Survey of the Architecture of Data Ecosystems for the Chief Data Officer of the Dutch Ministry of Infrastructure and Water Management

Geonovum

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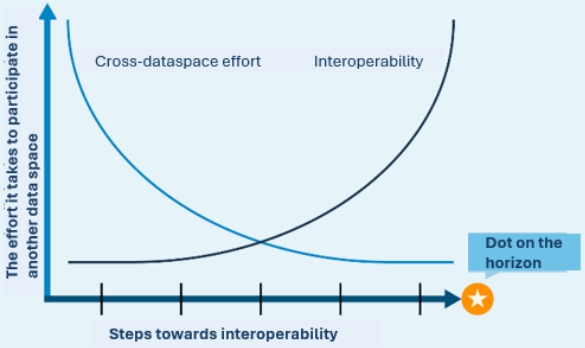
An interplay of data ecosystems

Current societal challenges require the exchange of data between different data ecosystems. It is important that data can flow 'effortlessly' from one domain to another, even if conditions apply.



Alone you go faster, together you go further

What we are working towards is the efficient and effective use of data between data ecosystems. Interoperability is necessary for this. This takes effort to achieve. By investing, the dot on the horizon comes closer.

This flotilla consists of:

- Basic Data Infrastructure (BDI) / Digital Infrastructure Logistics (DIL)
- Federated Data Space (FDS)
- Digital Mobility System (DSM) / National Mobility Access Point (NTM)
- National Geo Information Infrastructure (NGII) / View on the Netherlands (ZoN)
- Dutch Metropolitan Innovations (DMI)-ecosystem
- European Mobility Data Space (EMDS)
- Digital System of Data Sharing in the Built Environment (DSGO)
- Digital System Environment and Planning Act (DSO)
- Digital Environment System of Permit Referral, Supervision and Enforcement (VTH)
- Digital Infrastructure for Future-Proof Mobility (DITM)

The power of together: The flotilla

One or more boats can set out to explore a specific subject - like discovering an unknown island - and then share their findings with the entire flotilla.

Imagine the ecosystems as ships with unique characteristics and qualities. By sailing as a flotilla rather than solo, the ecosystems can benefit from each other's specialties along the way.

All boats in the flotilla set a course for the common dot on the horizon

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Source: Geonovum

1. Introduction – the mission and the approach

Similar system agreements are currently being made within several organizations and initiatives for federated data sharing between parties (both market parties and governments). This is driven by the broad societal challenges (housing, climate, livability, etc.) for which data from multiple domains must be brought together and that for each domain it must be clear what the data represents and what the concepts mean.

These similar system agreements also lead to the realization of very similar components or building blocks, such as standards, software building blocks, basic facilities or even services.

Architects and programme / project managers involved in the Ministry of Infrastructure and Water Management (I&W) determined that there could be potential benefits if the development of these basic facilities were taken up jointly and/or reused.

But before a common basis can be created and then (possibly) developed together, it is important to first make an survey of the technical content of what is already available to certain components within the various initiatives. This report contains the results of that survey, supplemented by a number of scenarios for the future.

The results of this report are based on three plenary sessions with the (lead) architects of the 10 data ecosystems and the Chief Data Officer of I&W and her employees and separate in-depth interviews with the architects of each of the data ecosystems, supplemented by desk research.

2. The playing field – 10 data ecosystems

Within the scope of this assignment, 10 data ecosystems were included. By data ecosystems is meant here: environments in which organizations can exchange data in a sovereign and trusted manner to create value.

Each of the 10 data ecosystems has its own origin and its own characteristics on the dimensions of this definition. The environments and organizations differ, types of data exchanged differ, the degree of trustworthiness differs and the use cases differ. This chapter provides a brief explanation of the data ecosystems. More details can be found in the appendix.

Of the 10 data ecosystems, 4 focus mainly on Mobility and Logistics:

1. BDI / DIL:
   The Digital Infrastructure Logistics (DIL) programme investigates and encourages the smarter use of data exchange in freight transport. For this purpose, the Basic Data Infrastructure (BDI) is used.
2. DSM / NTM:
   The Digital Mobility Data System (DSM) and the National Access Point Mobility Data (NTM) complete parts of the ITS Directive (Intelligent Transport Systems).
3. EMDS:
   The European Mobility Data Space (EMDS) is one of the Common European Data Spaces in the European Data Strategy and focuses on data sharing in the mobility and transport sector.
4. DITM:
   The Digital Infrastructure for Future-Proof Mobility (DITM) is set up for automated transport to make mobility more efficient and safer.

Five other data ecosystems focus more on different aspects of the living environment:

5. DMI:
   Dutch Metropolitan Innovations (DMI) wants to create a digital link between mobility, space and sustainability, so that both the available space, the mobility system and the energy network can be used better and cities are more resilient to the consequences of climate change.
6. DSGO:
   The Digital System of Data Sharing in the Built Environment (DSGO) is aimed at the Built Environment sector. From infrastructure to housing and utilities. The scope is broad, including bridges, office buildings and rails. The original goal was to reduce emissions in the construction industry. Asset management is also a major driver.
7. DSO:
   The Digital System Environment and Planning Act (DSO) is actually a data space for regulations and supports the implementation of the Environment and Planning Act. The DSO offers a digital counter (Omgevingsloket) where initiators, governments and stakeholders can quickly see what is allowed in the physical living environment.
8. VTH:
   The Digital Environment System of Permit Referral, Supervision and Enforcement (VTH) programme aims to improve the provision of information in the VTH domain.
9. NGII / ZoN:
   The multi-year vision ‘View on the Netherlands’ (ZoN) describes the further development of the National Geo Information Infrastructure (NGII) to tackle the complexity of the ‘spatial puzzle’ in the Netherlands in a data-driven manner.

The tenth data ecosystem is particularly binding in nature (within the government):

10. FDS:
    The Federated Data Space (FDS) focuses on interoperability between systems (standards) on the one hand and on making data available for use between governments on the other.

Despite the differences in origin and characteristics, we will see later in this survey that large common denominators can be found in all these initiatives on ‘data sharing under conditions’. Partly these are already converging, partly there are great opportunities. The trick is to get generic items standardised in data ecosystems for maximum interoperability and to leave the specific items ‘free’ for a good connection with the specific purpose.

3. The Dream - Interoperability between Data Ecosystems

As outlined in the introduction, the architects and programme/project managers involved identified potential benefits if the development of basic facilities were taken up together.

This was considered from the technical side, with benefits such as:

- Reduced cost of shared components through scaling up
- Increased adoption speed
- Optimized management
- Avoid vendor lock-in

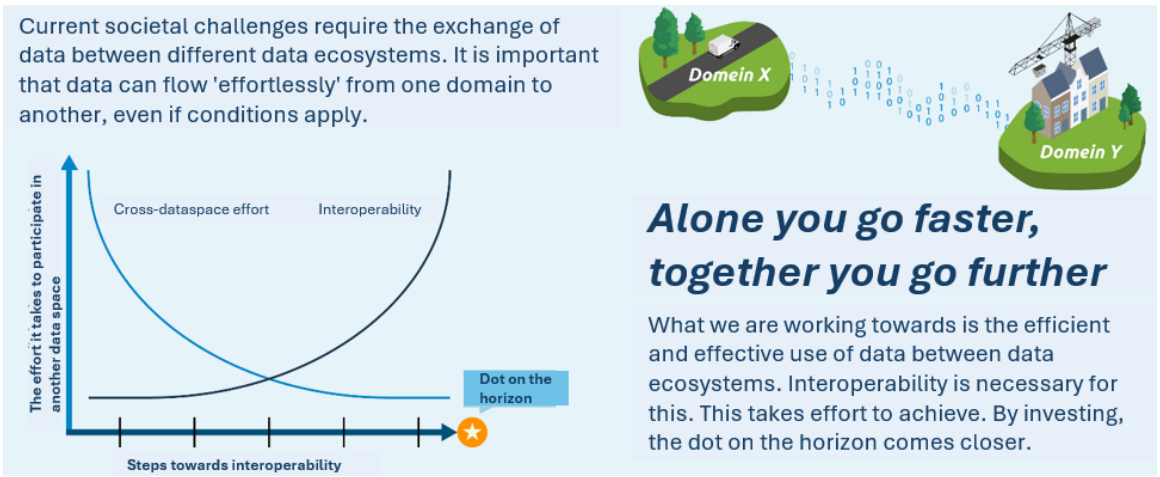
And also from a governance perspective:

- Burden relief if a participant wants to use multiple ecosystems and, for example, 'enrollment' is unambiguous
- With a shared knowledge base, the Netherlands is better able to influence developments in Europe

But the most striking word from the list and the word that is currently mentioned at many tables and is central to many developments is 'Interoperability'.

The Chief Data Officer of IenW also expressed this powerfully in her dream at the beginning of the research:

> Data should be able to flow 'effortlessly' from one domain to another in order to create value for the social challenges.



The graph above translates this dream image. The graph shows on the vertical axis how much effort it takes to be able to participate in another data space (also called: another data ecosystem). Or in other words: how much effort it takes to be able to use data from another domain. If we now position ourselves in time at the beginning of the horizontal axis, then you see that it is now possible to use data from another domain, but you will now have to make (significant) effort for it.

The dream image, the dot on the horizon in the graph, is that over time it will take (much) less effort to use data from another domain: the 'cross-dataspace effort' decreases and interoperability increases. However, that dream image does not come closer by itself. Steps will have to be taken to achieve this. The dashes on the horizontal axis represent these steps and the scenarios in Chapter 7 provide input.

Cross-dataspace exchange will never be completely effortless, but that's for a reason. Trusted data sharing is always accompanied by certain permanently necessary actions and is only possible within the authorization conditions. Therefore, the cross-dataspace effort line does not drop to 0 and therefore 'effortlessly' in the notes to the graph is marked in quotation marks.

Cross-dataspace exchange is relevant. The interviews with the 10 data ecosystems alone provided several examples of substantive overlap, such as:

- NTM data is interesting for predictive logistics in BDI/DIL
- Planning is crucial in construction phases (DSGO), logistics (BDI/DIL) plays a major role in this; There is also a logistics side (BDI/DIL) to the theme of 'cleaner and emission-free construction' (DSGO)
- The Key Register Buildings is part of ZoN, where DMI has living in scope
- The digital VTH system programme is based on the Environment and Planning Act and has interfaces and possible overlaps with the DSO and with key register data from ZoN
- Where ZoN often has geo-information about buildings, DSGO (also) contains BIM information (Building Information Modelling) about the same buildings.

The topic of interoperability is also high on the agenda in Europe. For example, on 12 April 2024, the Interoperable Europe Act (focused on cooperation and digital exchange between public authorities for public services) entered into force. This Act builds on previous initiatives, such as the European Interoperable Framework containing the widely used interoperability quadruple:

- Legal interoperability
- Organisational interoperability
- Semantic interoperability
- Technical interoperability

Due to the scope of the assignment, the present report focuses on technical and partly on semantic interoperability.

