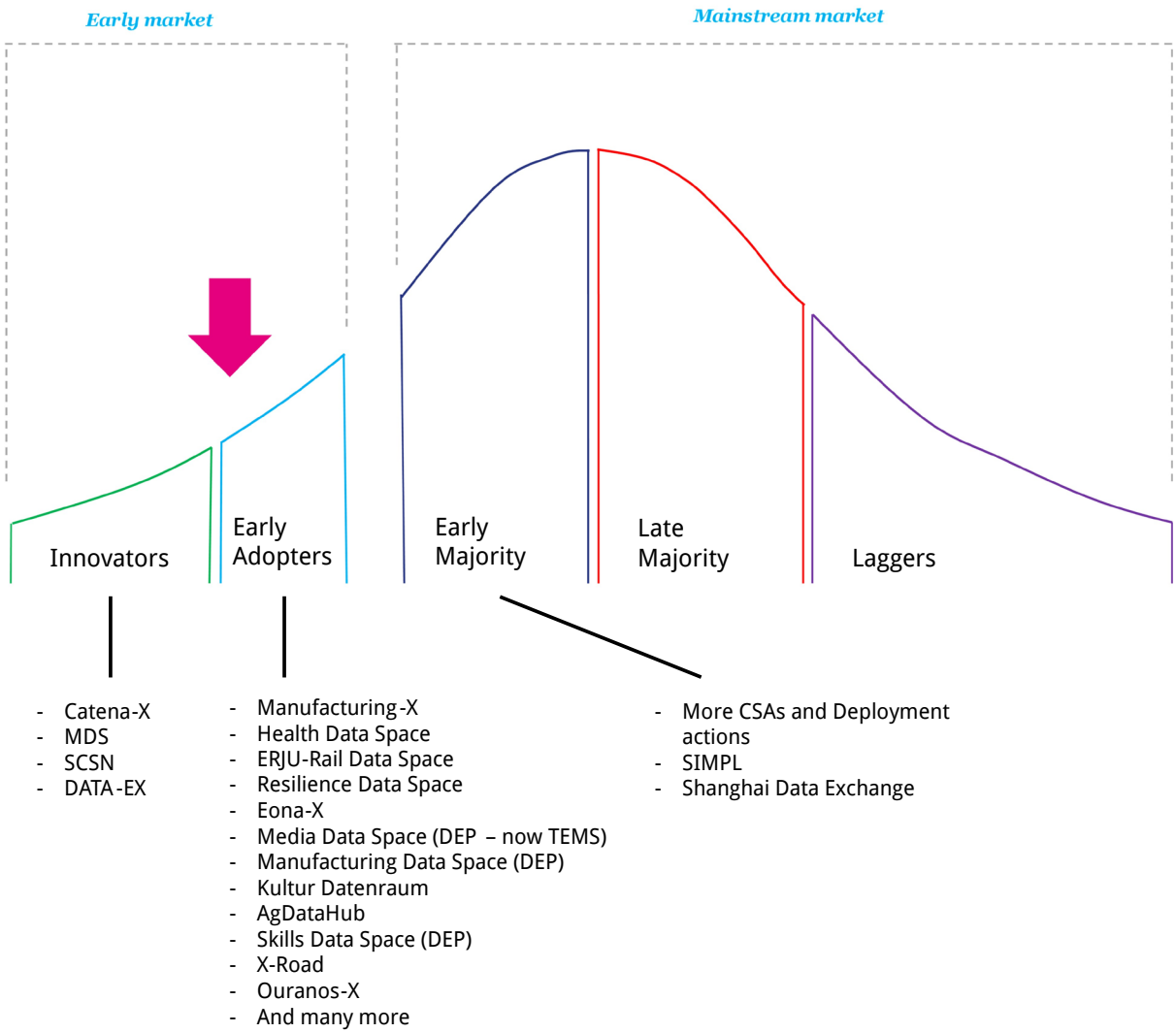

Figure 1: Adoption of data spaces with some examples

2. Business models for data spaces

This section starts by defining the concept of a business model. Then, it introduces the concept of a data space, to explain what is meant by a business model for data spaces. Finally, it indicates the complexity of business model analysis for data spaces and the actors therein

2.1 The concept of business models

Let's start by explaining the concept of a business model.

The most widely used business model definition today is that of Alex Osterwalder, stating that a business model "describes the rationale of how an organization creates, delivers and captures value". This definition is operationalized in the Osterwalder Business Model canvas, shown in Figure 2.

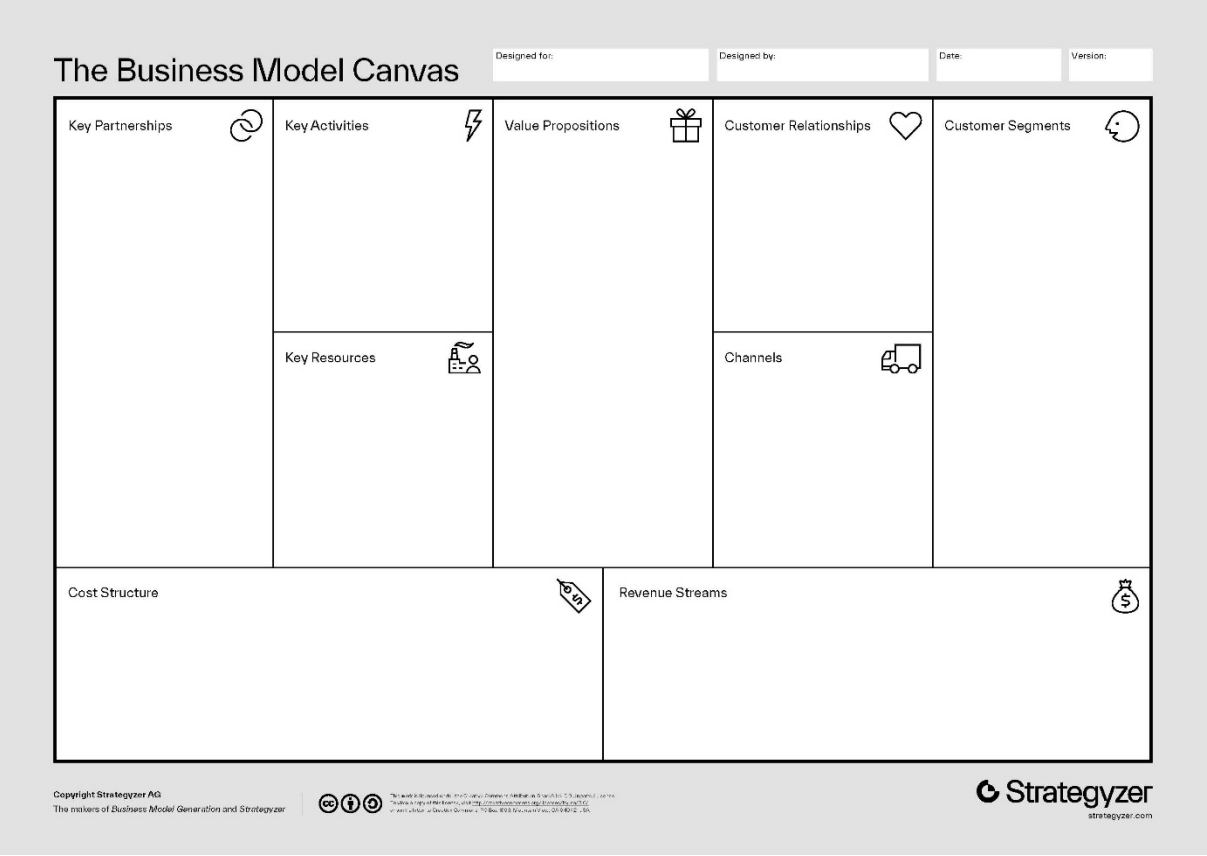

Figure 2: The Osterwalder Business Model Canvas

A business model sits somewhere between business strategy and business processes[1]. The business model helps to find a way to realize the strategy set forward in the vision, goals and objectives. The business model must be translated into organization, implementation and workflows.

The Osterwalder definition is not the only, nor was it the first. The minimal view on a business model is a company's plan for making a profit[2]. However, this view is a bit restricted and leans very much towards the definition of a business plan. More generic and useful definitions of a business model cover a variety of aspects around value creation, as illustrated in Table 1.

