Space Data Space

Blueprint

31 March 2025

V1.0

For the Space Data Space to succeed, we believe it should possess the following characteristics:

1. Grounded in real-world use cases that provide unique added value for end-users.
2. Enable the utilisation of a wide range of space-based data, both open source and private/commercial (including SatEO, meteorology, SatNav, SatCom, and space safety).
3. Cultivate an ecosystem of collaboration.
4. Establish trust through a transparent and suitable governance model.
5. Build a reliable technical foundation for space assets, ensuring interoperability with Data Spaces from other sectors.
6. Enhance user experience and ensure privacy compliance.
7. Develop a strategic plan for growth and phased rollout.

Prepared by

Participants to SDS-Next activities (see details in section §15).

Document information

Document Type	Blueprint
Reference	SDS-Blueprint-31032025
Issue/Revision	V1.0
Date of issue	31/03/2025
Status	Final

Human Author

Olivier Dion - Onecub

Human Contributors

Emmanuel Mondon - Space Cooperative Europe
Eric Pol - aNewGovernance
Elisabeth Sourgens - ESA
Adrien Pain - CS, a Sopra Steria company
Piotr Zaborowski - OGC
Cécile Théard-Jallu - De Gaulle Fleurance
Thomas Jansen - HEUKING
Almudena Sánchez González - GMV
Nicolas Saporiti - Géo212
Matthias De Bièvre - Visions

Human Reviewers

Luis Mariano González Casillas - GMV
Jurry de la Mar - T-Systems
Grzegorz Taberski - iTTi
Jean Brangé - AFNeT Services
Amèle Benamara - GAEL-Systems
Krzysztof Getko - Cloudferro
Mathieu Bataille - ESPI
Pascal Legai - ESA
Isabelle Duvaux-Bechon - ESA

Acknowledgment

The author acknowledges that ChatGPT (powered by OpenAI's language model, GPT-4 - www.openai.com) was used in this document but only for summarising texts and improving English writeups.
The writing, editing and reviewing were performed by the human author, contributors and reviewers.

ESA fully funded Activity

This document has been done in the context of SDS-Next Study funded by the European Space Agency - Director General's Services - Strategy (DG-5S) with an amount of 240,000 EURO excluding VAT and travel expenses (Purchase Order N. 5001038351).

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Contact

For any information, comment, feedback related to this document, please contact Emmanuel Mondon:
emmanuel.mondon@spacecoop.eu

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Placing the Space sector at the centre of the EU data strategy

The *Space Data Space Blueprint* presents a forward-looking roadmap, positioning the Space sector at the forefront of digital innovation in alignment with EU objectives. In the emerging era, creating a European single market for data will be critical for Europe's digital autonomy, competitiveness, and sustainable development.

The European Commission's 2020 data strategy envisions a seamless flow of data across sectors within the EU, supporting the creation of numerous data-sharing ecosystems of public and private data, known as 'Common European Data Spaces', in sectors like Agriculture, Energy, Mobility, Finance, Health, Smart cities, the Green Deal, Skills, and more. While Space is not currently listed among the initial 14 priority sectors for the Data Spaces by the European Commission, we believe it will be pivotal to this vision. This document aims to lay the foundation for a 'Space Data Space', designed to interconnect with these other essential sectors. Given the Space sector's links with nearly all other sectors, we believe that the Space Data Space has the potential to become one of the most horizontal Data Spaces.

The *Space Data Space Blueprint* offers practical guidance for establishing a reliable and interoperable Space Data Space, enabling seamless data-sharing among Space stakeholders and other sectors highlighted in the European data strategy. Seven other sectors have already published their Blueprints, serving as valuable models.

Creating added value beyond open data

Europe currently ranks third in Earth Observation (EO) data revenue, holding a 14% market share behind the USA (44.1%) and Asia-Pacific (20.4%). Although Europe is the leading provider of Earth Observation open data, it faces significant gaps in private and commercial data-sharing and value-added services, with forecasts for 2030 indicating a slight decrease in market share. Europe cannot lead in open data while allowing others to capitalise on its investments, particularly where Artificial Intelligence is involved.