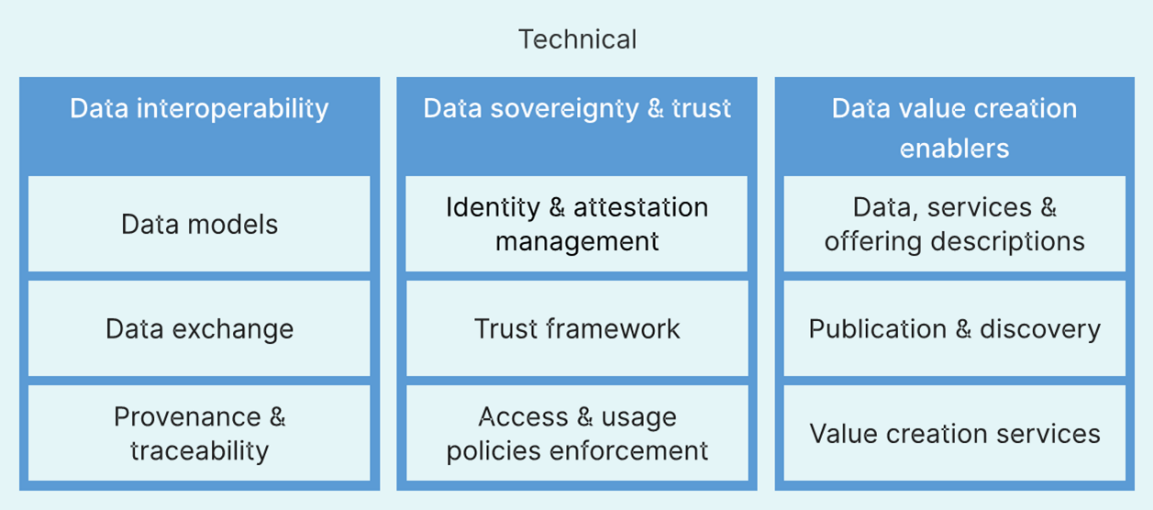
The European Strategy for Data is also very relevant in this context. It operationalises the vision of a European 'single market for data' through the concept of data spaces with a focus on interoperability and standards within and across sectors. One of the pillars of this data strategy is the Data Act, which entered into force on 11 January 2024 and includes Article 33: 'Essential requirements for data interoperability, data sharing mechanisms and services as well as common European data spaces'.

In order to give concrete expression to the interoperability requirements of the Data Act, the European Commission has currently submitted a Standardisation Request to the European standardisation organisations CEN, CENELEC and ETSI and is now taking the first steps in working groups to draw up the necessary standards, including for cross-sectoral interoperability in the field of trusted data sharing. Some of these standards will become mandatory. The European Commission has included in the Standardisation Request that the Blueprint of the Data Spaces Support Center (DSSC, funded under the Digital Europe Programme) should be included as a basis for the standardisation work.

4. Survey – reference to the Annex

In the first plenary session with the architects of the 10 data ecosystems, it was decided to use the Technical Building Blocks from the Blueprint of the Data Spaces Support Center (DSSC) as a 'coat rack' to give substance to the assignment to make an survey of what is already available in terms of components within the various initiatives on a technical and content level.

This Blueprint describes the building blocks needed to set up trusted data sharing. It contains 'business and organisational building blocks' and 'technical building blocks'. Because of the scope of the assignment, this research focused on only the technical building blocks. During the interviews with each of the 10 data ecosystems, it was mapped out for each building block which components (standards, software building blocks, basic facilities) are in use for the data ecosystem in question.



Source: Knowledge-base - Data Spaces Support Centre

In this chapter, the columns from the above Blueprint are explained. The available components in the data ecosystems on these building blocks are described in the appendix.

4.1 Data interoperability

A clear understanding of data is crucial to ensure that data is interpreted and used accurately and consistently. This should be done at both semantic and technical level. Semantic interoperability focuses on the meaning of concepts and the relationships between them. Technical interoperability refers to the syntax. Dataspaces must therefore identify data models and standardize the technical interfaces (APIs) for data exchange. In addition, tracking may be necessary to make the process of data exchange verifiable (origin and traceability).

The appendix describes the available components in the data ecosystems on these building blocks.

4.2 Data sovereignty & trust

In order not only to make open data freely available, but also to 'share data under conditions', it is important that there is trust between participants when interacting and when carrying out data transactions. The Sovereignty and Trust building blocks provide the ability to ensure the reliability and authenticity of participants' information (identity & attestation management), while participants can exercise sovereignty over the data they share (access & usage policies

enforcement). The Trust Framework is intended to ensure that participants adhere to the agreed rules and standards within the data space.

The appendix describes the available components in the data ecosystems on these building blocks.

4.3 Data value creation enablers

One of the ultimate goals of a dataspace is to generate value through data sharing. To achieve this goal, data and services must be found. The Data value creation enablers column from the Blueprint provides the technical tools to make this possible, divided into the following building blocks: describing data, services and offerings (metadata), publishing and being able to find them (catalogues) and value-added services (value creation services).

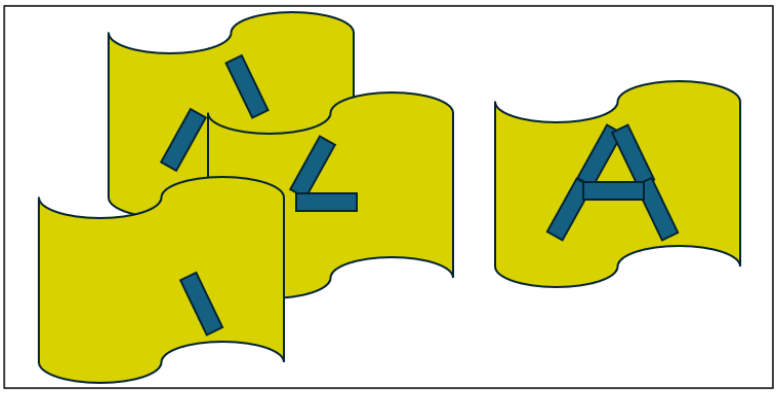
The appendix describes the available components in the data ecosystems on these building blocks.

5. Patterns – what stands out in the analysis

When summarizing the results of the interviews (see the appendix), it was noticeable that data ecosystems did not always cover all building blocks. But looking at all 10 data ecosystems, it did become clear that on every building block, one or more data ecosystems already had an interpretation.

5.1 The 10 data ecosystems together form the contour of an integral and entire data architecture through the eyelashes

Putting the interview results together was reminiscent of a famous comic book in which three separately hidden documents together gave the information to find a treasure.



Illustrative drawing: separate stories brought together give the necessary information

The stories of the 10 data ecosystems were different, in terms of origin, in terms of use cases, in terms of technology, interpretation and interactions. Each strong in itself. But taken together, the power arises. Taken together, they form a contour for an integral and entire data sharing architecture.

5.2 Some are advanced on the Data Plane, some are advanced on the Control Plane, together on the way to value

A clear pattern that emerged was that some data ecosystems are strong and advanced on the data plane (the 1st column from the Blueprint) and others on the Control Plane (the middle column from the Blueprint).

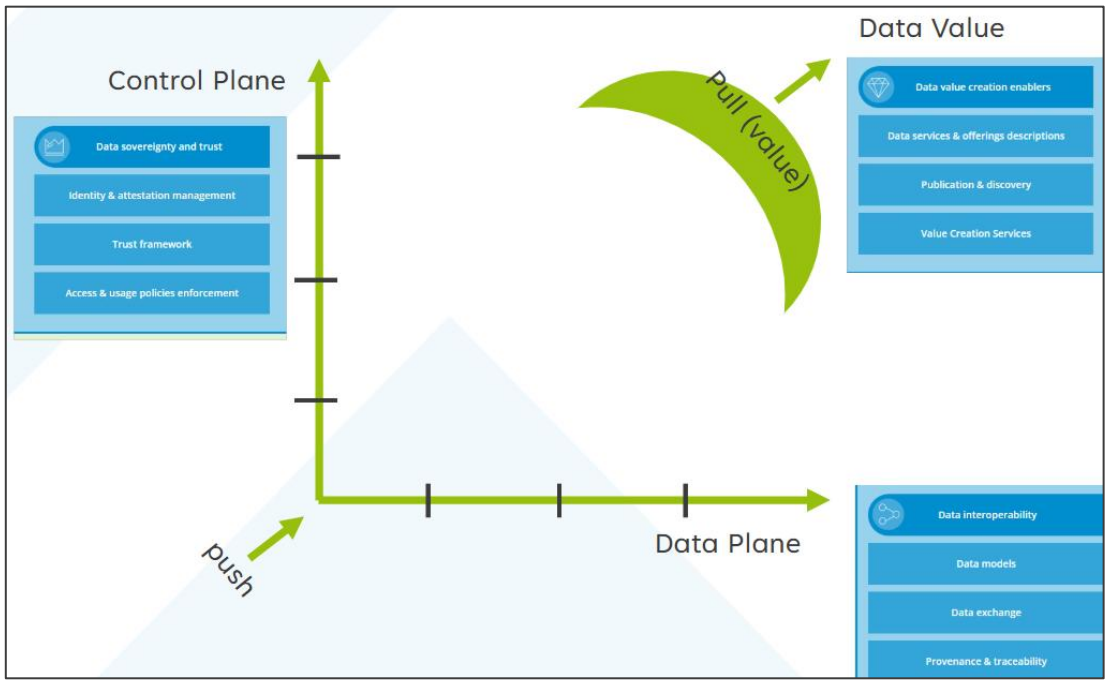
For example, NGII/ZoN has traditionally known many information models and there is a lot of attention for exchange standards and data quality. But because the focus of NGII/ZoN to date has been mainly on open data, the functionalities of the control plane are less developed.

A data ecosystem such as DMI has put a great focus on the Control Plane. With iShare they give substance to data sovereignty and trust. On the data plane, however, DMI does not provide rules for data models, because it concerns so many domains. DMI follows existing standards. If 2 players find each other with an exotic standard, then that's fine within DMI.

These are two examples, and so each of the 10 data ecosystems has its own position in how far advanced they are in the building blocks.

That contemplating drew the picture that parties can clearly help each other. The figure below shows this. When you compare the degree of advancement on the Data Plane and the Control Plane in an axis system, you see that data ecosystems that are advanced on the Data Plane, but less advanced on the Control Plane, have opportunities to create extra value when they 'move' towards the Control Plane. This makes it possible to also create value on the basis of 'closed data'. The ecosystems that are already well advanced on the Control Plane can help them with their experience.

Conversely, you see that data ecosystems that are advanced on the Control Plane, but have (had) little attention for the Data Plane, have opportunities to create extra value when comprehensibility, availability and resilience in the field of data (data models, data exchange standards, quality) are addressed. After all, this promotes mutual reuse and the interchangeability of data. The ecosystems that are advanced on the Data Plane can help them do just that.



In this way, all data ecosystems work towards the top right where the value is central. This is partly motivated by a 'pull': the use cases for which the data ecosystems have been established will call for the movement towards value. In part, this will also be prompted by a push. In the past, we saw this, for example, with the INSPIRE directive that required governments to make environmental information available according to certain standards. In the future, the standards under section 33 of the Data Act (interoperability) may also provide a push.

Best practices and standards help with this movement. Not only does it accelerate, but it also increases interoperability between data ecosystems, helping each other to rise to the top right is part of the scenarios in Chapter 7.