Table 1: Overview of common definitions of the term 'business model'

Reference	Business model definition
Hamel (2002)[3]	The "core strategy, the strategic resources, the customer interface, and the value network as the main components". He stated that "customer benefits, the configuration of competencies, and the company boundaries are acting as intermediaries between the four components".
Shafer et al. (2005)[4]	A business model as a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network.
Mitchell and Coles (2003)[5]	Business model as the "combination of "who", "what", "when", "where", "why", "where", and "how" a company provides its customers with its products."
Morris et al. (2005)[6]	A business model is a concise representation of how an interrelated set of decision variables in the areas of venture, strategy, architecture and economics are addressed to create sustainable competitive advantage in defined markets
(Zott & Huy, 2007)[7]	A business model (Zott & Huy, 2007) consists of an activity system (i.e. the goods/information that are being exchanged and the resources and capabilities required to enable the exchange), a structure (i.e. the participating parties, their linking, order of exchanges and exchange mechanism for enabling transactions) and governance (how to control the flow of information, resources and goods and provide incentives for the participants in the transactions).
Teece (2010)[8]	A business model articulates the logic, the data and other evidence that support a value proposition of the customer, and a viable structure of revenues and costs for the enterprise delivering value
Alex Osterwalder (2010)[9]	The business model describes the rationale of how an organization creates, delivers and captures value.

It is clear in the Osterwalder canvas, as well as in a lot of the definitions from Table 1, that the "value proposition" in the central concept in the business model: what we bring to the market and what our customers are interested in. It is the 'promise of value' to be delivered. Once we have the value proposition clear, the business model aims to understand how this value is created, delivered, and captured.

A rather restricted view on the value proposition talks about value the company promises to deliver to customers should they choose to buy their product[10]. This definition explicitly talks about "a company" that is offering a product. More generically, the company can be

seen as an organization that does not necessarily aim at pure profit maximization. A lot of business models have been described for non-for-profits or governmental organizations. They are not so much interested in making a profit, but still want to generate value for their customers. More generally stated, they want to create value for the users of their offering. This value should not be restricted to direct monetary value only. The value can be economic as well as societal value.

Note that, for this purpose, variations of the Osterwalder canvas exist that include also societal costs and revenues[11].

Defining a business model is one thing, selecting an appropriate business model is another. As a result, different authors have tried to provide a classification of business models. A. Ovens (2015) gives some background on the business model definition and lists some "typical" business models that can be observed in real-life. A common classification nowadays are the 55 types of business models suggested in the Sankt Gallen business model navigator[12] Depending on what you're looking for, those classifications can provide some insights.

However, there is no one-two-three-hurray solution to identifying a suitable business model. What we hope to bring across in this position paper is not so much "what type of business models exists", but rather "how to reason about a business model". The aim is to provide concepts and insights that can help understand how a certain business model works or why another does not work.

In the complex value networks that we experience nowadays, opposed to the more straightforward linear value chains, it is extremely important to understand the perspective from which the business model is developed. The business model is to be considered from the perspective of the actor who is putting the value proposition on the market. This actor can be any kind of organization: a commercial company, a non-for-profit company or even a governmental organization. Clearly, it can be relevant to consider several business models for several actors at the same time, as they will impact each other (as will be discussed in later sections). To emphasize the perspective of the business model you are considering (the organization that is putting the value proposition on the market), we recommend including it explicitly in the business model template.

We believe that the following parts are essential elements for describing a business model, as illustrated in Figure 3.

Those will be considered in the remainder of the paper.

- WHAT is put on the market. This defines the value proposition, which is a central concept to any business model. It is the promise of value to be delivered, the offer that is brought onto the market allowing us to fulfil a need at the customer side.
- WHO puts the value proposition to the market. It indicates which perspective is taken. This element is left implicit in a lot of business model templates. We strongly recommend making it explicit, though, as it is essential to understand, especially when we are faced with a complex value network of interacting actors.

- HOW is this value proposition put on the market. This groups elements like the key resources (what do we use), key activities (what do we do) and key partners (whom do we rely on) and is linked to the resulting cost. This business model element captures the entire left-hand side of the Osterwalder canvas.
- TO WHOM is the value proposition being offered. This mainly describes the customers, in a lot of case in different customer segments. It may also involve the customer channels and customer relationships and impact on the revenues. This business model element therefore captures the entire right-hand side of the Osterwalder canvas.
- BALANCE between costs and revenues. Costs and revenues should be balanced to have a sustainable business model. Note that both economic and societal costs and benefits can be considered, depending on the context and the nature of the actors developing the business model (WHO).

When analysing business models in complex value networks with multiple interacting parties, we recommend explicitly mentioning the party for which the business model is presented (WHO) in the business model template.

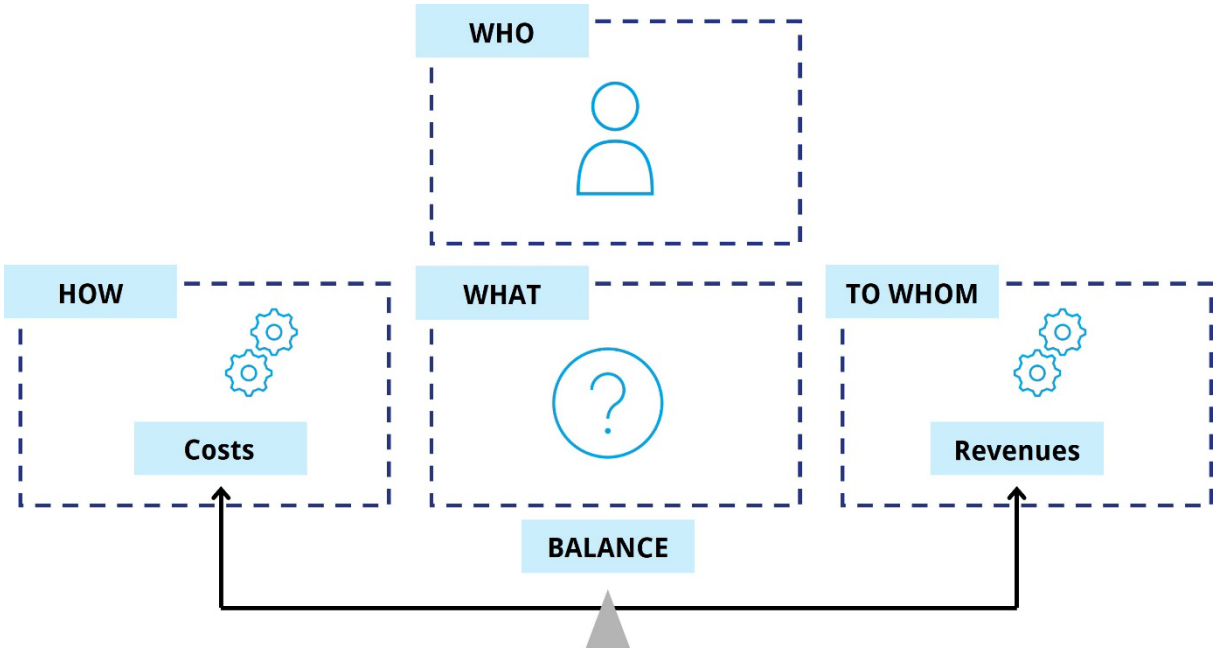

Figure 3: Roles and elements that are relevant when describing a business model

💡 **A business model helps to understand how an organization creates, delivers and captures value. The business model is therefore always taking the perspective of the actor who puts the value proposition to the market.**

2.2 The concept of data spaces

Let's now focus on the concept of data spaces. A data space enables data sharing between data providers and data consumers: sharing and processing data along the value chain.

The most important design principle for data spaces is to ensure data sovereignty for all data. This even enables the sharing of sensitive and most valuable data assets between selected participants. The IDS architecture leads to data sovereignty for data providers. This is the basis for offering smart services and for establishing innovative business processes[13].

Figure 4 shows the different roles which can exist in a data space. At least two participants share data and services. Next to them, we also can find identity providers, data catalogues, vocabulary providers, app stores, and transaction logs. Besides the existence of soft infrastructure, the figure also depicts the fact that data providers can define usage policies for all their data which then are checked with a potential data consumer before data is shared in case both parties agree to the usage policies.

Overall, we can say that the value proposition of a data space is 'enabling sovereign data sharing for value creation'[14].