The primary goal of the Space Data Space is to establish a reliable environment for sharing private and commercial data, beyond open data, promoting innovation through collaboration and community engagement to unlock new value through data-driven approaches. Expected outcomes include greater reusability and added value of space data across sectors.

A Blueprint rooted in concrete use cases

Data Spaces will play a vital role in enhancing the quality of life and generating value for individuals, organisations, and governments. The design of Data Spaces is significantly influenced by data-sharing use cases. It is crucial to formulate use cases with scalability in mind to anticipate future expansions and mitigate scalability-related challenges.

The *Space Data Space Blueprint* specifically addresses scenarios pertaining to the cross-sectoral reuse of space data assets. It develops two initial use cases in detail for the Civil Security from Space (CSS) domain, while paving the way for many more.

Building an ecosystem of collaboration and trust

The Space Data Space fundamentally emphasises the critical role of collaboration among a diverse array of stakeholders, both within the Space sector and beyond, anchored in a foundation of trust. In an era of rapid data growth, establishing an ecosystem that harmonises the interests, rights, and sovereignty of data and service providers is essential for encouraging active participation.

This Blueprint acknowledges that the complex web of relationships within this ecosystem requires a careful balance of business, legal, and ethical considerations. The Space Data Space will be built on standards and established trust frameworks.

Building interoperability within the Space sector and across sectors

The effectiveness of a Data Space depends on its ability to offer interoperable access to data from varied sources via harmonised open protocols and to support a decentralised and federated approach to data pooling and sharing. Moreover, by leveraging interoperability standards across Data Spaces, Data Spaces foster a decentralised and federated ‘ecosystem of ecosystems’ spanning multiple sectors.

The Blueprint introduces key Data Spaces support organisations, standards and open source components (such as the DSSC, iSHARE, Simpl, Gaia-X, IDSA, Fiware, etc.) and outlines a reference architecture that provides a transparent framework for creating standardised connections between data sources and services. This framework ensures that data transactions comply with established technical, business, legal, and regulatory conditions.

Designing a top-down and bottom-up governance

Governance is essential for the sustainability, and reliability of a Data Space. To encourage widespread adoption, decision-making must operate on multiple levels: Data Spaces need to balance top-down alignment in areas such as trust, regulatory compliance, and sectoral/cross-sectoral interoperability, with the bottom-up momentum and specialised insights contributed by local and thematic ecosystems.

The Blueprint acknowledges the complex and multi-faceted nature of governance, involving a diverse array of stakeholders from various space projects, programmes, services, and sectors, including both public and private entities, and major players as well as small and medium-sized enterprises (SMEs). The Blueprint presents a governance framework emphasising on the need for a sectoral Coordinating Authority for the Space sector, namely the ‘European Space Data Space’ (ESDS). It also highlights the major role of EU and ESA (including non-EU) member states, and the creation of multiple bottom-up initiatives (such as the CSS Data Space initiative) on particular domains and thematics.

A Strategic rollout plan

The Blueprint provides a detailed rollout plan that includes identifying initial use cases, establishing a combined top-down and bottom-up governance model, offering legal and business model insights, and outlining the initial elements of a technical roadmap. Drawing on the experience of other sectors' Blueprints (Agriculture, Energy, Smart Cities, and more), it avoids reinventing the wheel. Additionally, it lays out the next steps for concrete implementation.

The *Space Data Space Blueprint* lays the foundation for a vibrant and sustainable Space Data Space. Its holistic approach ensures a comprehensive and resilient ecosystem. Through strategic growth and collaboration, this Blueprint envisions the Space Data Space as one of the pillars of the future European data strategy, while increasing the value of European space data.

Recommendations

Here is a summary of all recommendations of the *Space Data Space Blueprint*:

Table 1 - Summary of recommendations

Reco 1: Europe should leverage Data Spaces to unlock the potential of space data.

Reco 2: Europe should leverage Data Spaces to avoid abusive market power lock-in.

Reco 3: Europe should leverage Data Spaces to create value with private and commercial data, beyond open data.

Reco 4: The Space Data Space should help unify fragmented and dispersed data from various space assets.