5.3 Different implementations of trusted data sharing

A number of data ecosystems work with iShare as a Trust Framework. This is mainly in the data ecosystems where the government and the private sector work together. Within the government, specifically with the Federative Data System, the FSC standard is especially mentioned when it comes to large-scale, secure and reliable data exchange with identity registration and automated checks based on policy and access rules. Both have their own origins and histories.

In 2024, the Dataspace Protocol was published, which is in the process of becoming an ISO standard. The Dataspace Protocol covers parts of iShare and FSC. This can have a convergent effect. In any case, iShare is known to be involved in the Eclipse Foundation where the further development of the Dataspace Protocol takes place and consultations are already taking place between FSC and iShare, The precise scoping, or interoperability, or (partial) convergence is a topic that could be looked at in further scenarios.

5.4 Different implementations of identity management

Also in the identity management section, we see differences between data ecosystems within the government and data ecosystems in collaboration with the market. Whereas government data ecosystems often rely on centrally issued X509 (PKI.Government certificates), some data ecosystems with private parties are working on Self-sovereign Identities (SSI) which are based on Decentralised Identifiers, Verifiable Credentials and Blockchain technology.

Differences in themselves do not have to be a bottleneck, as long as interoperability is guaranteed. This is also a topic that could be looked at in follow-up scenarios. In any case, the data ecosystems (of both blood groups) indicate that there are challenges when it comes to identities below the organizational level (employee level) and when there are delegations (for example, a subcontractor acting on behalf of a client). See also Chapter 6.

5.5 Convergence in Metadata

In the metadata section, we see convergence. In all data ecosystems, DCAT is seen as the metadata standard to facilitate interoperability between data catalogues published on the Internet and ODRL for capturing the conditions. DCAT enables decentralised publication and access to catalogues (federated search of datasets across multiple catalogues, also known as the 'no-wrong-door principle'). Also in the case of the NGII, for example, where metadata is often still made use of ISO19115 and ISO19119, we see activities to convert / translate this to DCAT.

6. Opportunities for cooperation – generic functionalities

During the second plenary session with the architects of the 10 data ecosystems, an survey was made on which building blocks the most opportunities for collaboration are seen. Different ideas were put forward, but two topics stood head and shoulders above it, with a third being added to the discussion:

A. Data sovereignty & trust: I want to know who you are and what you are allowed to.

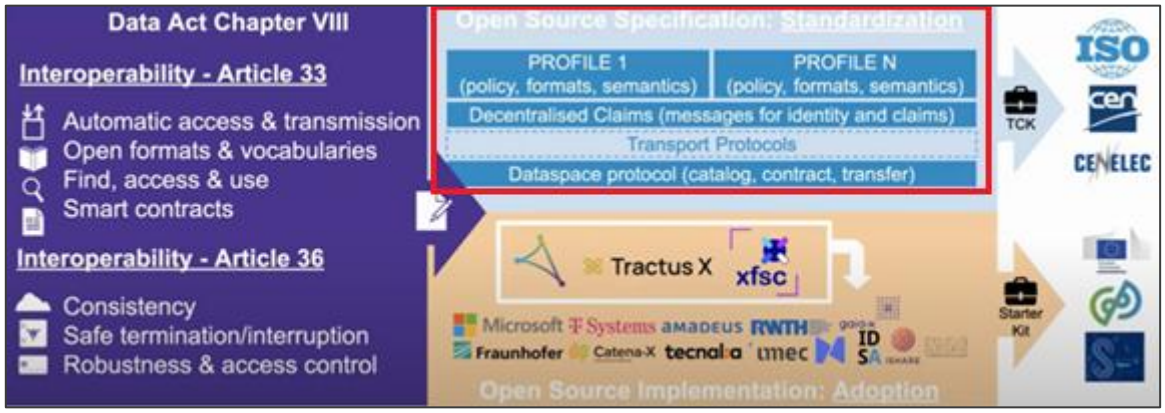
B. Publication & discovery: I want to know and understand what you have to offer.

C. Access & usage policy enforcement: I want to know what I can do with it.

In short, these are generic functionalities of data ecosystems (applicable regardless of the domain or sector of a data space) where it is inconvenient if this is arranged differently per ecosystem.

In several places, this distinction is now made between generic and specific functionality. For example, the European Mobility Data Space (EMDS) talks about an Interlinking Layer in which Discoverability and Data Access are in scope and a Common Carrier Layer with data sovereignty & trust in scope (federated identity registry).

This is in line with the plate of the Eclipse Foundation in which generic protocols are set up with specific profiles on top. Here too (in the red box below) you can see that Catalog (publication & discovery) and Contract (access & usage policy) are dealt with in the generic Dataspace Protocol and Identity and Claims in the generic Decentralised Claims Protocol.



Source: Eclipse Dataspace Community Call 2024

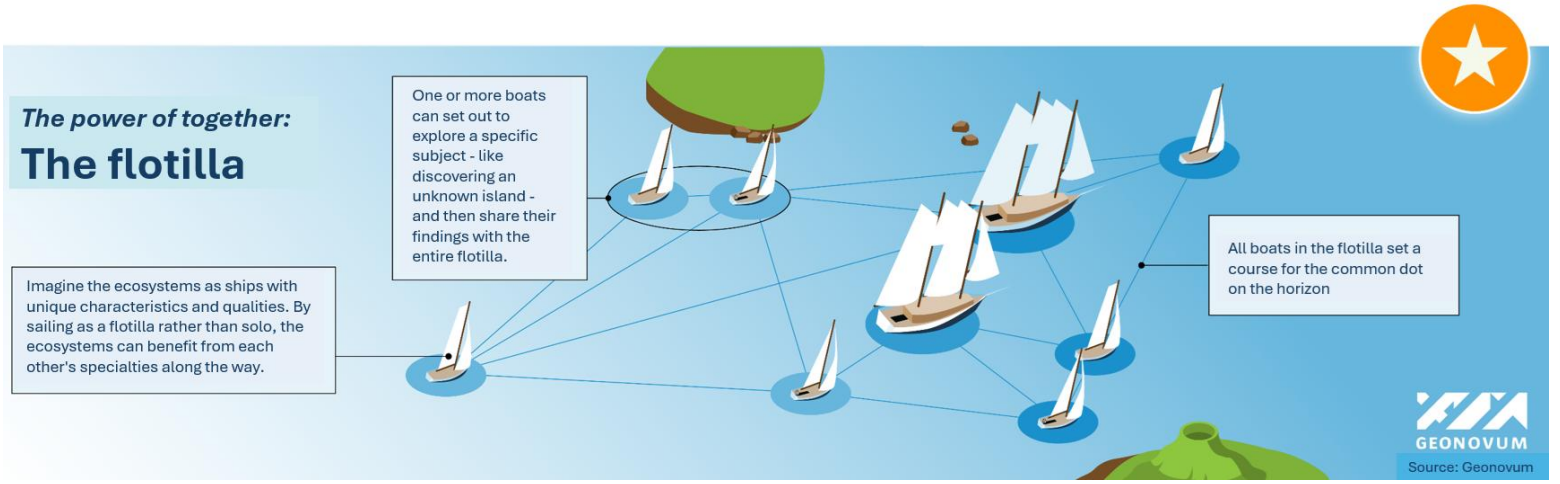
The choice of the aforementioned topics as a start for the interplay between data ecosystems therefore seems to be well in line with international developments.

7. Scenarios – possible routes forward

When the architects of the 10 data ecosystems during the second plenary session discussed the position of each data ecosystem in the axial system 'Control Plane / Data Plane' (see section 5.2), it became clear that the data ecosystems can learn a lot from each other by working together. On each subject, 'providers' of information and 'consumers' of information can be identified.

This gave rise to the image of a 'flotilla': a group of different boats that sail together to 'protect' and 'help' each other. A flotilla is a partnership to jointly achieve a goal: For example, sailing around the Cape. Each ship keeps its own authenticity and independence, but puts its strengths at the disposal of the greater good. And in turn, enjoy the merits of other ships in the fleet. Regular and planned coordination is necessary to continue to see the larger connection and to determine the joint route. This metaphor fits well with the idea of working together with the data ecosystems to capitalise on the opportunities for collaboration and to get closer to the dream of 'effortless' interoperability between the data ecosystems.

Each data ecosystem has its own captain, but they work together (in the fleet) to achieve the 'final goal'. They agree on which data ecosystems (exploratory boats) will investigate certain topics in order to come up with solutions for the entire fleet and, above all, with the following starting point: We must sail forward! Let's do things and make it as easy as possible.



Using the metaphor of the flotilla, we outline five scenarios in this chapter to work together towards the future in the field of architecture. Scenarios 2, 3, 4 and 5 can also coexist in which, for example, subjects are already being worked on in the short term in accordance with Scenario 2 and at the same time activities are being started in order to move towards Scenario 3 and/or 4 and/or 5 in the (medium) long (er) term.

Figure: the five scenarios

7.1 Scenario 1: Do nothing

In this scenario, the flotilla is waiting for wind. No one sets a common course and each data ecosystem continues to invent its own wheel. The idea in this scenario is: Standards for interoperability between data spaces will come from Europe 'by themselves' at some point and service providers will (as always) continue to sell their solutions. Opportunities to influence standards in Europe are not addressed in this scenario and risks of vendor lock-in, by not steering towards interoperability, are not reduced. And should a standard eventually emerge, there is a chance of significant re-work to implement it.

7.2 Scenario 2: 'Opportunistic' cooperation

In this scenario, the flotilla focuses on low-hanging fruit and one or more collaborations are started via cherry picking to take steps towards the dream image. These could be, for example, explorations, or joint sessions to define positions on standardisation proposals from Europe or, for example, testbeds on component interoperability.

For a follow-up process, the topics A, B and C from Chapter 6 would be the first obvious ones to tackle.

7.3 Scenario 3: Focused cooperation

This scenario builds on scenario 2, but with a 'final picture' in mind. The full spectrum of interoperability on the entire interplay of building blocks is translated into a backlog in which necessary explorations, testbeds and implementations are given a place. On an agile working method (because taking into account the latest developments in this field is a must) the flotilla works towards maximum interoperability. This requires a considerable joint effort, but on the one hand brings the dream image closer and on the other hand (given the emphasis on interoperability in the Data Act) can also potentially count on a lot of interest (and therefore influence). The flotilla makes agreements about who plays on which European playing field to increase knowledge, presence and influence.

This scenario (and also scenario 4) requires more than bringing together a number of skilled architects to solve a substantive problem. In the present study, the focus was on the technical-content side and the 'Technical Building Blocks' from the DSSC Blueprint (the blue building blocks on page 7) were the guideline. When working towards scenario 3, governance aspects are crucial.

For a follow-up process, a survey could be carried out with the programme managers of the 10 data ecosystems on the basis of the Business and Organisational Building Blocks of the DSSC Blueprint, working towards a number of scenarios how organisational cooperation with the 10 ecosystems could be designed together.

Source: [Knowledge-base - Data Spaces Support Centre]

7.4 Scenario 4: Interdepartmental cooperation

This scenario can build on both scenarios 2 and 3. The dream of interoperability between data ecosystems in this scenario extends beyond the 10 data ecosystems of this research, also extending to multiple departments. Because presumably the generic functionalities of data ecosystems in those data ecosystems are comparable and interoperability with those data ecosystems would ensure an even greater impact of the dream image.

For this scenario (as described in scenario 3) governance is crucial.