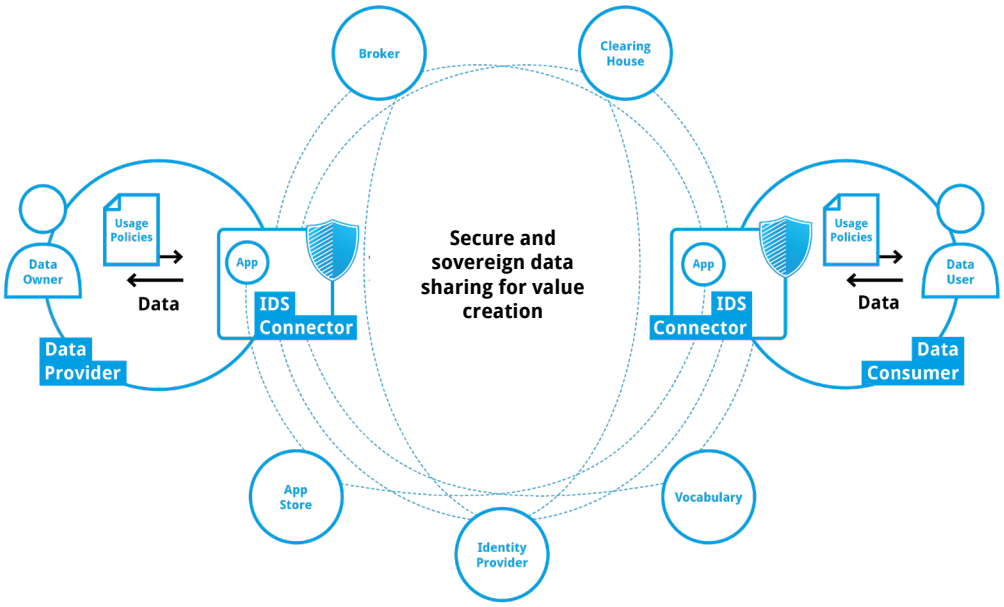

Figure 4: The different roles in a data space

This sounds good, but what does it mean in practice? The value of the data space is made tangible thanks to the USE CASES it enables. Data space participants are offering data products, which could be data sets, data services, or combination thereof. These data products are then used in final products or services to enable a certain practical use case. In a logistics context, the data product could be data sets with positional data and capacity of trucks and vessels, the final product can be a synchro-modal route planner implemented in

an actual use case. In the automotive context, data products could be emission reports per company, whereas the final product can be an end-to-end emissions report covering the entire value chain (see Figure 5).

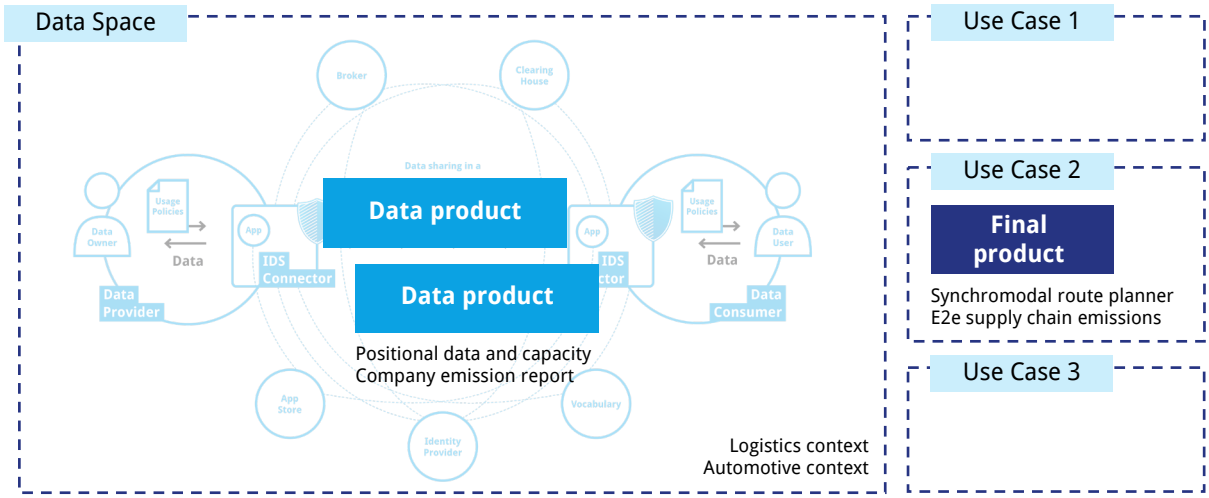

Figure 5: Example of different use cases enabled by a data space

Version 2 of the glossary of the DSSC describes a data space as follows: "A distributed system defined by a governance framework that enables secure and trustworthy data transactions between participants while supporting trust and data sovereignty. A data space is implemented by one or more infrastructures and enables one or more use cases."[15]

Within a data space data providers can define usage policies for the data they are offering to other participants. The mechanism which ensures that these usage policies are put in place is called usage control. "Usage control is an extension to traditional access control (see Figure 6). It is about the specification and enforcement of restrictions regulating what must (not) happen to data. Thus, usage control is concerned with requirements that pertain to data processing (obligations), rather than data access (provisions). Usage control is relevant in the context of intellectual property protection, compliance with regulations, and digital rights management."[16]

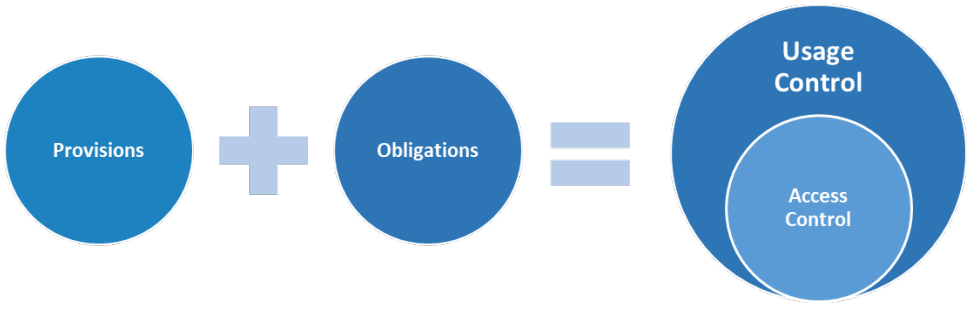

Figure 6: Usage Control consists of provisions and obligations [16]

If a participant of a data space finds a data set which is of interest, the first communication steps and the negotiation about the usage policies need to be standardized. Therefore, the

IDSA community defined the specifications for the so-called Dataspaces Protocol (DSP). The DSP is a set of specifications that help different organizations share data using Web technologies. These specifications explain how to publish data, make agreements, and access data within a data space[17]. To achieve this the DSP differentiates the control pane (standard procedure to negotiate data sharing) and the data pane (open for different data sharing scenarios, like confidential data sharing, streaming data, or event-based data). Figure 7 shows this differentiation and provides more context.