Reco 5: The Space Data Space should offer new market opportunities with other sectors having their own Data Spaces.

Reco 6: Data Spaces, and the Space Data Space, should become Europe's key differentiator in the race for AI.

Reco 7: The Space Data Space should help existing data lake of the Space sector to transition to Data Space initiatives or federate with it.

Reco 8: The Space Data Space should identify data-sharing use cases by consulting Space stakeholders as well as Data Spaces from other sectors.

Reco 9: Civil Security from Space could benefit from a dedicated Space Data Space initiative, that would be one of the first initiatives of the Space Data Space.

Reco 10: Natural disasters management and drivers for migration are relevant initial usage scenarios for the Space Data Space initiative.

Reco 11: ESA should help build the Space Data Space by federating existing resources and initiatives.

Reco 12: Space sector industry players should help build the Space Data Space by federating existing resources and initiatives, including non ESA.

Reco 13: The Space sector should become one of the key sectors of the Common European Data Spaces, and of the European data strategy.

Reco 14: The Space Data Space should establish a sectoral Coordinating Authority, proposed to be named the European Space Data Space (ESDS). Stakeholders such as ESA, ESA/EU member states, and industry players should assess options for its structure.

Reco 15: Each Space Data Space initiative should designate at least one Operating Company. Establishing a single Operating Company to support multiple Space Data Space initiatives would facilitate resource sharing and efficiency.

Reco 16: The Space Data Space Coordinating Authority should design a sectoral Rulebook that could be inherited by all specific Space Data Space initiatives.

Reco 17: Legal aspects should be managed at the sectoral level within the Coordinating Authority to streamline efforts and ensure process harmonisation.

Reco 18: Each Space Data Space initiative should set up a Data Space Governance Authority (DSGA) and explore possible structural frameworks.

Reco 19: Each Space Data Space initiative should propose its own business model, while the Space Data Space Coordinating Authority should help with a sectoral business framework for better interoperability.

Reco 20: Each Space Data Space initiative should implement existing reference models proposed by key Data Spaces support organisations.

Reco 21: Simpl should be a key component of the Space Data Space, as Destination Earth will be one of the six pilot projects (Simpl Live) for its deployment, starting in 2025.

Reco 22: Key standards for technical building blocks regarding interoperability and trust should be harmonised through the European Space Data Space (ESDS) Coordinating Authority.

Reco 23: The Space Data Space should adopt existing industry standards to the greatest extent possible.

Reco 24: Each Space Data Space initiative should propose a data collaboration platform.

Reco 25: The UX/UI elements of all Space Data Space initiatives should be harmonised, at least at the sectoral level, using a design system proposed by the Coordinating Authority.

Reco 26: All Space Data Space initiatives should leverage existing technological stacks and tools working in other Data Spaces.

Reco 27: All Space Data Space initiatives should adopt existing cross-sector standards already utilised in other Data Spaces.

Structure of the Blueprint

The transformative approach that data strategies have introduced across multiple EU/ESA member states aligns with the substantial value they aim to deliver. This is a complex topic. As with any Blueprint, the document you are about to read provides guidance on how to construct a Data Space specifically for Space data—hence its considerable length.

To help you find what you need, we will outline its structure. Whether you are viewing this in print or via a Wiki, you can focus on the sections relevant to you and skip the rest—for example, if you already know what a Data Space is, you can move past those details. Nevertheless, all the information remains available for reference.

The initial question that motivated the SDS-Next study
and the current Space Data Space Blueprint was:

"Should Space leverage the 2020 EU Data Strategy
and similar upcoming regulations in other non-EU/ESA member states?"