7.5 Scenario 5: Cooperation in a European perspective

In this scenario, the ecosystems work together to translate the vision and impact of Europe as well as possible into implementations and vice versa to influence Europe as well as possible with the knowledge of the implementations. The ecosystems make a survey which European tables the Netherlands is represented at and by whom and the Dutch message there is coordinated. The ecosystems also work together to monitor new developments from Europe, to translate them into implementations and to define and introduce Dutch positions.

For this scenario (as for scenarios 3 and 4) governance is crucial. A first step could be to map out the European tables and the Dutch representation on them.

Annex – the survey of the architecture of 10 data ecosystems

Reading guide

This overview does not aim to fully describe the data ecosystems, therefor the reader is referred to the websites and architectures of the data ecosystems themselves. This overview is intended as a 'dry survey' (based on the Technical Building Blocks from the Blueprint of the Data Space Support Center) to feed the further analysis at interfaces between the data ecosystems (in the main report). For each building block, the relevant information that was retrieved during the investigation is described. By compiling the information per building block in tabular form and highlighting the mentioned components and standards, insight is provided into the degree of variation or overlap of the current state of affairs. The in-depth interviews with each of the data ecosystems to retrieve the information for this survey took place in the period November 2024 to January 2025. The survey can therefore be seen as a 'photo' from that period.

It can be seen that some areas in the table remain empty. That is correct and not bad, the ecosystems are at different stages of development and the focus of the ecosystems also means that some building blocks have been developed further than others (and that some building blocks have not been touched either). Also, the filling of the areas in the table will sometimes seem somewhat unbalanced, for some areas more information came up during the study, than with other areas . This is also a given, given the speed of the investigation and this also does not stand in the way of the purpose of the investigation. The overview provides a broad source of information that provides the basis for the analysis and further conversation about the interfaces between the data ecosystems.

O. Domain, origin (year) and purpose of ecosystems

1. DMI (Link: DMI ecosystem) *Desk research:* **Dutch Metropolitan Innovations (DMI)** wants to establish a digital link between **mobility, space and sustainability,** so that both the available space, the mobility system and the energy network can be used better and cities are more resilient to the consequences of climate change. To make this data between governments and companies, findable, usable and interchangeable, an ecosystem with technology and rules of the game is needed, in which it is clear how parties deal with each other and with each other's data. So clear rules in practice for data use, privacy, security and reuse. The DMI ecosystem is a collaboration between the business community, knowledge institutes, municipalities, provinces and the ministries of Infrastructure and Water Management (IenW) and Housing and Spatial Planning (VRO). The initiative started in June **2021** and in 2023 the programme received co-financing from the NGF, which runs until October **2028.** The DMI ecosystem then continues, financed by each participant's own contribution.	2. BDI/DIL *Desk research:* The **Basic Data Infrastructure (BDI)** is an agreement system and is about the controlled sharing of data with each other, who has access to this data and Conditions for that access to the data. The **Digital Infrastructure Logistics (DIL)** programme investigates and encourages the smarter use of data exchange in freight transport. For this purpose, the Basic Data Infrastructure (BDI) is used. The DIL programme will run from **2023 to 2027.** An important characteristic of the logistics sector is that data exchange is often event-driven and very short-cyclical. Logistics runs on SMEs and it is a hard market with few margins, which means that transport companies do not automatically have money and attention for innovations for the long (er) term. But the pressure on digitization is increasing due to challenges such as CO2, staff shortages and more traffic jams, which can only be solved in the chain.	3. DSM/NTM *Desk research:* In **2023,** the Minister of Infrastructure and Water Management informed the House of Representatives that in the coming years he will work with involved parties on a **Digital Mobility Data System (DSM)** with the objectives that: • the traveller can travel faster, more sustainably and more safely from A to B • optimal use can be made of the mobility system • we keep a grip on our traffic management • Multimodal travel is made easier. The DSM must ensure an orderly and coherent system of national and local digital facilities, standards, data, data sources and agreements on (use of) mobility data. The **National Access Point Mobility Data (NTM)** plays a facilitating role in this, both in facilitating structural cooperation between the various authorities and in facilitating cooperation between the government and the market in order to arrive at good travel, route and policy information. Both fulfil European obligations; DSM ensures the implementation of the European ITS directive in the Netherlands, NTM helps with this.
4. DSGO (Link: www.digigo.nu) *Interview:* The **Digital System of Data Sharing in the Built Environment (DSGO)** is aimed at the **Built Environment sector**. From infrastructure to housing and utilities. The scope is broad, including bridges, office buildings and rails. Rijkswaterstaat, Rijksvastgoedbedrijf, Bouwend Nederland and Techniek Nederland are important stakeholders. *Desk research:* In order to realise the DSGO, the DSGO programme ran from **2022-2024** and, as of July **2024,** the DSGO was taken into management by the digiGO foundation: the network of and for professionals in the design, construction and engineering sector. In October 2024, 39 parties signed the Administrative Agreement on the Digital Built Environment with 21 policy measures to work together more and better digitally.	5. VTH *Desk research:* in **March 2021,** the van Aartsen Committee presented a report concluding that the **Digital Environment System of Permit Referral, Supervision and Enforcement (VTH)** is not functioning properly (too much fragmentation and non-committal). In **June 2022,** the programme plan InterAdministrative Programme Strengthening VTH system was adopted. The participating parties are IPO, VNG, Omgevingsdienst NL, IenW, BZK and JenV. This programme had a duration of 2 years (2022-2024). Pillar 3 was about the information provision VTH. As of **October 2024,** pillar 3 has been converted to IenW: the Digital Environment System VTH programme. This is a temporary programme organisation under the responsibility of IenW with the task of strengthening	6. FDS *Interview:* **The Federated Data Space (FDS)** wants to be a connecting factor: on the one hand, **ensuring interoperability between systems** (standards); on the other hand, focus on **making data available for use between public authorities:** the system of key registers with a ring around it (organisational aspects), for example, some 200 sector registrations have been appointed by law, ambition to publish at least that the registrations are there and to get started with the first 10 high potentials. *Desk research:* The FDS was mentioned in the letter to the House of Representatives on the Inter-administrative Data Strategy that was sent to the House of Representatives in November **2021.** In **2023,** the basic concept of the FDS was put in place. The FDS is a trust framework with agreements, standards, facilities and system functions to make the best possible use of the

DSGO forms the appointment system to which you can join and in which participants can exchange trusted and controlled data. There are facilities such as an authorisation register, an authentication service and a system catalogue as a role described in the appointment system. The Digigo Foundation provides the DSGO-related facilities participant register, conformance test tool and developer portal. Other services will come out of the market. The original objective was to **reduce emissions from construction. Asset management** is also a major driver.	the provision of information in the VTH system and of directing the realisation and implementation together with all the system parties involved. In addition, the programme plan is currently being written in which the programme assignment and scope from the steering committee are included. *Interview:* in addition to data exchange between **governments,** there are also **companies** that need to share information (e.g. in the context of the LAVS – National Asbestos Tracking System).	data potential of the **Dutch government** for **social issues and (proactive) services.**
7. NGII/ZoN *Desk research:* **View of the Netherlands (ZoN)** is the multi-year policy vision 'Working together data-driven on the **Physical Environment '**from **2024** of the **Council for Geo-information**. The Council for Geo-information consists of the parties BZK/VRO, IenW, EZK, LNV, Defensie, VNG, IPO, UvW, Rijkswaterstaat, RIVM, Kadaster, TNO, Geonovum, NSO and CBS. After the island state of Malta, the Netherlands is by far the most densely populated country in Europe with a population and economy that is still growing. Every square centimetre therefore already has a destination and at the same time new tasks require more space. The **spatial puzzle** is enormously complex in terms of content and administration. The aim is to address this complexity in a data-driven way: Decide on the basis of information. This movement doesn't start at zero. The current **National Geo Information Infrastructure (NGII)** has been operational for years and is widely used. The NGII includes the basic geo-registrations facilities such as Public Services on the Map (PDOK) and agreements and standards that are regulated by law in a number of cases. To get a feel for history: The BAG (Key Register of Addresses and Buildings) Act entered into force in **2009,** PDOK has been in existence since **2013** and the geostandards have been on the list of open standards of the Standardisation Forum since **2014.** Further development and expansion of the NGII remains essential as described in 'View of the Netherlands'. *Interview:* In addition to open government data, ZoN also looks at closed data and data from private parties.	8. DSO *Interview:* the **Digital System Environment and Planning Act (DSO)** is actually a dataspace for regulation *Desk research:* The Digital System Environment and Planning Act (DSO) supports the implementation of the Environment and Planning Act. The DSO offers the Digital Single Counter (Omgevingsloket) where initiators, governments and stakeholders can quickly see **what is allowed in the physical living environment**. Developments of the DSO started around **2014**, but since the Environmental and Planning Act entered into force on 1 January **2024,** the DSO is also in force and replaces the applications Omgevingsloket online (OLO), Activititeiten Internet Module (AIM) and Spatial Plans (ruimtelijkeplannen.nl) The **Ministry of Housing and Spatial Planning (VRO)** is responsible for the strategic management of the Digital System Environment Act. The **Cadastre** is responsible for tactical management. The development partners (**Kadaster**, **RIVM, Rijkswaterstaat, Geonovum, KOOP, KING and BIJ12**) are responsible for operational management. Users of the DSO are initiators (**citizens and businesses**) and competent authorities (**municipalities, provinces and central government**).	9. EMDS *Interview*: The European Commission introduced the Common European Data Spaces in the 2020 Data Strategy. The **European Mobility Data Space (EMDS)** is one of them with the following areas of application: • Personal Mobility • Logistics • Cooperative, connected and automated mobility (CCAM) *Desk research:* EMDS aims to provide a common technical and governance framework to enable interoperability and remove barriers to **data access and sharing in the mobility and transport sectors.** A Coordination and Support Action (CSA) was carried out in **2022-2023** to explore how the building blocks of a mobility data space could be put in place. In November **2023,** the European Commission issued a formal communication on the implementation of the EMDS. This already mentioned the **Interlinking Layer** because it was recognized that in the mobility domain there were already so many initiatives (the number 271 was mentioned as operational data sharing environments as inventoried by the EMDS CSA) that connecting is more important than new initiatives. The preparatory study of the EMDS Interlinking Layer in 2024 focused on 'discoverability and data access'. Trust and sovereignty are not addressed in this. These are even more complex, which TNO has written a discussion paper about: the **Common Carrier Layer**. The ongoing EU deployEMDS project (2023-2026) will further shape the testing and definition of aspects of future architecture for EMDS. In the architecture, the **IDSA Dataspace Protocol** is used and the **Eclipse Data Connector (EDC)** is chosen , First working data spaces (under the EU strategy of DGMOVE) must be realized by the end of 2025. The **EDIC Mobility and Logistics** in formation (facilitated by IenW) focuses on the realization of standards in cross-border data-sharing processes. Interoperability between data spaces in Europe. There is no such instrument at the moment, which is why standardisation processes are not making real progress at the moment.
10. DITM *Interview:* DITM stands for 'Digital Infrastructure for **Future-proof Mobility'.** It is a four-year programme **(2022-2026)** drawn by IenW. Within the project, TNO is working with partner companies on the implementation of the digital infrastructure for **automated transport to make mobility more efficient and safer.** One of the work packages within DITM is the realization of the digital infrastructure. TNO, with a number of parties such as TomTom, Monotch, VTRON and Siemens, looks at what you can achieve with a complete dataspace implementation (what is the added value).		