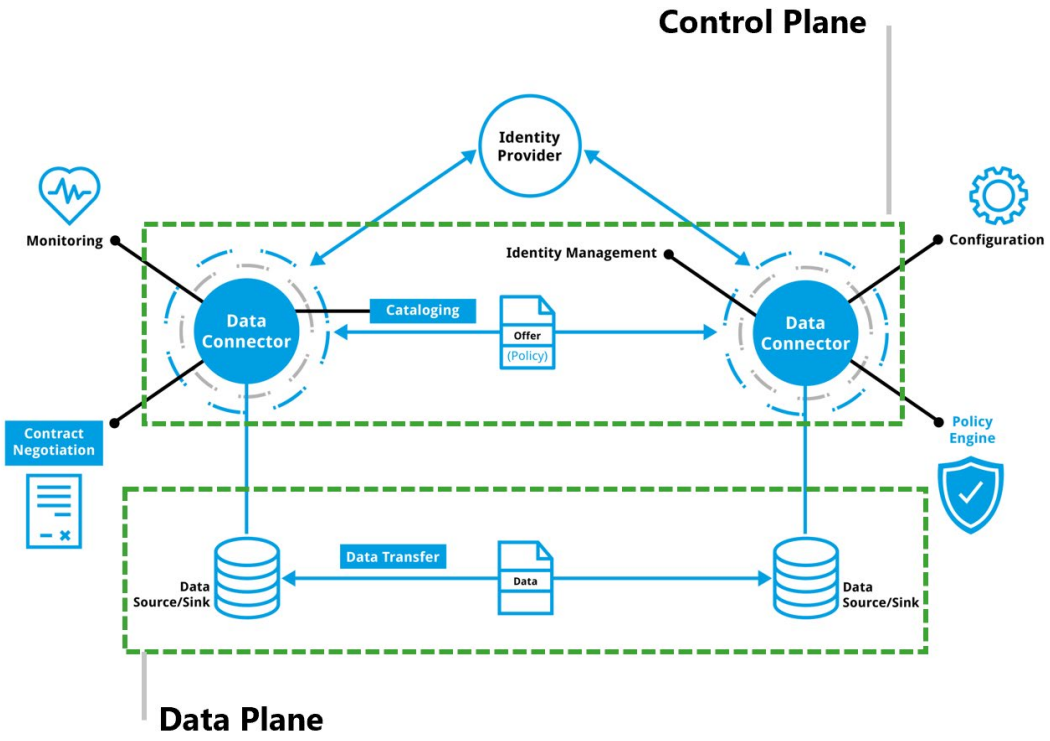

Figure 7: Overview of Dataspace Protocol and its context

When we are talking about the business model for an ecosystem, are we taking the perspective of this distributed system? Are we taking the perspective of one of the data space infrastructure providers or the data space authority? Or that of one of the data space participants who is joining a data space to share data or to offer their services to other participants? The business model for the data space and the different related actors will be the focus of the next section.

💡 **A data space is a distributed system, bringing together multiple actors: the governance authority, the organizational (legal) entity, optionally one or more intermediaries and the data space participants sharing data or offering value added services. It is often unclear which of these perspectives we are taking when talking about the business model for a data space.**

2.3 Data space business models

Now that we understand the concepts of a business model and a data space, let's try and combine both and focus on data space business models.

In the current section, we will highlight the fact that the ultimate business model for a data space does not exist. We should distinguish between different business models for the different actors involved in data spaces. Besides that, we will zoom a bit deeper into the value created through data sharing.

2.3.1 Business models for different actors

The data space is a distributed system, an ecosystem of actors aimed at data sharing. The business model for a data space is not a single business model. It is a combination of business models for the different actors in the data space and those business models should somehow be aligned.

💡 **It is important to distinguish between business models for the data space infrastructure (which would be based on cooperation, or at least coopetition) and business models for the participants, which act mostly on individualistic and competitive behaviours.**

The data space participants will benefit from additional value creation resulting from data sharing. However, the individual participants' incentives and therefore the individual actors' business models might not be aligned. Let's consider data consumer versus data provider. Often the initial idea and motivation for data sharing stems from the data consumer, who sees improved value, more data and reduced costs. The data provider on the other hand often fears costs and risks by investing in data quality and interfaces and fears losing strategic control over data and its value. The data space should provide solutions (data products) that can help to solve this imbalance.

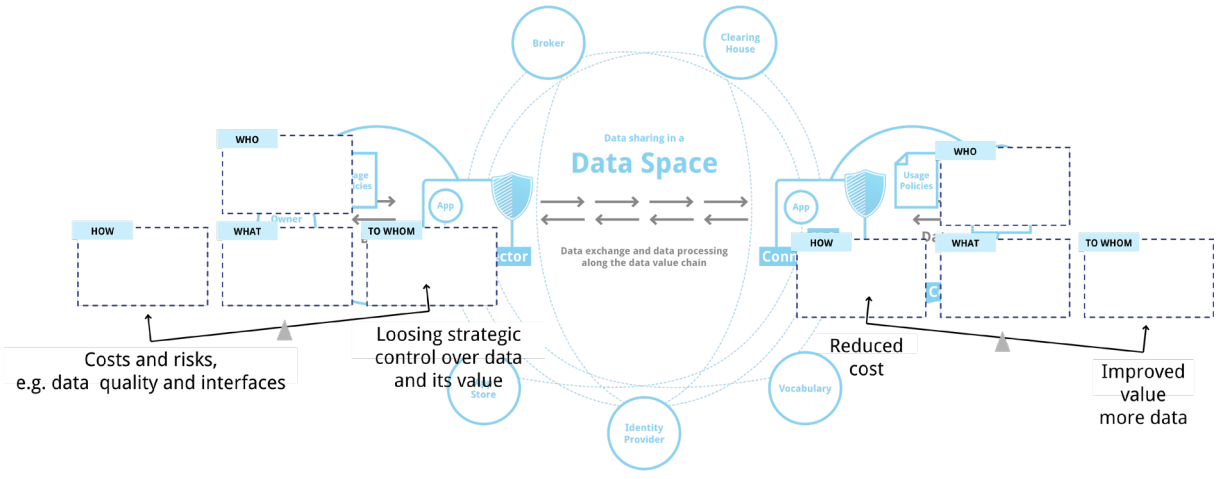

Figure 8: Data providers and data consumers experience different trade-offs between costs and revenues

💡 **A data space business model is collaborative. 'Collaborative' means that the business models of the different actors involved are to be aligned.**

Now, let's move to the business model for the data space infrastructure. The value of the data space depends on the value perceived by the data space participants. For a data consumer the value of the data space increases when more data providers participate in the data space and the other way around. These effects are called positive cross-side network effects[15] the value of the system for participants on one side grows with more participants on the other side. (Note the also positive same-side effects are possible, where the value of the system for participants grows with more users on the same side). We experience two-way and continuous value creation, the essential characteristics of a platform business model[16]. This is opposed to the linear one-way value creation we experience in a pipeline value chain.

Thanks to the existence of the two-sided network effects, the data space business model can be considered a platform business model. However, keep in mind that this does not mean that the data space is a platform! A data space, like a platform, enables data usage from multiple sources. Whereas a platform centrally aggregates this data, a data space is distributed, it empowers participants to maintain their data sovereignty while sharing their data (decide how and when others may use data) and at the same time being able to consume data of other participants.

Given that the data space business model has the characteristics of a platform business model, we can potentially learn from platform strategies. We want to get the continuous two-way value creation between data consumers and data providers started: we are facing a chicken-and-egg problem. Several strategies could be helpful to bootstrap the platform business. The first set of strategies aims at strengthening one side first. Working on the quantity of users on a certain side can be done by applying a seed (providing funding to attract enough users on one side) or building on existing positive same-side effects (an existing network of users on one side). Alternatively, we can start by focusing on selected users that add a lot of value to our system, the so-called marquee users[17].

A second set of strategies works on both sides at the same time: attracting participants who can act on both sides, leveraging an existing platform (making a broader offer) or applying big bang adoption (foreseeing all valuable services for users on both sides from start). Finally, strategies could work on the redistribution of value. If one user side has a higher willingness to pay than another side, one can have the ‘money side’ subsidize the other user side.

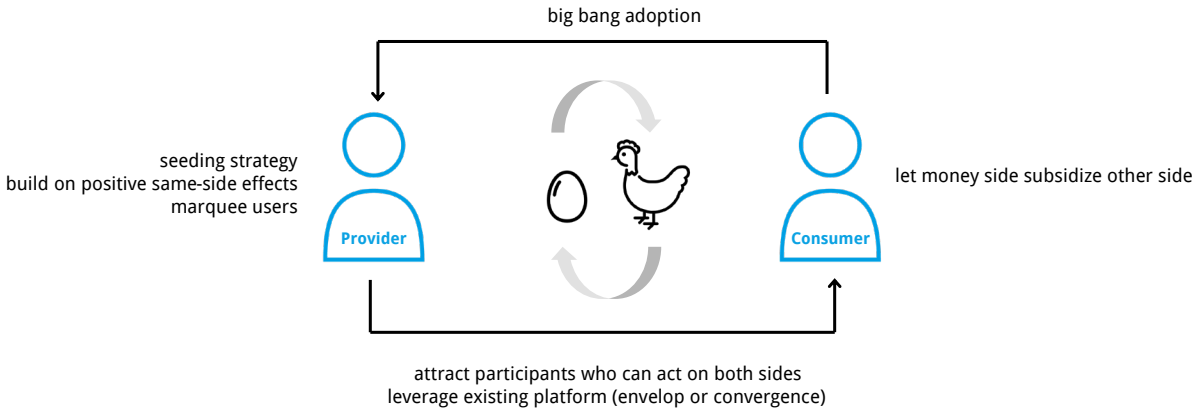

Figure 9: Several strategies can help to solve the chicken-and-egg problem in case of a platform business model

💡 **A data space business model is multi-sided. 'Multi-sided' indicates that the value of the dataspace for the data providers grows when more data consumers take part in the data space and the other way around.**

Finally, if we zoom into the business model for an organizational entity of a data space, we see that there often is some public involvement. Revenues for this actor are therefore partially relying on public funding, either project-based or via ongoing subsidy. As the data space starts to generate value via the use cases (as discussed before), the value recuperation from use cases might grow over time. The recuperation from use cases can be based on several pricing schemes (see next section), it can be uniform or tailored per use case. Overall, this value will grow with more synergies between use cases. On the cost side, the organizational entity faces development and operational costs. Economies of scale start kicking in when reuse of data products increases, for instance over multiple use cases. In the long term, the balance between costs and revenues will be improved by capturing multiple added value from multiple use cases. The business model will not be constant over time.