- *Chapter 2 outlines the objectives of the Blueprint and details the methodology used.*
- *Chapter 3, in reference to the initial question just mentioned above, describes the European context, in terms of data strategy, Space strategy, then presents why Data Spaces can add value and why there should be a Data Space for the Space sector.*
- *Chapter 4 digs deeper in what a Data Space is, describes its principles.*
- *Chapter 5 goes concrete and describes what can be done via Data Spaces and focuses on what they can bring to the Space sector by focusing on the different use cases that have been envisaged by the Space Community of Practice (CoP) working groups who met between the November 2023 Madrid event until 1st July 2024.*
- *Chapter 6 acknowledges that the page is far from blank. It describes the landscape; current space data programmes which can bring their experience and their data sets, as well as the existing Data Space organisations.*
- *Chapter 7 is another hands-on one, since it describes the governance required to implement a Data Space for the Space sector.*
- *Chapter 8 digs into the legal side that will enable data-sharing to happen.*
- *Chapter 9 addresses the subject of potential business models which will enable sustainability of the Data Space, as well as its success.*
- *Chapter 10 looks under the hood and describes the technical elements needed to make the Space Data Space a working reality.*
- *Chapter 11 lists potential next steps.*

2. Introduction

2.1. Objectives of the Blueprint

2.1.1. What is a Data Space Blueprint?

The EU-funded Data Spaces Support Centre (DSSC)[1] aims to create a comprehensive network of stakeholders by bringing together all relevant organisations involved in developing Data Spaces. Recently, **the DSSC released the initial version of a *Data Space Blueprint* in 2024**[2], with version 1.5 currently in progress. This Blueprint provides **a coherent and detailed set of guidelines to support the entire Data Space development cycle**, including a conceptual Data Space model, core building blocks, and recommended standards and specifications. **The DSSC Blueprint is not sector specific**.

At the same time, **the EU Commission has funded initial sector-specific studies** through Coordination and Support Actions (CSAs) in sectors like Agriculture, Smart Cities, Mobility, Tourism, Skills, and Energy. **These studies produced seven Blueprints, one for each sector.** The DSSC also took part in these studies, aligning its overarching vision with each sector to promote coordination.

2.1.2. Purpose of the Space Data Space Blueprint

This document represents a collaborative effort involving ESA's Civil Security from Space Programme (CSS) and representatives from the Space sector at different levels (ESA, EU/ESA member states, industry, etc.). Beyond presenting the Blueprint for establishing the Space Data Space and outlining a roadmap for its implementation, **this document serves as an entry point for understanding the fundamental frameworks and building blocks that underpin the Data Space concept**. While it includes essential descriptions of the Space Data Space's components, **it is not intended to be an exhaustive reference or a detailed implementation document**. Instead, it gives an **overview of the topics and links to additional resources** are provided for readers seeking more detailed information.

The *Space Data Space Blueprint* introduces a conceptual framework defining core elements for semantic interoperability, technical reference architecture components, governance principles, business models, and data stewardship structures to facilitate efficient data-sharing based on European values and rights.

The Space Data Space presented in this Blueprint **is designed to become an overarching governance & infrastructure facilitating interoperability for existing, and new, space data-sharing initiatives, through federation mechanisms**. This Blueprint aims to guide the creation of a pooled, shared, trusted, transparent, and user-friendly data ecosystem where all European Space stakeholders regardless of size or geographic location within the EU and ESA member states (including Switzerland, Norway and the UK), can participate, collaborate, and share data.

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[1] https://dssc.eu/

[2] https://dssc.eu/space/BVE/357073006/Data+Spaces+Blueprint+v1.0

Additionally, **it is crucial for the Space Data Space to connect and facilitate data-sharing with other sectoral Data Spaces** such as Mobility, Health, Finance, Agriculture, Green Deal, Energy, Smart Cities, Media, etc. The Space Data Space has the potential to drive innovation by developing new data-driven products through added-value enhanced data. By providing decision-makers with reliable information, the Space Data Space will enhance strategic planning in various industries, leading to increased competitiveness, sustainability, and resilience. The Space Data Space will create value by supporting the emergence of new cross-domain and cross-sector services, fostering job creation, improving stakeholder collaboration, and adopting new business models.

The intended audience for the *Space Data Space Blueprint* encompasses potential participants with a range of roles, including policymakers, developers of Data Space technology, data contributors, and data consumers. These participants come from both the public and private sectors and vary in size from corporate stakeholders to SMEs, as well as in scope from global to local levels. Consequently, the relevance of the subsequent sections may differ depending on the reader's specific roles and objectives within the Space Data Space.