There are 4 use cases, two are (digital) infrastructure oriented and 2 are vehicle oriented. The infrastructure-oriented use cases are:

- ISA (Intelligent Speed Assist)
- GLOSA (green light optimal speed assist)

For this purpose, data from traffic lights, static and dynamic maximum speeds (matrix signs) and (HD) maps are exchanged with vehicles.

A. Data Interoperability

A1. Data models
DSSC describes the scope and goals of the Data Models building block as (freely translated):

'Data models ensure that data is interpreted accurately and consistently when it is exchanged. The data model consists of metadata that provides information about semantics, which helps to interpret the actual data exchanged. Such models are relevant when two parties want to exchange data. When the same data model is used, semantic interoperability becomes possible and data can be exchanged seamlessly.

Data models are like dictionaries that help parties speak the same language when exchanging data. Just like in the real world, each party works with a different world view, so data models are important for data exchange. This requires a balance between the need for strict uniformity to keep data consistent and easy to understand, and the need to take into account that different organisations have different requirements for their data.'

1. DMI	2. FDI/DIL	3. DSM/NTM
Miro: DCAT & ODPS (already available) *Interview:* DMI does **not regulate data models** as it covers so many domains. DMI follows existing standards. The ecosystem is open to a diversity of players, domains and interests. If two players find each other with an exotic standard, that's fine. It's about the flow of data. It is possible that parties within DMI make agreements together.	*Miro:* OTM (already available), DCSA (already available), LEO (to be built), standard trip data (to be built) *Desk research:* The LEO **(Logistics Event Ontology)** lightweight BDI format aims to bridge existing standards in logistics data sharing, such as **OTM, FEDeRATED, OneRecord, DCSA, GS1, UN/CEFACT, EDIFACT and many others.** It is not the intention to fully map all the details of all standards on one model. Instead, the LEO format distills the minimum data needed to track goods through the supply chain based on the ultimate cargo owner (BCO) perspective. LEO is now based on GS-1's OpenEPCIS as a generic basic format for exchanging events via open standards. There are several publications available about this LEO standard. Events are almost not yet included in data models, this concerns data such as: • Transport: arrival, departure, ETA, planned • Cargo: loading, unloading, pick-up, gate-in • Trade: booking	*Miro:* standardization of data formats within Europe via NAPCORE, such as DATEX II, or point at which agreements are made, is being considered (already available); Consultation on METR/DATEX/TN-ITS etc (already available) *Interview:* The NTM is grown from NDW. The goal was an independent post for publishing data from 7 official data nodes (including DOVA, MOVE, Portbase, NDW, RDW). Publish these nodes to NTM: NTM is the National Access Point for mobility data. The data stays with the source (federated). **Datex2** = information model with semantics, but no obligation on the encoding (e.g. XML) The disadvantage of standardization is that if it does not fit, parties go their own way. Solutions could also talk to each other via an adapter. These are also called knowledge models, where the adaptor consists of data ingestion and transformation based on knowledge (logic). In order to increase semantic interoperability, Geonovum has been commissioned by DSM to develop a conceptual model (MIM layer 1) and a conceptual information model (MIM layer 2) of (the data in) the ITS directive, which must be connected to (or preferably reused from) existing models in this field.
4. DSGO *Interview:* The domain is large, there is a lot of data. The DSGO itself does not contain data models and data formats. This is in the other parts of the digiGO cluster digital ecosystems, namely GEBORA (the Built Environment Reference Architecture) and preferred standards. The DSGO may refer to standards for specific agreements. *Desk research:* On the digiGO site, **many existing standards are listed,** managed by various organizations. For example, the DICO standard for the electronic exchange of information between manufacturers, wholesalers, construction, maintenance and installation companies and housing	5. VTH *Miro:* Conceptual information model VTH physical living environment (to be developed) *Interview:* there is no digital VTH system, there are no standards. The **conceptual information model VTH Physical Environment is now being developed.** This creates the generic top layer above the existing standards and connects the existing standards to it.	6. FDS *Miro:* Models ⫽ federatief.datastelsel.nl (to be built) *Interview:* Data processing log, MIM, SKOS, OWL. The standards of the Forum Standardization (PTOLU) are followed. What could come is a (voluntary) headline on the standards. *Desk research:* In order to make the most of the potential of data, the meaning and interdependence of data elements must be clear. It is therefore crucial that the data model of FDS supply is transparent to (potential) customers.

corporations or, for example, BRICK, the semantic standard for description of building components or BIM (Building Information Modelling) and many more standards. *Interview:* A conceptual information model is included in the GEBORA. This also takes into account Digital Product Passports and Building Passports. *Desk research:* The **conceptual information model** describes the information that is created, stored, shared and used throughout the life cycle in the value streams and processes. This is done by defining the key business objects and describing the relationships and key attributes of these business objects. It is also based on existing standards. *Interview:* there are certainly also challenges in the field of data models and data formats, such as the relationship between CityGML and iFC.	*Desk research:* The standards associated with the conceptual information model VTH Physical Environment include: • the new information model in the context of Environmentally Harmful Activities (MBA) • Existing Information Model Applications and Notifications (IMAM) • Existing External Security Information Model (IMEV) • A project of a province: IMAADV (Information Model Always Up-to-date Digital Permit) and • The Conceptual Information Model Environment Act (CIMOW) There is room for other information models to be included later. The programme also foresees a 'Same Language' project. In this project, information standards are also developed for subdomains. Think, for example, of a data-based permit, risk-oriented working, supervision, etc. In June 2024, Geonovum conducted a study on the conceptual information model VTH Physical Environment. It recommended following the **MIM**guidelines, translating the models into **Linked Data**, publishing concepts such as **SKOS**, following the **management and development model for open standards (BOMOS)** and having the model formally recognised as an open standard (**Forum Standardisation**).	Information models can be divided into a number of levels of consideration, for example, there is a distinction between: • A model of concepts: a conceptual framework within which concepts of meaning and interdependence are provided. A conceptual framework is expressed using the **standard NL-SBB** based on the international standard **SKOS** • a conceptual information model and a logical information or data model. The conceptual information model describes that reality as faithfully as possible and is formulated in natural language (the 'what'). The logical information or data model describes how concepts are used in the interaction between systems and their users and between systems. In contrast to a conceptual model, this is much more about the 'how'. The standard **MIM** offers tools to give substance to this. The models can be expressed using 'classic' modelling techniques such as **UML and ERD**. However, there is great potential in the concept of linked data. This fulfills the need in which interconnectedness is incorporated into the basis. With linked data, the conceptual information model and the logical information model merge into each other. Linked data has the following complementary standards for the design of information models: **RDF, RDFS, OWL and SHACL.** UML and ERD on the one hand and the set of linked data standards on the other hand are not easy to convert to each other. That makes it a challenge within FDS to connect models expressed in UML or ERD with each other or with linked data models. • physical or technical data or data model: The final data exchange takes place via an API. The data model used by the API is the technical data or data model. For REST APIs, this is expressed using the **Open API Specification**. If the REST API exchanges data in the form of **JSON-LD**, this can be directly linked to an information model expressed in linked data. Other forms of linkage, for example to a model expressed in UML, require further research and/or standardisation.
7. NGII/ZoN *Interview:* Part of Zicht op Nederland is the geo-data foundation that consists of the geo-basic registrations on which sector data can connect. The **URI strategy** is very important for this. *Desk research:* NEN 3610 is the **basic model for geo-information models**. Information models, also known as data specifications, specify the content of datasets or data services. NEN 3610 provides rules for the unambiguous description, exchange of geo-information within the geo-information infrastructure. NEN 3610 is the basis from which **various sectoral information models** have been elaborated. For example, there are models for the application domains water (IMWA), public space (IMBOR, IMSW), environment (IMSound, IMAER), nature management (IMNA), traffic and transport (IMWV,) cables and pipes (IMKL) and public order and safety (IMOOV, IMDBK, IMEV). Some national basic registrations are also part of the NEN 3610 family, such as the basic registrations addresses and buildings (BAG/IMBAG), large-scale topography (BGT/IMGEO), topography (BRT/IMTOP), cadastral parcels, (BRK/IMKAD) and subsoil (BRO/IMBRO).	8. DSO *Miro:* MIM, CIM-OW, CIM-OP, STOP, STEM, STTR (all in use) *Interview:* The DSO has several information models drawn up under the **MIM:** • Conceptual information model Environment Act (CIMOW). This is the model with which the (geographical) objects are tracked (the status/impact of the decision-making on an object) • STOP/TPOD and IMOP (standard and information model for the preparation and publication of official government publications and application profile for environmental documents) • STAM and IMAM (standard and information model for receiving requests and notifications from the environmental counter • STTR and IMTR (standard and information model for creating and delivering applicable rules in the Omgevingsloket)	9. EMDS *Interview:* there are **endless data models**. Harmonisation on data models is not expected. The idea is: Live with the differences and make the **transformations** as easy as possible. The **Vocabulary Hub** mentioned by IDSA and DSSC can help with this. If there is a good use case, then parties will ensure that they understand each other. It is also expected that in the short term AI will be able to bridge the differences between data models (the 'translation'). The **Open Trip Model (OTM)** is a successful data model from the sector.

Information models publish their concepts in registers. Registers are accessed via the web. The **NEN3610 concept library** is an example of this. The Information Modelling Metamodel (MIM) is a standard that describes the metamodel by which information models – including for non-geo-information – are created. Geo-standards are offered in the Forum standardization (apply-explain-out list): • The geo-standards framework shall designate the current geo-standards for **data (information models), metadata**, **APIs**, **exchange formats , coordinate reference schemes**; • Process agreements on standardisation are laid down in **BOMOS** and management documentation;		
10. DITM *Interview:* DITM reuses what is available in terms of data models. No new data models are being developed in the DITM context. The sector has data models such as IVI (in vehicle information) , SPAT (signle phase and time) and MAP, standards for traffic light data and (dynamic) maximum speed data that are standardized ISO and ETSI. These models are used.		

A2. Data exchange
DSSC describes the scope and goals of the Data exchange building block as (freely translated):

The Data Exchange building block is about the mechanisms for the actual exchange of data between parties. This can involve different types of data exchange, such as data sharing, messaging, streaming, algorithm-to-data, etc. Clear guidelines are essential for data exchange protocols to ensure accurate communication and overcome technical interoperability barriers. Application Program Interfaces (APIs) must be defined (linked to a data model) and a choice must be made for the corresponding transmission method (e.g. SOAP, Event Streams (such as MQTT), Apache AVRO, Thrift, Protocol Buffers, etc).