💡 **A data space business model is evolving. 'Evolving' highlights that the importance of public funding as well as other characteristics evolve over time.**

Going back to the original question about the appropriate business model for a data space, we might conclude that there is no one-size fits all solution. Everything depends on the perspective you are taking and the related level of analysis. Concepts like collaboration, multi-sidedness, and evolution over time are helpful. They provide insights into the characteristics of the business models for the actors within the data space, that is a distributed system. However, those concepts remain quite abstract. To understand what best practices can be derived, we should study concrete data spaces in detail and say how we can map these concepts to their practice.

💡 **The one data space business model does not exist. It depends on the perspective you are taking. To understand what can be working business models in practice, we need to analyse actual use cases and working initiatives.**

The concepts brought forward here link to some of the core concepts of business model development indicated under the 'business and organizational blocks' in the DSSC Blueprint[18]

2.3.2 The value of data in data spaces

Any business model hinges on the question of how goods and services can be assigned value and be priced adequately. The main economic interaction is that products or services are exchanged between providers and consumers, they exchange value for utility. This value is expressed by means of the price.

In the context of data sharing business models, data derives its value from the information it carries, which can lead to knowledge that is in turn used to guide action. The larger the impact of the action in question, the more valuable the data it is based on becomes. As indicated in previous sections, the value of a data space is made tangible thanks to the use cases it enables.

A very important observation in this context is that data is a non-rivalrous good. It can be used or consumed by multiple people (even simultaneously) without being depleted or diminished in value. Unlike physical goods (which are rivalrous and can only be used by one person at a time), data can be reused indefinitely, and each additional use does not reduce its availability for others and keeps its function.

Since data can theoretically be used in an infinite number of ways and contexts, its value can differ according to the circumstances it ends up in. In some contexts, universally useful data sets could be the most valuable, in others it might be extremely specific ones with very particular usage. In case of very sensitive or competitive data, one might argue that the value of data could be reduced when being shared (although in such cases, the data can still be shared without loss of function). In some other situations the fact that the data is shared might increase the value (providing more recognition).

💡 **Data is a non-rivalrous good, which leads to ample opportunities for data valuation.**

Moreover, like a lot of other digital services and products, offering data products typically comes at a rather limited variable cost (most cost is fixed and linked to setting up the data space, for example).

Exactly this imbalance between the drivers for revenues (data is non-rivalrous, can be used multiple times, generating value upon each use) and costs (very limited variable costs) are a cause of success of digital platform business models. Thanks to the presence of strong multi-side network effects and the centralized structure of a digital platform, digital platform business models can drive consumers onto a platform via low prices, corner the market thusly, and then raise prices to break even or into profit.

In data spaces, value determination can be more difficult to master, as interoperability and the concept of sovereignty ‘undermine’ the basic tenet of digital business models. Data spaces are distributed ecosystems, where data valuation should be translated into pricing models for different actors involved. For example, data providers may price access to the

data, whereas data space infrastructure providers may price the participation to the data space.

💡 **The distributed nature of data spaces requires a fundamental re-thinking of value generation. Data valuation concepts must be considered in early stages of data spaces to ensure a solid foundation on which participants can engage.**

Data valuation concepts (allowing to understand where the perceived value comes from) must be considered in early stages of data spaces to ensure a solid foundation on which participants can engage. Actual pricing schemes, on the other hand side, are ways to exploit this data valuation and might differ over time and over the actors involved.

Typically, pricing techniques fall apart in three big categories. First, cost-based pricing techniques link the price to the cost for offering this product, adding a mark-up (covering for the expected profit). Second, market-based pricing techniques base the price on the prices set by competitors for similar products. Thirdly, value-based pricing techniques base the price directly on the value perceived by the consumers.

Because of the reasons mentioned above, value-based pricing techniques are more common in the context of data sharing business models than cost-based and market-based pricing techniques. Relevant value-based pricing techniques for data are the following[10]:

- Economic Model: This model assesses the value of data based on its economic impact. It looks at how data contributes to economic benefits such as job creation, cost savings, or revenue generation. This approach often involves complex calculations and economic theories.
- Income-Based Model: This approach values data based on the income it generates. It considers the revenue directly attributable to the data, such as through sales, subscriptions, or advertising.
- Utility-Based Model: This model evaluates data based on its utility or usefulness. It considers how data improves decision-making, operational efficiency, or customer satisfaction.
- Dimensional Model: This method values data by applying various dimensions such as accuracy, completeness, timeliness, and relevance. Each dimension is scored, and the overall value is determined based on these scores.
- Comparative Model: This approach compares the data to similar data sets within the organization or industry to determine its relative value. It often involves benchmarking and performance metrics. (Note that if we compare it with data sets offered by other data providers, we end up in competitive pricing).

💡 **Actual pricing schemes in data spaces are ways to exploit this data valuation and might differ over time and depending on the actors involved. Given the specific characteristics, value-based pricing techniques are more common than cost- or competition-based pricing for data.**

3. Data space initiatives and their business models

In the next section we want to illustrate and clarify the above-mentioned concepts via real-life cases. We explore how different data spaces are organizing their 'business model' and how individual actors cooperating within these data spaces have potentially adapted their business model.

We will discuss three data space initiatives:

- The **Mobility Data Space (MDS)** is a German initiative from the mobility sector that is focused on creating a sustainable data space for innovative mobility solutions, heavily supported by public-private collaboration. Despite the tasks associated with developing a sustainable business model, it emphasizes **community building** and **technical facilitation**.
- **Catena-X**, as a data space from the automotive sector, highlights the regulatory challenges of building a data space while striving for **economic sustainability**. Success will depend on the development of innovative **pricing models** that balance regulatory compliance with financial viability.
- **Smart Connected Supplier Network (SCSN)** demonstrates how a **coordinated effort** can create a scalable model for data sharing in manufacturing supply chains. Its success shows the potential for data spaces to drive efficiency and innovation.

For each data space initiative, the same structure will be followed, linking to the data space business model elements introduced in previous sections.

- **USE CASE - Actual use cases that lead to value creation in the context of this data space initiative.** Within a use case a final product is delivered (or multiple final products). This final product is enabled by one or more data products offered within the data space.
- **WHAT - The value proposition offered by this specific data space initiative**, defined as the set of data products and other related products and services it offers. This will be more specific than the generic data space value proposition 'enabling sovereign data sharing for value creation'.
- **WHO - The actors behind this data space** that bring the above value proposition to the market. Those can be the legal entity of a data space and may include intermediary actors.
- **HOW - Data space setup from a technical and organizational perspective.** What are technical and organizational choices? Are there any essential partners?
- **TO WHOM - The participants targeted by this data space initiative.** There will be at least two parties sharing data. Typically, the value will increase when more participants enter. What is the incentive of these different participants?
- **BALANCE between COST and REVENUES.** To be financially sustainable, costs and benefits for the data space should be balanced. This balance can be impacted by choosing appropriate pricing schemes that match the data space participants

perceived value. As a lot of data spaces aim at a societal goal (next to an economic goal), there is often government involvement and an influx of public money. This situation might evolve over time.

- **Solution to the CHICKEN-and-EGG PROBLEM:** It is important to get the network effects flowing and thereby increasing the value of the data space. Which strategies have been used to kick-start or facilitate the attraction of data space participants (data providers or consumers)?