2.2. Methodology of the Space Data Space Blueprint study

2.2.1. General Methodology

This report employs a diverse methodology to efficiently gather and analyse pertinent data and insights from various stakeholder groups in the Space sector. Key actions and their objectives include:

- **Inventory:** Conducted an extensive inventory of existing data sources and sharing initiatives to comprehend the current space data landscape, combining it with source material from Data Space support organisations (DSSC, Gaia-X, IDSA, etc.), as well as from other sectors Data Spaces (Smart Cities, Mobility, Tourism, Skills, etc.)
- **Surveys:** Distributed questionnaires to data ecosystems and stakeholders, collecting information on data gaps, overlaps, existing sharing initiatives, and expectations or requirements related to the Space Data Space.
- **Interviews:** Conducted interviews with selected stakeholders, initiatives, and other Coordination and Support Actions (CSA) relevant to the Space Data Space to gain deeper insights into data-sharing challenges and perspectives.
- **Working group meetings:** Focused on organisational aspects, use cases and technical building blocks of the Space Data Space.
- **Expert opinions:** Incorporated inputs from project partners, external experts, advisory boards, and external reviewers to enrich the analysis with a broad range of knowledge and experience in data-sharing initiatives and Data Spaces.

This Blueprint is based on 5 main elements presented in the following paragraphs:

1. A **Space Data Space preliminary study** conducted in Q4 2022 and Q1 2023
2. An extensive **desk study** (2022/2023/2024)
3. A **kickoff workshop in Madrid** in November 2023

4. A series of **Space Data Space community meetings: SDS-Next** (Q1-Q2 2024)
5. A **second workshop in Brussels** in October 2024

2.2.2. Space Data Space Preliminary Study (Q4 2022 - Q1 2023)

"A Data Space is coming out of the willingness of actors of an ecosystem to share data. To assess the desirability of a Data Space for Space, we needed to meet a significant sample of all categories of stakeholders in and outside the Space sector."

In the third quarter of 2022, the European Space Agency's Directorate of Telecommunications and Integrated Applications (D/TIA) (now Directorate of Connectivity and Secured Communications, D/CSC) commissioned Space Cooperative Europe SCE (Germany), the first Societas Cooperativa Europaea (SCE) dedicated to space, in collaboration with aNewGovernance AISBL (Belgium) and Onecub SAS (France), to conduct a *Preliminary Study* regarding the potential development of a 'Space Data Space'. This initiative aimed to:

- **Foster synergies** with the Copernicus Data Space Ecosystem.
- **Facilitate the dissemination** of data/information from various space assets, including Galileo, Copernicus, Space Situational Awareness (SSA), etc.
- **Focus on end-users** through public and commercial value chains.
- **Capitalise on existing and upcoming initiatives** such as EU Destination Earth (DestinE), ESA Digital Twin Earth (DTE), ESA ScaleUp Programme, 'Digital Connected Globe', ESA Space Safety Programme (S2P) and ESA Civil Security from Space (CSS)
- **Support Common European Data Spaces** in sectors like Finance, Health, Agriculture, Mobility, Green Deal, Security, Energy, and more.

Various sectors, including Mobility, Agriculture, and Health already utilise space data. However, there is potential for expanded and scaled-up use of space data within the context of the EU data strategy. **The primary focus of the *Preliminary Study* was to assess the necessity and feasibility of the Space sector's participation in the EU data strategy** and recommend how such participation could materialise.

Given the strategic nature of this endeavour and the seniority of interviewees, face-to-face or remote video interviews were preferred. The objective was to contact a representative sample of the ecosystem, engaging key players whose perspectives are pivotal to the success of the foreseen Space Data Space. **Over 250 individuals and organisations from the Space and Data ecosystems, both public and private, across most ESA member states, were approached and 50+ one to one interviews were conducted**.