1. DMI *Miro:* building block is already available *Interview:* DMI strives for federated data sharing.	2. FDI/DIL *Miro:* EDC (to be built), Zero Trust API (already available) *Interview:* Some companies are now working on APIs, some are starting cautiously with connectors. However, small businesses do not yet know about APIs. *The* **EDC** shall be used for the control plane part of the exchange: Eclipse Dataspace Components. It is a framework: Components must match the use case you have. Only apply what you need. The data exchange also works with **edge-agreements:** For example, extracting only the unloading and loading moment from the data surrounding a logistics chain, and not all other sensitive information. There is now a control plane construction based on iSHARE. In addition to direct API links in the data plane, event brokers are now also supported for the exchange of logistics events. There are several publications available on low-impact links such as with webhooks and websockets.	3. DSM/NTM *Miro:* C-ROADS (both content and exchange, in conversation with DATEX (already available) *Interview:* NTM now officially does not perform any dataspace activities. They refer to parties that have the data and refer to point-to-point agreements that may be necessary. NTM is orienting itself on what role they should play in this. *Interview:* The use of Linked Data is low, DSM is not heading for a technological push, but want to tackle it if the business demands it. The ITS directive obliges the Netherlands to make data available, not necessarily to exchange them (especially between source holders). In the demonstrator of CGI the **EDC connector** is used. A new demonstrator will be running in which we want to go through 'smart contracts'. This smart contract follows a digitized work process in order to reach agreements to be able to exchange information between groups of parties later on the basis of these agreements. Within this demonstrator, this concerns the rental and letting of 'open wheels'.
4. DSGO *Desk research:* The system of agreements states that the system generally follows the technical open standards. In the first instance, the DSGO focuses on sharing data based on **REST APIs** according to the **API strategy of the Dutch government**.	5. VTH *Miro:* MBA Register (proposal for temporary provision is being worked out) *Interview:* Part of the current state of affairs is that there are a number of existing applications in which data is shared. Inspection view is an example of this, but also the REV, sound register, LAVS, etc.	6. FDS *Miro:* Dataservices ⅄ federatief.datastelsel.nl (to be built) *Interview:* Open API definitions, REST API, Cloud Events for notifications *Desk research:* the patterns *Questioning* (such as key query, search query or bulk query – for the latter the **Digilink Large Messages Interface Standard** can be used) and *notifying* are the basic exchange patterns within FDS.

<table>
<tr>
<td>The specified APIs enable standardised interaction between the systems of different parties. The following generic standards are used: <u>APIs, Restful, HTTP(s), TLS, PKI, OAuth 2.0, JSON, JWT and UNIX timestamps</u>

<u>Notifications</u> are something extra on top of iSHARE: Subscribe to events. This is done via webhooks subscription to the data service.</td>
<td>It has not yet been determined which existing applications are formally part of the system.

In addition, a data exchange mechanism is indeed provided in the system architecture. It has not yet been worked out in detail and determined how we want to do this. We have ideas for this and would also like to learn from other initiatives.</td>
<td>Questioning can take place via the <u>WUS Profile of Digikoppeling</u>. However, <u>the REST profile</u> is more modern and therefore more future-proof. REST-API <u>Design Rules</u> are available for this profile. The structure of a REST API is described via an <u>Open API Specification.</u>

Notification is about proactively notifying a user of events. A provider sends notifications from a ‘subscription’ that indicates for which types of events and for which population a customer wishes to receive notifications. The standard <u>NL GOV Profile for Cloudevents</u> is suitable for this.

A variant of notification is delivery. Upon delivery, messages are often provided with the (modified) data itself. However, this results in a copy of the source that may have become obsolete at the time of processing. It is therefore more straightforward to use the notification only as a ‘trigger’ of a processing process, and to retrieve the up-to-date data required for the processing by means of a search. If it is delivered, the standard <u>ebMS is included in Digilevering.</u></td>
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<td>7. NGII/ZoN

Desk research: the framework of geo-standards includes (among others) the categories:
- '<u>Geo-standards for Application Programming Interfaces (APIs)'</u>with standards for
Retrieving webmaps
Querying (downloading) vector data
Retrieving (downloading) raster data
Retrieving (downloading) sensor data
Querying metadata catalogs
Retrieving map tiles
Linked data
and
- ‘Geo<u>standards’ for exchange formats ’</u>with exchange standards for
Vector data
Raster data
Sensor data
3D data</td>
<td>8. DSO

Miro: API strategy (in use); URI strategy (in use)

Interview: The API and the URI strategy are of great importance.

Desk research: The Digital Environment Act (DSO) is being developed as an open system. All functionalities and data of the counter are offered as services (API). The services must be accessible enough to appeal to a broad development community. That is why there is an API and URI strategy.

The <u>API strategy</u> describes how the APIs are offered in an open and robust way. URIs provide a mechanism to refer to sources wherever they are located. The <u>URI strategy</u> makes all information of the digital system findable and accessible in a uniform and coherent way.</td>
<td>9. EMDS

Interview: the technical specifications of the Deploy-EMDS will address this issue.</td>
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<tr>
<td colspan="3">10. DITM

Interview: DITM applies IDSA's<u>Dataspace Protocol.</u> There is direct communication between vehicles (short range) and roadside equipment, but most communication currently goes ‘upstream’, which can be done via <u>C-Roads interchange</u> (C-Roads is a joint initiative of European Member States and road operators for testing and implementing C-ITS services in light of cross-border harmonisation and interoperability, the interchange a specified way to exchange IP-based information) and/or via the dataspace. DITM has implementations of both. DITM uses the <u>Eclipse Dataspace Components (EDC) framework</u> for the data space. With the ISA use case (intelligent speed assist), the data exchange is described via <u>APIs</u> with the <u>Open API Specification.</u> The GLOSA (green light optimal speed assist) is exchanged with a <u>message bus (pub-sub) based on AMQP 1.0</u>.</td>
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A3. Provenance & traceability
DSSC describes the scope and goals of the Provenance & traceability building block as (freely translated):

Some use cases require additional data (metadata) about the actual data shared for auditing and compliance. It may then be necessary to be able to check the transactions that take place or to know who has had access to certain data. The backward direction of a data value chain is called 'provenance tracking'. This means that a user can receive evidence about the origin of the data and the treatment of the data during the processing in the value chain. The forward-looking direction of a data value chain is called traceability. This means that a data provider can receive evidence of what has been done with the data. These provenance and traceability requirements are typically found in highly regulated industries or in cases involving high-value data.

1. DMI *Miro:* This building block is being built. *Interview:* the functionality of **'logging'** (notary) is provided, but is at an early stage. Because DMI has several marketplaces and a single governance layer (AMS-IX), the responsible bringing together and unlocking of the logging data in a central point requires explicit attention. And the question is: which data must be recorded and made available precisely for the benefit of whom. And is the logging on the data layer pushed through to the control plane or is there another mechanism.	2. FDI/DIL *Miro:* Event Choreography + JWT's (to be built) *Desk research:* The FDI provides irrefutability throughout the supply chain through a Chain of Trust based on Embedded **JWTs** combined with **VCs** to create a powerful mechanism for secure, flexible and privacy-protective information exchange based on known technology. There are two publications describing how JWTs can provide easily accessible tracebility and guaranteed provenance via signed tokens.	3. DSM/NTM *Miro:* Data quality requirements from NAPCORE (already available) *Interview:* there is no login to view the catalog. Everything's open. Usage is not logged. There is machine-to-machine exchange, but many datasets can also be downloaded 'normally' via the NTM portal.
4. DSGO	5. VTH	6. FDS *Miro:* Traceability federatief.datastelsel.nl (to be built) *Interview:* Standard data processing log *Desk research:* A standard for traceability (focused on provenance) is the **PROV** family of standards. Data necessary for traceability are, among other things, recorded in logbooks. Available standards for these logs are **FSC logging as a transaction log** and **Standard log data processing.**
7. NGII/ZoN	8. DSO *Miro:* node with logging (in use)	9. EMDS *Interview:* It is not known whether the Deploy-EMDS will address this issue.
10. DITM *Miro:* capabilities of data spaces combined with PKI possibilities (to be built) *Interview:* DITM has not yet set up any specific cases in this area, in terms of dataspace mechanisms. DITM looks at and compares generic capabilities of dataspace with the C-ITS domain specific capabilities. On content (in the messages) you can see where it comes from, but this is not logged / tracked. We are working on PKI at message level, this is already in the C-ITS standards. In addition, the Trust building block also provides part of the ability to rely on provenance. The C-ITS (Cooperative Intelligent Transport Systems) already regulates a lot in the field of Trust (PKI). The Trust Framework should ensure that parties with bad intentions are excluded. If you can set up a transfer, you can actually already trust that it is familiar. It is a combination of Trust & quality. The mechanisms from those worlds are used. Basic Trust & check on the messages (is on the fly). With a dataspace, you should be able to follow the Trust end-to-end. Accountability comes around the corner, for example legal information when driving too fast.		

B. Data sovereignty and trust

B1. Identity & attestation management
DSSC describes the scope and goals of the Identity & attestation building block as (freely translated):

This building block lays the foundation for the following building block: the Trust Framework. This building block 'Identity & attestation management' is about the need to identify parties, together with the services and data products offered. It provides the means to present and exchange information needed to support activities in the data space in a secure, reliable and sovereign manner. This includes, for example, in addition to **the verification of identity**, also the verification of compliance with the agreements in the ecosystem (for example, compliance with the standards). A positive outcome of the compliance checks provides a 'proof of membership of the ecosystem' and provides a basis for Trust. Such an outcome of a compliance check (e.g. on the basis of a Conformity Assessment Scheme) leads to an 'attestation' that is necessary to operate in the ecosystem. The building block describes, among other things:

- described the use of cryprographically safe, privacy-respecting and machine-readable **verifiable credentials for digital attestations**
- the use of **'verifiable and decentralised identities',** allowing secure online interactions (decentralised identities refer to a decentralised system without central registers or 'third party intermediaries')
- solutions to support **self-sovereign exchange of attestations allowing** secure communication with wallets
- And, specifically for identities, how these can be verified using **'qualified Trust Service Providers'** (based on the European Digital Identity Framework Regulation)