3.1 Example 1 – The Mobility Data Space

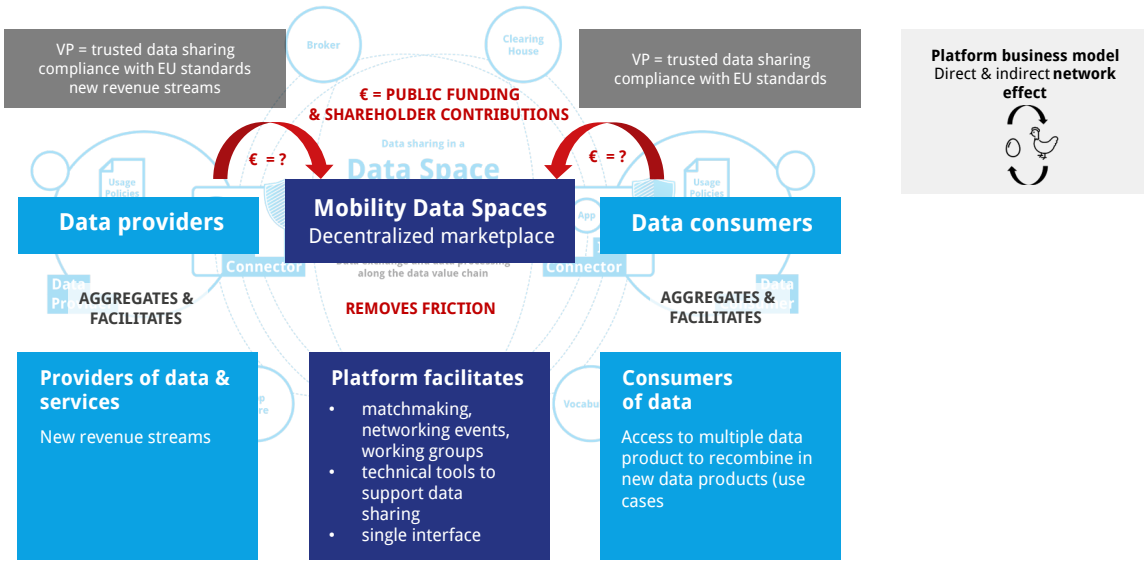

Figure 10: Simplified Representation of The Mobility Data Space Value Network & Business Model

USE CASE: Actual use case that leads to value creation in the context of this data space initiative

The key problem that led to the set-up of the Mobility Data Space (MDS) was twofold, 1) the recurring data exchange challenges and 2) over-reliance on dominant platforms.

Data driven innovations in the mobility sector are key to optimizing public transport, road traffic, transportation of goods, intermodal mobility solutions, and many more. The challenge is that either data providers and data users must set up their own interface to share data, or they had to use data spaces which are mostly located outside the EU – until the MDS was founded. The data space is especially useful for all use cases, which build on a m-to-n relationship, where multiple data providers, multiple data users or both are involved.

The MDS enables use cases that focus on data-driven innovations in the mobility sector. Examples include smart city applications, traffic routing, road safety analysis, and services minimizing vehicles searching for charging stations. A notable use case is "Pay as you drive," where insurance companies collaborate with OEMs to offer insurance packages based on

actual vehicle usage. Another example includes Esri's integration of real-time traffic data into digital twins of towns and cities, improving urban mobility and infrastructure planning.

WHAT: The value proposition offered by this specific data space initiative, defined as the set of data products and other related products and services it offers.

The MDS offers a secure, decentralized data marketplace that fosters innovation in mobility solutions by enabling trusted data sharing among various participants. The value proposition includes

- Infrastructure to break down data silos: providing a platform for secure data exchange that adheres to European standards (such as GDPR), and
- Facilitating peer-to-peer data transactions. Data providers can sell their data multiple times, without the value being depleted, creating additional revenue streams. Data gets an additional value: data can be sold multiple times without being depleted. Moreover, data with low value for the data owner could be valuable for other companies which generate data-based business models
- The platform also supports technical tools like the Eclipse Data Space Connector (EDC), making data exchange easier and more accessible.

The primary goal of the MDS is to create a decentralized, trusted data-sharing platform that supports innovative mobility solutions by allowing various stakeholders, including public and private entities, to exchange mobility-related data securely. The MDS is an operational data space.

WHO: The actors behind this data space that bring the above value proposition to the market.

The Mobility Data Space is a German government-backed initiative, also supported by shareholders from the private sector, aimed at creating a sustainable data-sharing platform for innovative mobility solutions. But the data space was always focused on Europe and was intended as a blueprint for other initiatives.

The MDS was initiated by the German Federal Government in 2019, with support from public and private stakeholders such as the Federal Ministry of Digital Affairs and Transport (BMDV), acatech Foundation, Deutsche Bahn, Deutsche Post, and HUK Coburg. with the primary goal to support the mobility transition. At the same time, it should be demonstrated that a sustainable business model can be derived from a data space. Thereby the MDS supports the digital transformation in Germany and Europe towards a digital and data-driven economy and reduces the reliance on dominant tech companies.

The MDS is aligned with the European cloud initiative Gaia-X and is funded by the Federal Ministry of Digital Affairs and Transport (BMDV). The project was spearheaded by the acatech Foundation, which founded the non-profit organization DRM Datenraum Mobilität GmbH in 2022 to oversee the MDS.

HOW: Data space set up from a technical and organizational perspective

From a technical perspective, the MDS uses the Eclipse Data Space Components Connector (EDC Connector) to facilitate onboarding, either via on-premise installations or connector-as-

a-service options. This technical infrastructure allows decentralized, secure data exchange and ensures compliance with GDPR. On the organizational side, the MDS is supported by a team of community managers who foster collaboration, provide matchmaking services for participants, and organize networking events. The MDS is sustained through a combination of public funding and shareholder contributions.

A use case to minimise traffic searching for a charging station illustrates the unique advantage that a data space offers by minimising the interfaces in m-to-n relationships between use case participants. Ideally, the comprehensive optimisation of charging station search traffic and/or charging station locations would include:

- Real-time charging information from vehicles of different makes (data providers).
- Location data from app and satnav providers (data providers and users).
- Data from energy providers/power grid operators (data providers and users).
- Parking space usage data.
- Etc.

If this data was exchanged directly between the participants, each new party joining the use case would have to negotiate how the transfer should take place with every one of the existing participants and, in the worst-case scenario, implement m interfaces. In the MDS, on the other hand, a single interface (the EDC Connector) enables access to m data providers and n data users.

From a policy and organizational perspective, it is important to note that the MDS is hosted in Europe and designed according to European rules with an international data exchange in mind.

TO WHOM: The participants targeted by this data space initiative

The MDS targets various participants, including public and private entities in the mobility sector. These participants include data providers (e. g., OEMs, transportation companies) and data consumers (e. g., urban planners, mobility service providers, app developers). The platform is particularly useful for 'm relationships', where multiple data providers and users interact. The value for participants increases as more join the data space, and the MDS actively works to attract new participants.

In addition to these benefits for end users, there are also new revenue opportunities for data and service providers, such as selling either raw or enhanced and analysed data based on multiple data sources, licensing mobility apps, etc. Local authorities and public bodies can use new mobility solutions to provide better public information, optimise local public transport or cleaning service deployment, and much more besides. Aggregated, processed data from multiple sources or third-party data in general can also be useful to infrastructure operators and urban planners.

The fact that a wealth of mobility-related data is stored in a single database structure, often with identifiers, makes the MDS attractive to data service providers, too. The services they can offer include:

- Data qualification and harmonisation.
- Aggregation of similar types of data in a single structure.
- Data analysis.
- Data anonymisation support.

BALANCE between COST and REVENUES

The challenge currently facing the MDS – and other data spaces – is that sharing or trading data calls for a change of mindset. Many organisations are reluctant to share their data due to legal restrictions or concerns about competition. Some do not yet appreciate the potential for earning revenue from their data, while others are worried that making their data available could violate regulations like the GDPR. This is why the role of the MDS Community Management team is so important. While the project faces challenges in developing a viable business model, it is supported by strong public and private sector collaboration, with a focus on community building and technical facilitation to ensure long-term success.

Solution to the CHICKEN-and-EGG PROBLEM

The MDS employs several strategies to overcome the challenge of attracting participants. The community management team plays a key role by facilitating participant engagement through matchmaking, networking events, and working groups. The MDS aims to reach a critical mass of participants to trigger network effects, thus increasing the value of the data space. As of autumn 2024, nearly 200 participants have joined, making the MDS one of Europe's most advanced data spaces.