Here is a list of **some significant quotes** that were heard from several relevant sources from the Space and the Data ecosystems, during the 2022 Space Data Space *Preliminary Study*:

- *Each Space programme has its own ecosystem. But we need to improve connectivity of the whole system to generate actionable value.*
- *We need to break the silos of Space.*

- *Why would Space be different when it comes to data?*
- *User uptake is critical, as well as accessibility to data.*
- *Space needs more collaboration and cooperation.*
- *The European Space sector has to think and act globally. It must start breaking its silos.*
- *Destination Earth is a gateway, supporting other Data Spaces.*
- *Without interoperable data, DestinE and Copernicus may fail.*
- *Value from space data can be improved. By opening to other sectors.*
- *There is strong political pressure on developing downstream.*
- *There is no doubt space data-sharing is a key issue. This and the necessary coordination without the ecosystem.*
- *Space is a complex and political sector. If there is consensus, there should be a Data Space for Space.*
- *Let us start with Earth Observation first, leveraging DIAS (Data and Information Access Services).*
- *A Copernicus Data Space should exist in 2 years from now.*
- *We could support the use of space data by non-space teams.*
- *Why should we create a new entity? Space data has all the tools it needs.*
- *Matchmaking between demand and Earth Observation is already present.*
- *I don't believe in cooperation. I think one actor has to take the lead [read 'us'] and create the backend that can then be used by the downstream actors.*

First takeaway is that most respondents believe **there is a need for more interoperability between space data sources**. This follows numerous comments related to the need to 'break silos' and the fact that each programme has its own tools, resulting too often in the necessary processing of external data prior to them being aggregated with in-house data to create value.

Another one is that **downstream should be further developed**. We noticed at this level **a frustration at the hiatus between the production of open data and data monetisation**. To achieve that goal, **user uptake** needs to be developed. This can only be achieved by information, accessibility control of sharing, and ease of use. This is typically what a Data Space is delivering.

However, some respondents stated that **current programs** and tools in place were **sufficient** but **needed more investments**. This impression was strengthened by the fact that the actual definition of what a 'Data Space' is was not known, when the vocable was used. For them, some programs already had or were building their own Data Space. In that case, they meant either an interface or a data lake which does not follow the definition of a Common European Data Space, as described in §4 of this document.

Overall, what emerged was the **lack of knowledge** by a significant proportion of Space sector respondents of the 2020 EU data strategy. To start with, Data Spaces go beyond open data. They enable voluntary and controlled sharing of private resources. However, with the deployment of the Space Data Space enlarging the client base of space data, it will also have a positive effect on use of space open data. Should the decision to proceed with a Space Data Space be taken, **communication should be a key priority**.

On non-space interviewees, **the need for space data-sharing improvement**, both in volume and in ease of access (discoverability) was well emphasised. It seems that access to space data is still considered as specific to some sectors or some companies (*read space-related, technology savvy, significant size…*), when use-cases described prove the contrary. Mechanically, if a Space Data Space is put in place, the interoperability building blocks will address those issues and **unlock** immediately **new end-users**.

Furthermore, this will **unleash creativity** of companies, startups, and public services that is not foreseen yet. On the subject of unexpected creativity (aka serendipity) by the ecosystem, a company like Apple had the same experience and is still rejoicing on it: When it launched its App Store, it imagined developers would come up with apps to manage or enhance messaging; they did not think developers would come up with finance or health apps, games, music, management tools and so on. This resulted in the App Store generating in 2021 $12.1 billion revenue.

An example mentioned by one of our interlocutors was **geolocation**. We all know the pain of filling in expense sheets, starting with retrieving and going through the receipts of the month and filling in relevant forms, even though they are online. What about embedding location data into a business expense form as proof of spend, or in attendance records especially related to working-from-home monitoring. This implies linking those data with banking data and HR data in companies' servers. For **lack of trust**, this cannot be done through Google Maps. An enrichment of Galileo data could be a good source, providing the right trust, cybersecurity measures. This would create an interesting service employers would be prepared to pay for and staff interested in using.

This addresses one of the issues that is necessary for a Data Space to take form, which is the **creation of services** that are enticing, be it for their **financial value** (I save money or I make money) or their **social/societal value** (I gain quality time, I can concentrate on what matters, I contribute to a sustainable environment…).

When our objective was to get feedback, numerous respondents were **curious to know more** about Data Spaces and what could be done through interoperability. We then happily shared more information on the EU data strategy from a use case, governance and technological point of view. This was very well received with one respondent exclaiming: "Why would space be different when it comes to data?".