1. DMI	2. FDI/DIL	3. DSM/NTM
Miro: iShare (in use) *Interview:* DMI shall have an **authorisation register** and a **participant register**. DMI is based on iShare. iShare, however, is fully focused on organizations, but for DMI it is also necessary to be able to identify individual employees within those organizations. iShare focuses in particular on M2M, with minimal human interaction. However, the marketplaces within DMI also refer to (public) organisations with **procurement mandates for their employees**. To this end, DMI provides a register of roles, in which authorised representatives of each DMI participant can themselves record the mandates of their employees.	*Miro:* iShare inspired (already available) *Interview:* Logistics is a global industry. That makes it a challenge. You don't have much to gain from eIDAS if you work with parties outside Europe. *Desk research:* The Representation Chain is a building block that allows other entities to **verify mandates.** This goes through **JWT's.** There is a demo available that shows how this is set up within the BDI.	*Miro:* NTM = Keycloak (in use) *Interview:* If someone wants to be a publicist in the catalogue: registration form on the website: The content manager approves. This is an analogue process. Underwater: **Key Cloak** implementation, this can also be made available to the outside world. DSM has only 2 years to go, so no eHerkenning/eIDAS has been implemented. For now, content is the most important thing.
4. DSGO	5. VTH	6. FDS
Miro: iShare, unless; Authentication service (already available) *Interview:* DSGO will follow the IAA model of **iSHARE.** DSGO will not supply an **authorisation register** itself, but this will be a supply from the market. This is based on roles and authorisations (delegation)are also kept. *Desk research:* For the identification of organisations, **EORI or Chamber of Commerce numbers** are used in the DSGO. In the DSGO, all communication between the parties takes place between the machines of the parties. Therefore, authentication must take place in the connection between these machines, in order to ensure a degree of certainty of the identity of these machines. One-way (server only) **Transport Layer Security (TLS)** is used within the DSGO to authenticate the identity of data service providers. The DSGO requires the use of QWAC certificates in accordance with EIDAS. Authentication in data services takes place in different ways, depending on, among other things, the type of data service user. For machinery on behalf of a Party: signed with a **QSeal certificate** via an **authentication JWT,** again in accordance with EIDAS.	*Interview:* In the current state of affairs, the Inspection View application does have some Identity and Access Management functionality, but this is not based on verifiable credentials etc. It is more like **Role Based Access Control**. This also applies to other existing point solutions in the system. VTH wants to take the step from point solutions to an application landscape in conjunction where IAM is filled in in a mature way in which, among other things, GDI is used. The (concept) system architecture VTH has included the use of the **GDI** (Generic Digital Infrastructure, e.g. eHerkenning).	*Miro:* Identity federatief.datastelsel.nl (to be built) *Interview:* now: FSC with PKI Government and E-recognition as Trust framework Future: a.o. IDSA is working on Decentralized Identifioer (DID) and Verifiable Credentials (VC), which need a Trust Framework > in the form of Wallets > issuers are needed > that need to be hung in a framework > interesting development for FDS **FDS identifies organisations, not individuals.** Parties with a legal task. A person in government always operates under the responsibility of an administrative body *Desk research:* Identifying characteristics applicable to a participant within the FDS are the Chamber of Commerce number, the RSIN, the OIN and the FDS Participant ID. Other identifying characteristics may be applied in an agreement to identify the participant or a processor designated by the participant, such as a host name, public key thumbprint or a certificate thumbprint. A participant identifies himself within the FDS using an identifier. Potentially applicable identifiers within the FDS when making a connection are a **PKIoverheid Services X.509 certificate with an OIN for TLS** and an **eIDAS QWAC X.509 certificate with an OIN or Chamber of Commerce number**.

		Within the FDS it is possible to exchange data under a digital (delivery) agreement. A digital (supply) agreement indicates who exchanges data within the FDS on behalf of a customer or provider. Possible means of identification for signing digital (delivery) agreements are a **PKIoverheid Services X.509 certificate with an OIN for signing electronic documents** and an **eIDAS Qualified eSeal (QES) X.509 certificate with an OIN or Chamber of Commerce number.**
7. NGII/ZoN	8. DSO *Miro:* GDI (in use); Own permissions component (in use); OAuth2 (in use) *Interview:* In the DSO, Competent Authorities can log in with **eHerkenning.** The Competent Authority is a party within the system, which is relied upon. It is linked to case data of the Competent Authority. The DSO does not know an employee of the competent authority, but the competent authority (e.g. the municipality) ensures that the employee can/cannot be in the case system. The phenomenon of '**authorising**'or '**delegating**'(supposing you are not competent and you authorise someone to apply for a permit on your behalf) was necessary, but is not included in DigiD. Enquiries with the parties did not provide any relief, so DSO built a solution itself (linking BSNs to each other), it was not known whether there were standards for it.	9. EMDS *Interview:* EMDS goes to the standard architecture: V**erifiable Credentials**. What is a point of attention is that when you set up a dataspace, you start with an authority. It issues certificates. And that is where the silo actually starts. It actually requires a different architecture. You want to avoid having to go through an on-boarding process with accompanying legal agreements and certification at different authorities in order to obtain a Verifiable Credential. For mobility and logistics, this is not a desirable and scalable model. The **Common Carrier Layer** addresses this challenge. It is still unclear to what extent it will be accepted and adopted by the EMDS and/or the EDIC. In mobility and logistics, **delegation of** rights is an important phenomenon.
10. DITM *Miro:* Decentralized Claims protocol (already available) *Interview:* **Decentralized Claims Protocal** is used. Standard protocol that is also implemented at EDC. Going deeper than just identity: Attribute based trust is expressed in ODRL policies. Include permissions in the catalogue via DCAT (according to DSP). Through **Verifiable Credentials,** the certificates are awarded. On attributes that can be determined by a party, e.g. membership dataspace, or NDW that says that party may join (NDW then assigns an attribute to that party). In the negotiation phase, this is then checked (exchange credentials).		

B2. Trust framework
DSSC describes the scope and goals of the building block Trust framework as (freely translated):

This building block is about the technical means to verify that participants adhere to a set of policies, procedures and rules established by the governance framework. It plays a crucial role in ensuring data sovereignty, ensuring that each data provider retains control over its data, while promoting transparent processes, implementing robust security measures and promoting interoperability. The building block describes, among other things:

- **Conformity Assessment**: a standardised approach to collect evidence that participants adhere to the agreements made (referring to the European Interoperability Framework)
- Establish a list of **Trust Anchors** (such as Trust Service Providers for Identities) to ensure the authenticity, integrity, and reliability of participants' identities and related claims
- Validation **and verification of claims and attestations** using standards such as W3C Verifiable Credentials

1. DMI	2. FDI/DIL	3. DSM/NTM
Miro: iShare (in use) *Interview:* DMI is based on **iShare:** there is a conceptual model and iShare offers a practical guide on how to apply it.	*Miro:* iShare inspired (already available) *Interview:* Logistics is a global industry. That makes it a challenge. For example, you may suddenly have to deal with a Chinese subcontractor who uses a completely different Trust framework. This is a trust between frameworks. *Desk research:* The BDI builds on an existing innovative agreement system for digital trust for data sharing developed in the Netherlands: iSHARE (Trust Framework for Data Sharing) In addition to iSHARE, research has now also been carried out into other frameworks based on EIDAS, OAUTH and OpenID Connect. We are working on a system whereby identity standards can be used in combination. So that	*Miro:* C-ROADS trust domains (already available)

<table>
<tr><td></td><td>having an identity in one framework automatically leads to rights in another trusted framework.</td><td></td></tr>
<tr><td>4. DSGO

Miro: iShare, unless (already available)

Interview: DSGO uses iShare. Also because it is important to be able to exchange with other systems, for example in logistics that also use iShare.</td><td>5. VTH</td><td>6. FDS

Miro: Security | federative data system.nl (to be built)

Interview: If you are a participant, you are trusted. The ‘participation administrator’ facilitates participation. At the moment, BZK is the only participation administrator. It may designate others in the future (e.g. DUO to allow settings in reverse). There are requirements for the participation administrator (because it checks whether participants meet the requirements).

We chose (mutual) TLS because it is the safest and most secure way of connecting.

It is being worked on that a participant (user) takes responsibility himself (instead of the provider being responsible for everything), this means that not everyone can join.

FDS clearly separates the control plane from the data plane.

Desk research:
This scheme function facilitates the trusted data exchange among participants, thus reassuring participants in a data exchange transaction that those other participants are who they claim to be and that they comply with defined rules/agreements. This can be achieved through organisational measures (e.g. certification or verified references) or technical measures (e.g. remote attestation).

Within the FDS, data is exchanged over a secure connection (such as HTTPS) in which both the provider and the recipient are identified using a reliable identifier (see previous block).

In FSC, both sender and recipient are identified with a digital certificate (mutual TLS). In addition, FSC exchanges take place under a digital contract. This contract includes identifying characteristics of both exchanging parties, for the calling party via a ‘public key thumbprint’ and for the calling party via a ‘hostname’ of the API endpoint.</td></tr>
<tr><td>7. NGII/ZoN</td><td>8. DSO</td><td>9. EMDS

Interview: If the findability is regulated and there is sensitivity: then it is important to agree that the conditions will be validly followed between each other, you do not need a central party (only connector, DSP and qualified signature). That is the philosophy for Trust within the pre-wrought Common Carrier Layer approach. It is still unclear to what extent it will be accepted and adopted by EMDS and/or the EDIC. Legality is thus enforced by means of a legally binding signature (qualified signatures – eIDAS).

An authorization register is also required.</td></tr>
<tr><td colspan="3">10. DITM

Interview: DITM uses the Decentralized Claims Protocol here. On top of that, we experiment with Trust frameworks from the domains themselves (e.g. CTS).</td></tr>
</table>

B3. Access & usage policies enforcement
DSSC describes the scope and goals of the Access & usage policies enforcement building block as:

This building block is about the rules and regulations that determine who has access to the data, how they can obtain the data and what they can do with it. There are two phases: the negotiation and enforcement phases. It enables participants in an ecosystem to define and enforce policies related to the data. This policy is consolidated in machine-readable and executable format, policy negotiation is supported, consent management mechanisms are implemented and policy implementation is enforced. DSSC cites **Open Digital Rights Language (ODRL)** as a good candidate for standardizing the definition of policies and **eXtensible Access Control Markup Language (XACML)** for the operational execution of access policies.

1. DMI *Miro:* AMS-IX (already available) *Interview:* AMS-IX, as a governance layer above the marketplaces where you can find data products and services, offers the certainty that certain checks have been carried out, e.g. someone is a participant, there is good payment behaviour, purpose limitation between application and intended data, compliance with the DMI Agreement Scheme. This is in addition to the marketplaces where access polices can also be added to a data offer. The standard **e-Flint** is used. This is close to ODRL, but not the same, it's pretty domain-specific. AMS-IX works with **XACML**. Enforcement is indeed on the data layer, the token is included in the headers. But it remains a transaction between two parties, DMI does not want to make a decision about that, does not want to impose an obligation.	2. FDI/DIL *Miro:* iShare inspired (already available) *Interview: **ODRL** allows you to create machine readable policies.* BDI uses XACML from the iSHARE framework. ODRL is also used from the dataspace variant.	3. DSM/NTM *Interview:* It is still unclear whether NTM should also take up the functions of contract negotiation.
4. DSGO *Miro:* iShare, unless; authorisation register (already available) *Interview:* DSGO defines **license codes**. The data service provider shall determine the licence applicable to the data involved in the data service and shall record a reference to the licence in the data service specification. This reference refers to an exhaustive list of licenses with different (user) rights that is included in the agreement system. These license codes are based on the iSHARE license codes. *Desk research:* In the agreement system, the subject of authorisation is divided into the preparation of authorisation policy, the preparation of authorisation information and the taking of an authorisation decision. These different authorization aspects are based on the **XACML** standard for (online) access policy. Given XACML, it maps the authorization policy to Policy Administration Point (PAP), maps organizing authorization information to the Policy Information Point (PIP), and taking the authorization decision to Policy Decision Point (PDP). The Policy Enforcement Point (PEP) is implemented in the API.	5. VTH *Interview:* access is now mainly focused on exchanges between governments. However, there are also companies (for example LAVS – National Asbestos Tracking System) that have to upload data.	6. FDS *Miro:* Access federatief.datastelsel.nl (to be built) *Interview*: FSC standard; FDS works on deliveries between public authorities, so no contracts Research on federated access is ongoing: how do we harmonize access rules, for example the authorisation decisions for the BRP work there, but are not standard, see also Project FTV (FederatedAccess Granting Federation.datastelsel.nl). *Desk research:* Access is restricted at different levels: - Determining whether a connection is entered into - Determining whether a data question may be asked - Determining whether information relating to an entity is provided - Determining which data of an entity is provided Implementation of these restrictions can be expressed in, for example, Policies. For the **FSC Standard,** an extension is under development to combine policies with FSC. There are a limited number of standards related to access provision, e.g. **ODRL** and **XACML**. Which standards are suitable in the context of FDS is still the subject of research.
7. NGII/ZoN	8. DSO	9. EMDS

Interview: The **URI strategy** is very important to be able to grant access to attributes.		*Interview:* **ODRL** to make the contracts machine interpretable when exchanged via the Dataspace Protocol
10. DITM *Miro:* dataspace protocol: contract negotiation – Open Digital Rights Language (ODRL) (to be built) *Interview:* the **dataspace protocol (ODRL)** and **the Decentralised Claims Protocol**. This applies until the time of contract, what happens afterwards is not technically checked, which is more legal in nature		

C. Data value creation enablers

C1. Data services & offerings descriptions
DSSC describes the scope and goals of the Data services & offerings descriptions building block as:

An important requirement for any ecosystem is that the dataset(s), the services that enable the use of data and the offers (offers) of data and services must be described comprehensively and accurately. This comprehensive description ensures the interoperability, findability and usability of data and services within the data spaces.