3.2 Example 2 – Catena-X

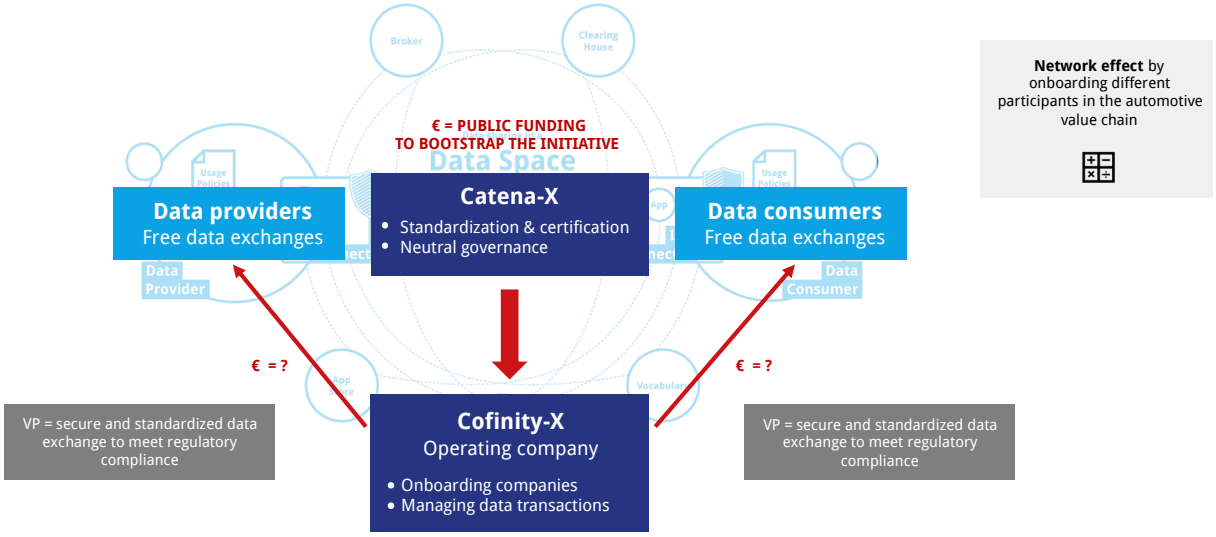

Figure 11: Simplified Representation of The Catena-X Value Network & Business Model

USE CASE: Actual use case that leads to value creation in the context of this data space initiative

Catena-X was established in response to several critical developments and challenges in the automotive industry, including the complexity of value chains for companies like Volkswagen and BMW, the disruptions caused by the COVID-19 pandemic, and the need to comply with emerging data regulations such as the Data Act and AI Act.

The initial use case identified by Catena-X centred on enhancing transparency, traceability, and sustainability within the automotive value chain. To address these industry challenges, eleven targeted use cases were developed within the Catena-X data space, including:

- Product Carbon Footprint Tracking
- Battery & Product Passports
- Resilient Supply Chains
- Traceability of Parts
- Master Data Management

These use cases are designed to address regulatory and operational challenges within the automotive industry, with the aim to improve supply chain transparency, compliance, and efficiency.

WHAT: The value proposition offered by this specific data space initiative, defined as the set of data products and other related products and services it offers.

Catena-X provides a secure and standardized data space to enable compliance with regulatory requirements as well as improve supply chain transparency and efficiency in the automotive industry. Its modular and standardized use-case architecture delivers value by reducing time to market and implementation costs while fostering innovation. Participants across the value chain can benefit equally from the system, which facilitates data sharing in a transparent and compliant manner.

Additionally, Catena-X captures value by offering an extensible ecosystem that can scale across various participants, from manufacturers to software providers. The value proposition revolves around making compliance easier and providing secure data exchange.

WHO: The actors behind this data space that bring the above value proposition to the market.

Catena-X is a collaborative ecosystem with significant actors from both the automotive and technology sectors, including:

- Major automotive manufacturers: BMW, Volkswagen, Ford, Renault, ...
- Automotive part suppliers: Bosch, ZF, Schaeffler, ...
- Technology providers: Siemens, SAP, Deutsche Telekom, ...

- Start-Ups: Circulor, Spherity, sovity, ...
- Research organisations: Fraunhofer, DLR, ...

Catena-X leveraged public funding, including initial investments from the German Ministry of Economic Affairs, and assembled a strong community of stakeholders. These stakeholders work together to provide solutions for compliance, traceability, and sustainability within the automotive supply chain.

HOW: Data space set up from a technical and organizational perspective

Catena-X formed an operating company called Cofinity-X, that is responsible for the practical and operational aspects of running the data space, including onboarding companies and facilitating secure data exchanges.

The project also built upon existing frameworks such as GAIA-X, the International Data Spaces Association (IDSA), and the Eclipse Dataspace Connector (EDC). The technical setup focuses on compliance, security, and interoperability.

TO WHOM: The participants targeted by this data space initiative

Catena-X targets multiple participants within the automotive value chain, including:

- Major automotive manufacturers: BMW, Volkswagen, Ford, Renault, ...
- Automotive part suppliers: Bosch, ZF, Schaeffler, ...
- Technology providers: Siemens, SAP, Deutsche Telekom, ...
- Start-Ups: Circulor, Spherity, sovity, ...
- Research organisations: Fraunhofer, DLR, ...

The incentive for participants revolves around compliance, improved supply chain management, and the ability to share data securely and efficiently. The more participants join the data space, the greater the value created through network effects.

BALANCE between COST and REVENUES

One challenge for Catena-X lies in the creation of a sustainable business model for the operating company, as well as for the participating actors. On the one hand, a sustainable balance must be found between the costs and benefits of each individual participant, e.g., data provider, data user, app provider, etc. On the other hand, a sustainable financing model must be established for the operating company Cofinity-X, which provides the necessary data space infrastructure for the data exchange, which, however, also incurs costs.

Public funding initially helped to bootstrap the initiative, but the future of Catena-X depends on finding ways to balance compliance needs with economic viability, possibly through a combination of participation fees, service charges, and value-added services.

Solution to the CHICKEN-and-EGG PROBLEM

To kick-start the data space, Catena-X used public funding and leveraged strong partnerships with major automotive players to build a solid initial community. The set-up of Cofinity-X as operating company also helped in creating the necessary data space infrastructure for data sharing. However, convincing smaller companies, e.g., suppliers, to participate remains a challenge. Strategies for incentivizing broader adoption, especially among smaller companies, are still in development.

3.3 Example 3 - SCSN

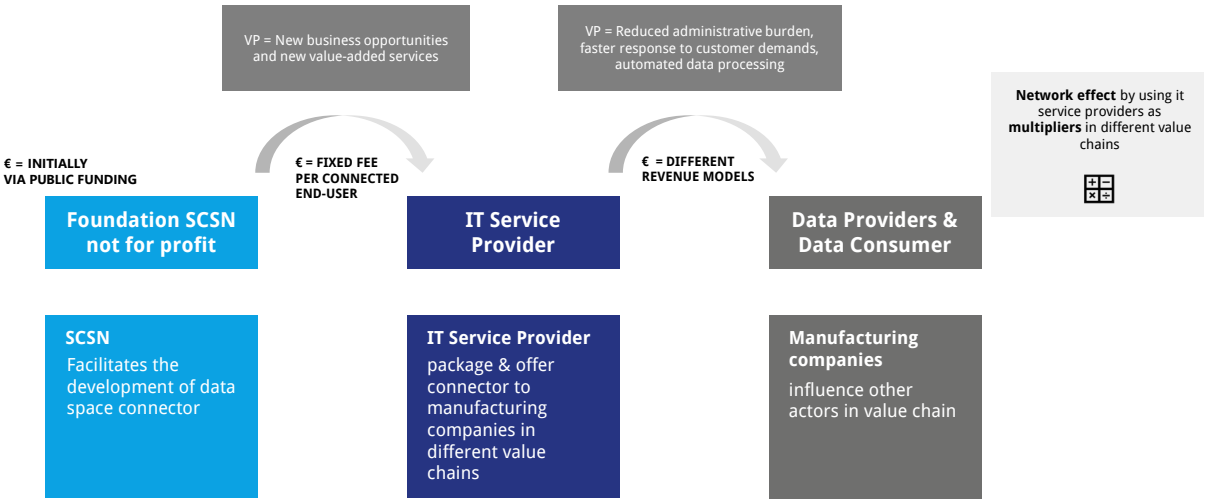

Figure 12: Simplified Representation of The SCSN Value Network & Business Model

USE CASE: Actual use case that leads to value creation in the context of this data space initiative

The Smart Connected Supplier Network (SCSN) initiative began as an applied research project in 2015 aimed at enhancing data sharing among actors in complex manufacturing supply chains. SCSN started with a focus on the Eindhoven Brainport region of low volume, high complexity, and high mix productions, involving the extensive supply chains of companies such as ASML and Philips. These supply chains are characterized by high complexity and low volume outputs, like ASML lithography machines and lab equipment, thus ensuring that collaboration in the supply chain is essential. The challenge was to optimize and harmonize data exchange across various IT systems used by different actors in these supply chains.