To summarise, there is an overwhelming support for a Space Data Space, especially in the non-space respondents, but also amongst the space respondents, even though they may have not been exposed to the concept of Data Space prior to our discussion.

While there was general consensus on the ideas of data-sharing and interoperability and the need for a Data Space for Space, some respondents involved in existing space data programmes expressed their worry that the deployment of the Space Data Space would be detrimental to their own programme. On the contrary: those **existing world class programmes such as Copernicus or Destination Earth are great assets to build on**. Their experience, but also the value and quality of data makes an excellent base, **linking them with other open data and private/commercial data programmes**, existing or to be developed. Data-sharing, interoperability and governance will enable higher user uptake

and the unleashing of more value, thanks to the trust framework the Data Space will provide. Ultimately, creating an agile federated network of data for Space will **create a unique, powerful and resilient competitive advantage for Europe, its Space sector and its economy**.

However, the potential development of a Space Data Space will have to **take oppositions or questioning into account** and ensure a profound cooperation and collaboration with all initiatives. The good news for the space industry is that those initiatives exist and their data are already used by other sectors such as Agriculture and Finance. The whole point of the development will be to **build on and with already existing initiatives, not to compete with them**.

2.2.3. Desk study (2022/2023/2024)

The foundation of the *Space Data Space Blueprint* is rooted in an analysis of contemporary Data Space literature, **drawing from sources within EU institutions and Data Space support organisations** like DSSC, Gaia-X, IDSA, FIWARE, and others.

Additionally, **this study extensively incorporated insights and approaches from Blueprints from other sectors**, slated for publication in 2023/2024. These Blueprints are derived from preliminary studies conducted by Coordination and Support Actions (CSA) projects in 7 key sectors:

- Green Deal[3]
- Tourism[4]
- Skills[5]
- Agriculture[6]
- Smart Cities[7]
- Mobility[8]
- Energy[9]

The *Space Data Space Blueprint* wants to take part in the **cross-sectoral convergence approach** advocated by the 2020 European data strategy. Furthermore, this study engaged with key stakeholders from various organisations and initiatives throughout, sharing information about the standard aspects of building a Data Space and the specific characteristics unique to the Space Data Space.

2.2.4. ESA-ESPI Madrid kick-off Space Data Space 2023 Workshop

Desirability of public and private stakeholders for a Space Data Space has been confirmed by the extremely positive answer and attendance (approx. 100 people - see

[3] https://www.greatproject.eu/

[4] https://www.tourismdataspace-csa.eu/wp-content/uploads/2024/01/DRAFT-BLUEPRINT-Tourism-Data-Space-v3.3_final.pdf

[5] https://www.skillsdataspace.eu/

[6] https://agridataspace-csa.eu/

[7] https://www.ds4sscc.eu/

[8] https://mobilitydataspace-csa.eu/

[9] https://enershare.eu/wp-content/uploads/Blueprint_CEEDS_v2.pdf

the list in Appendix §14.6) at the Space Data Space event organised by ESA together with the ESPI[10] (European Space Policy Institute) at the EU SatCen[11] (European Union Satellite Centre near Madrid in Spain) on 22-23 November 2023.

This workshop gathered representatives from the EC (DG CONNECT and DG DEFIS), ESA member states (Finland, Hungary, Poland, Spain), EUSPA, European Industry and companies (startups but also large players like Airbus, OHB, SES, Eutelsat, T-Systems and GMV), user communities and academics[12].

More importantly, **they all expressed their wish to see the Space Data Space implemented concretely**. Amb. Sorin Ducaru, EU SatCen Director General at the time, stated that all sectoral European Data Spaces (more than 14 sectors now) were potential clients of space data[13].

The event aimed at providing a forum for stakeholders to express their requirements regarding a potential Space Data Space; highlighting initiatives that could be part of it or are aligned with the Data Space concept; and identifying potential obstacles and challenges.

Participants were split into 3 working groups to discuss three topics:

1. A Space Data Space for which objectives?
2. Which governance for the Space Data Space?
3. Connecting the Space Data Space with third parties, existing space projects and other Data Spaces.