The description of the dataset(s) concerns characteristics such as spatial, temporal and spatial resolution and characteristics related to the distribution of the dataset such as data format, packaging format, compression format, the frequency of updates and the download URL.

The description of the service includes features such as 'endpoint description' and 'endpoint URL'.

The description of the offer (offering) concerns characteristics such as description, provider, creator, price, license, data format, current version, previous versions and access rights.

The building block provides guidelines for describing using standard vocabularies such as the **Data Catalog Vocabulary Version 3 (DCATv3)** and details the guidelines for defining policies with standard technologies, namely the **Open Digital Rights Language (ODRL).**

1. DMI *Miro:* Participants (in use) *Interview*: Within DMI, the participants are responsible for this themselves, but the marketplace providers are expected to support them as part of their services (or take over this task entirely).	2. FDI/DIL The dataspace variant of the BDI uses exactly the same tools and components as **Catena-X (Tractus-X / EDC)**. This includes a central catalog function, data licenses and contract negotiation via ODRL, meta-data discovery and endpoint descriptions. The dataspace variant is one of the implementation variants that is supported.	3. DSM/NTM *Miro:* NTM.ndw.nu - in accordance with metadata Mobility DCAT-AP. Organisations can register as a publicist and make their data services available and describe (in use); FRAME-NEXT architecture (which is being developed in NAPCORE) does a rudimentary start for service offering (already available) *Interview:* NTM currently uses mobilityDCAT-AP. This is an extension to DCAT-AP *version 2.0.1*. This will be upgraded to version 3 next year.
4. DSGO *Miro:* data service specification (already available) *Interview:* ***DCAT***	5. VTH	6. FDS *Miro:* Metadata ⇔ federation.datastelsel.nl (to be built) *Interview*: DCAT has been named as a prominent standard. There is currently no data for which payment has to be made, because it is an exchange between governments. Financing is a question, but that is of an organizational nature. *Desk research:* Within the FDS, metadata such as Linked Data is exchanged. Linked data encompasses a whole family of standards and best practices. In order to effectively apply Linked Data within the FDS, Linked **Data Design Rules** are used within the FDS.

		In the following areas, FDS describes the structure of metadata to be used: - The Participant Liist of the FDS - The Participant Characteristics of the different participants within the FDS - The offer within the FDS **(DCAT)** - The concepts used within the offer (**SKOS** and **NL-SBB**) - The data definition used within a dataset provided (**MIM** or **OWL**) - The quality characteristics of the offer within the FDS (**DQV**) - The data sharing relationships established within the FDS
7. NGII/ZoN *Desk research:* metadata is often recorded in the geo-information sector via **ISO 19115** (geo-datasets) and **ISO 19119** (services). Translations are currently underway to convert this ISO metadata to **DCAT**.	8. DSO *Miro:* Dev Portal with API descr (in use)	9. EMDS *Interview:* ***DCAT***
10. DITM *Interview:* **DCAT** and **ODRL.** No linked data for the data and services themselves.		

C2. Publication & discovery
DSSC describes the scope and goals of the Publication & discovery building block as:

This building block embroiders on the previous building block. This is about the publication and being able to find the descriptions. For providers, this involves managing access to descriptions, publishing the descriptions and keeping the published descriptions up to date. For the user, it is about being able to search through the descriptions and find the most suitable offer.

In an ecosystem you can opt for a central catalog (metadata broker) or a decentralized solution (point-to-point) where (within the policies) each participant can search each catalog of another participant.

The current Catalogue Protocol from the Dataspace Protocol deals with the description of datasets and data services. In addition, it will also be more and more necessary to describe separate services from the next building block (value creation services). This will be addressed in future versions of the DSSC Blueprint.

1. DMI *Miro:* AMS-iX (in use) *Interview:* the marketplace where you can find data products is supervised by a central governance layer (AMS-IX). The combined offer of all marketplaces in the Ecosystem can be found in a Products and Services Catalogue.	2. FDI/DIL *Miro:* Association (already available), DNS (already available) *Interview:* The dataspace variant of the BDI supports these functions: same tools and components as with **Catena-X (Tractus-X / EDC).** This includes a central catalog function, data licenses and contract negotiation via ODRL, meta-data discovery and endpoint descriptions. The dataspace variant is one of the implementation variants that is supported.	3. DSM/NTM *Miro:* NTM = register for discovery (federation). **MobilityDCAT-AP** (in use). *Interview:* NTM is the data intermediary specialized for meta data. NTM can be seen as the metadata broker. Based on federated data: good description, contact person, organization, what licensing conditions. The catalogue was developed on the basis of Java. The catalogue can be searched using the MobilityDCAT API. This also allows you to upload. Available in **SPARQL*** (endpoint on catalog), **JSON-LD** and **RDF-XML**. * This is still being worked on, a rudimentary version is available
4. DSGO *Miro:* System Catalogue Specification (already available); Data services catalogue (to be built) *Interview:* As the first part of a system catalogue, a participant register will be built for DSGO. Perhaps other catalogue functions will be provided by market parties in the future.	5. VTH	6. FDS *Miro:* Publication federatief.datastelsel.nl (to be built) *Desk research:* The FDS offer shall be published in a **catalogue**. There is one official FDS catalogue that makes the entire offer within the FDS available to interested parties. In addition, there may be alternative catalogues that publish (parts of) the FDS offer, such as sectoral and/or international

Desk research: In the **system catalogue** you will find an overview of the available data services and the data service providers (**participant register**). The system catalog consists of both a website where everyone can browse through the catalog, and a machine-readable information that is available as a data service. In the future version, the System Catalogue also contains information on market provisions. *Interview:* The role of the System Catalogue is still in full development. We will start with the participant register and investigate the further implementation of the catalogue function for data service discovery. It is also considered to develop this value added service as a market supply and thus add it as a role to the agreement system.		catalogues that have included the FDS offer as part of a broader (information) offer. A catalogue is not itself the source of the published metadata, but collects the offer from linked data files with metadata published by providers. The provider is responsible for providing the metadata file according to the guidelines of the FDS (self-description). A web application is offered for the benefit of people. Information made accessible to persons is also offered machine-interpretable (using **RDF-a**), supplemented as necessary with alternative linked data formats (such as **Turtle**, **JSON-LD** and/or **RDF-XML**) and a **SPARQL API** for the purpose of freely querying the available metadata.
7. NGII/ZoN *Desk research:* metadata catalogs is a widely accepted provision by public organizations to make geo-information discoverable for (re)use. Nationally, this has led to a **National Geo Register**, in which approximately 8,500 datasets / services can be found from various different organizations. The national geo-register is connected to the government's open data portal, also to the European geo-portal.	8. DSO *Miro:* system catalogue (standards tbc) (in use) *Interview:* the **system catalogue started** as a dictionary (the concept of scaffolding is different for a builder than for a water board). The harvesting of this data takes place in several ways: Based, among other things, on a starter set from municipal data.	9. EMDS *Interview:* **DCAT**
10. DITM *Miro:* DCAT (already available) *Interview:* there is no central catalogue, a **federated catalogue** is used. If you're a member of the ecosystem, you can crawl other people's catalogs based on your identity (credentials) and serialize them as JSON-LD. Then you can view and search everything yourself (there are not many datasets and services yet). Catalogues can be retrieved on the basis of a list of identities (which can be retrieved from the registration service). Knowing the identity is enough to find and query the location of the corresponding catalog.		

C3. Value Creation Services
DSSC describes the scope and goals of the Value Creation Services building block as:

This building block is about the services needed to create value on the data from the ecosystem. These services are located in different corners, such as:

- Complementing the capabilities of the ecosystem (e.g. data visualization, data quality or data enrichment)
- Act directly on data in the ecosystem that are under services (e.g. through selection, extraction or combination)
- Adding value to data products and data transactions that become available to the parties in the ecosystem (for example, making pre-trained Machine Learning models available and accessible or, for example, setting up data innovation labs or, for example, marketplaces)
- Enabling the connection to external infrastructures (requiring components such as an infrastructure catalog, a data gateway and an orchestrator)
- Enable the connection to external applications on top of the ecosystem (such as connecting to a Digital Twin, AI systems or, for example, integration with autonomous vehicles)

1. DMI *Miro: Marketplaces*Dexes and WeCity (in use) *Interview:* These services are expected to be provided by the suppliers of the marketplaces or by DMI participants specialised in such services.	2. FDI/DIL *Miro:* Event choreography (to be built) *Interview:* event choreography and trusted data exchange is the great added value of BDI. The value creation services originate at the BDI in the DIL Living labs. In any case, the following value services are in the making: • Improved use of digital waybills • Widely available digital container information • Trusted goods issuance and improved digital trust chain • Being able to use each other's identity frameworks	3. DSM/NTM *Miro:* Tested with EDC connector to subscribe to a dataset of NDW via NTM as a broker. NDW remains in the lead for data denial. Via EDC connector however parts of logging due to monitoring at NTM level. NTM is therefore a proxy (to be built) *Interview:* There are a number of ideas (not formal) that can be seen as value creation services: • a use-case register where you can attach data sources to the use-cases. • definitions in the technical data sources (xml, json, etc.) so that meaning can be given on dataset, data object and data

	• Digital Truck Lock Planning for Air Freight • Expected unloading moment container in seaports • Wide sharing of arrival moments in the logistics chain	elements to make automatic matches with the available data sources on the basis of text in the use case. • placing knowledge models (using graphs) between the data sources and the data users, so that the users receive exactly the (linked) data they need for their use case
4. DSGO *Miro:* Data service broker (already available) *Desk research:* The data service broker is an independently certified market facility within the DSGO that acts as a technical service provider on behalf of a data service provider or data service user and supports the provision of data services.	5. VTH	6. FDS *Interview:* Next year (2025) try things out in Digilab. *Desk research:* Digilab, innovation workshop for the federated data system. Digilab works on puzzles in the following categories: interoperability, trust, data value and governance.
7. NGII/ZoN	8. DSO	9. EMDS *Interview:* EMDS has no marketplaces, the question is also whether you want to arrange that. Mutual payments are arranged bilaterally and if something becomes a success, something will arise. Value Creating Services' (such as developing or facilitating marketplaces) are seen as applications that the market (and perhaps governments) will regulate themselves. How this development will proceed is unpredictable.
10. DITM *Interview:* DITM does not have a marketplace or app store.		

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