The initial use-case focused on "Purchase to Pay Information," addressing the common issue of data being shared via email, phone calls, and PDFs to support the procurement process of manufacturing companies. This manual process was inefficient and prone to errors, prompting the need for an interoperable solution. Existing solutions such as EDI are not available for SMEs given their large setup cost and lack of scalability. SMEs are hesitant to invest in digitization, which is specific to one customer or supplier, because they are aware that they serve many customers and have numerous suppliers. SCSN tackled this by

developing a communication standard that could model and harmonize data exchange, leading to the gradual evolution into a data space.

WHAT: The value proposition offered by this specific data space initiative, defined as the set of data products and other related products and services it offers.

The value proposition offered by SCSN is reduced administrative burden, faster response to customer demands, and automated data processing for manufacturing supply chains. It allows seamless, interoperable data exchange among diverse ERP systems, benefiting actors across the supply chain by reducing errors and improving efficiency. In addition, SCSN reduces overhead costs of already scarce personnel. IT service providers offer SCSN-connections-as-a-service, providing new business opportunities and value-added services for their customers. The service providers adopted various business models, ranging from per-message charges to fixed fees and premium packages.

WHO: The actors behind this data space that bring the above value proposition to the market.

The key actors behind SCSN include a range of manufacturing companies, IT service providers, TNO (Netherlands Organization for Applied Scientific Research), and Brainport Industries, a high-tech suppliers' cooperation. These actors collaborated to develop the initiative, which has now expanded to over 400 manufacturing companies and eleven IT service providers. Public funding and industry associations also played critical roles in the initiative's early success and growth.

HOW: Data space set up from a technical and organizational perspective

SCSN is organized around a not-for-profit foundation, managed by Brainport Industries, with a balanced governance structure. The governance board is chaired by Brainport industries and includes a supervisory board with representatives from each stakeholder category. The technical architecture involves standardized communication protocols that harmonize data exchanges across different ERP systems. IT service providers have played a key role in onboarding their existing clients into the data space, leveraging their networks to drive adoption. A fixed fee per connected end-user was adopted as the pricing model to ensure scalability and fairness, moving away from initial usage-based fees.

TO WHOM: The participants targeted by this data space initiative

The participants targeted by the SCSN initiative include large enterprises, small and medium-sized enterprises (SMEs), and IT service providers within the manufacturing supply chain. Larger parties like ASML and Philips, who already had digitalized processes, were early adopters, while SMEs in the middle of the supply chain benefited the most from SCSN's standardized approach, reducing their administrative burden. Industry associations and IT providers were motivated to participate as it allowed them to offer new services and increase competitiveness.

BALANCE between COST and REVENUES

Initially funded by public money, SCSN gradually evolved into a self-sustaining initiative. Public funding was crucial for the initial kickstart of the SCSN initiative. It helped develop

essential building blocks, such as the connector, and lowered the barrier to entry for companies. The operational costs are covered through fees paid by IT service providers using the SCSN data space connector. The decision to implement a fixed-fee model instead of a usage-based model has ensured broader participation and maximized value for all participants. While the initiative started with heavy reliance on public funding, it now operates in a balanced manner, with all actors deriving economic value from their participation.

Solution to the CHICKEN-and-EGG PROBLEM

SCSN overcame the chicken-and-egg problem by leveraging IT service providers as multipliers. These providers onboarded their clients into the data space, rapidly expanding the participant base. Larger parties (OEMs) were already digitizing portals at the beginning and end of the supply chain, leaving SMEs in the middle overwhelmed with multiple portals. SCSN's approach helped these SMEs by providing a single interoperable system. Onboarding new actors from different supply chains allowed SCSN to grow its user base rapidly, creating additional value with each new participant. This approach allowed SCSN to grow quickly by tapping into existing networks and building momentum. Additionally, the clear business need—lack of interoperability – provided strong incentives for early participation, further driving network effects.

3.4 Different business models for different actors observed in example initiatives

The above-described examples of Data Space initiatives give a first indication of the variety of possible business models depending on sector-industry, public-private collaboration and primary use cases. We summarise our initial conclusions on (1) the level of the data infrastructure and the (2) level of data space participants.

At the data infrastructure level, we identified challenges in fostering adoption and monetization of data exchanges. Each initiative received some public funding at the outset. For instance, Catena-X benefited from significant initial funding, while SCSN adopted a more modest, “bootstrap-like” approach. All three initiatives focus on data providers and consumers as the primary “end-users” of data products, while also engaging service providers. However, they employ distinct approaches: the Mobility Data Space follows a multi-sided platform model that matches data providers and service providers with data consumers. Catena-X established a joint venture, Cofinity-X, to serve as a marketplace for supply-demand matching, while also enabling direct data exchanges outside of this operational structure. SCSN, by contrast, uses IT service providers as intermediaries to reach both data consumers and providers across various manufacturing supply chains. This approach helps address the common “chicken-and-egg” challenge in data space initiatives, enabling accelerated adoption and scale as new actors in one supply chain attract others in their networks.

At the participant level, service providers can develop independent business models that leverage the data space infrastructure. In SCSN’s case, IT service providers develop revenue models in return for fees paid to the data space infrastructure (the SCSN Foundation). For

the Mobility Data Space, it remains unclear if and how additional service providers are charged for building business models on the platform. Similarly to SCSN, Catena-X's Cofinity-X generates revenue while enabling external service providers to offer their apps and services through the marketplace.

4. Conclusion

Since data spaces initially were defined from the technological point of view (cf. IDS Reference Architecture Model[]), the business perspective was lacking behind for some time, even though the International Data Spaces Association and its members always knew it only can be successful when the business perspective was equally represented. Therefore, the IDSA Rulebook[] started explaining data spaces from the governance and legal perspective to provide insights into the topic beyond the technical documentation. Still the gap between data spaces and business models remained significant and hence this position paper that aims at providing clearer insights into the business model perspective.

This paper does not propose an optimal business model for data spaces, as the suitable model depends on specific situations. Instead, it aims to sketch the context, provide common terminology, and key understandings, enabling stakeholders to speak the same language when discussing business models for data spaces.

It is essential to realize that a business model always takes the perspective from the actor who is offering the value proposition. This is even more relevant when analysing business models within complex value networks with interacting actors, like data spaces. In the context of data spaces, we can talk about the business model for data space participants (data providers as well as data consumers), or about the business model for the data space infrastructure. Next to that potentially one or more intermediaries could be involved, also having their own business models.

The generic value proposition of a data space is to 'enable secure and sovereign data sharing for joint value creation'. The actual value, however, is realized in tangible use cases. These use cases provide a final product or service that is built upon a data product from the data space.

The use cases as well as the data space inherently rely on the value of the data that is brought together and can be shared. The data is a non-rivalrous good, which leads to ample opportunities for data valuation. Actual pricing schemes in data spaces are ways to exploit this data valuation and might differ over time and over the actors involved.

Within data spaces, well-known digital platform models are 'undermined' thanks to data interoperability and sovereignty. Data spaces are distributed ecosystems, where data valuation should be translated into pricing models for different actors involved. Understanding the value created in early stages of data space development allows to ensure a solid foundation on which participants can engage. Only in this way a strong multi-sided and collaborative data space business model can be realized.

Value creation within data spaces is not only about monetization of data. Societal value creation is an important goal in a lot of data space initiatives. It is this societal value that justifies the involvement of public funding. In their initial stage, most data space initiatives rely on public funding. Over time, value recuperation from use cases should allow us to generate a revenue stream that can complement or obviate the public funding. Gradually a self-sustainable business model is to be developed, where economies of scale can be exploited on the cost side of the data space thanks to the reuse of data products for multiple use cases.

The paper illustrates the above concepts for three real-life examples, namely Catena-x, Mobility Data Space and SCSN. The examples show the actual business models and funding schemes that are used by the example data spaces.

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