This document reuses the key takeaways resulting from exchanges between participants and the ideas they expressed during the workshop.

Figure 1 - ESA-ESPI Madrid Space Data Space 2023 kick-off attendees

Takeaways of the ESA-ESPI Madrid Space Data Space 2023 kick-off
Source ESPI

[10] https://www.espi.or.at/
[11] https://www.satcen.europa.eu/
[12] https://www.linkedin.com/feed/update/urn:li:activity:7133469424044404737/
[13] https://www.satcen.europa.eu/Pages/satcen-hosted-the-esa-espi-space-data-space-workshop

<u>Takeaway 1:</u> Clear use cases need to be identified before establishing a Space Data Space, and Civil Security from Space (CSS) is a relevant starting point.

Space data play a significant role in various domains. To fully understand the potential added value of a Space Data Space, several use cases were identified during the workshop:

- Natural disaster management (e.g., floods, forest fires, etc.)
- Customs and border controls
- Civil safety (e.g., crowd monitoring)
- Agriculture and food security
- Meteorology
- Transport and mobility
- Health exposure (e.g. pollution, traffic)
- Critical infrastructure (e.g. energy grid, telecommunication)
- Search and rescue

Several of the identified use cases were related to civil security and crisis management. In this regard, it was agreed that **a Space Data Space would be useful for all phases of crisis management**: prevention, preparedness, response, and recovery. For instance, during floods, data from space systems can benefit search and rescue efforts, provide regional and localised mapping for infrastructure analysis and insurance coverage, support telecommunications, and predetermine spillover effects in neighbouring areas. But their added value can be further enhanced when they are combined with other data from non-space sources.

Serving civil security missions requires a solution that is responsive, i.e., which provides the right data, in the right place and at the right time, at the best possible cost. Such a need could be met by the creation of a Space Data Space. Moreover, while this requirement applies to crisis management, it can also be extended to use cases of another nature (e.g., agriculture). Civil security applications are therefore a first step to implement a Space Data Space (especially due to the pressing need to tackle them) but such infrastructure will also help solve challenges in other areas.

Given the multiplicity and diversity of the use cases, **there was large agreement on the fact that a Space Data Space will also be a key tool to contribute to and enhance other sectoral Data Spaces** by introducing space data into other sectors. In this regard, interconnection and interoperability between the different Data Spaces were strongly encouraged by participants, to further extend data-sharing.

<u>Takeaway 2:</u> The Space Data Space is a key enabler for facilitating accessibility and the ability to search/discover relevant data.

While space data have numerous applications, participants highlighted the **importance of easing access to these data within the Data Spaces**. Indeed, if data is not accessible, or if tools to easily find it are non-existent, then it is not possible to fully exploit it. Discussions during the Workshop highlighted that data discoverability is key. In this

context, a few important questions were raised, which should guide reflection on the topic, including:

- How do you know data exists?
- How do you search for it?
- How do you find the actual data that you need?

A Space Data Space would provide a solution to these challenges, by **setting up 'signposting' mechanisms that guide users to relevant data sources**. To make sure that the chosen mechanisms are appropriate, the adoption of a user/customer perspective in the creation of the Space Data Space is crucial. It would also encourage its broader use by beneficiaries once it has been established. In a similar vein, sharing details—such as how quickly data can be accessed and what equipment might be required—in advance is crucial to convince users and other key stakeholders to participate in a Space Data Space.

Takeaway 3: Security and trust of the Space Data Space must be ensured to guarantee its adoption.

Defining a secure data-sharing ecosystem was a central requirement from participants. Indeed, building trust and consensus within the Data Space will result in greater acceptance of the Space Data Space. In this sense, **Data Spaces should be first and foremost conceived as trust models for the controlled exchange of data**. Several principles are essential to create trust in the system:

- Availability/Discoverability
- Confidentiality
- Integrity
- Traceability
- User and provider accreditation and authentication

Availability of the data is strongly linked to the simplicity of accessing it, discovering it and searching for it, as mentioned above. Confidentiality would be of particular interest for security actors in the conduct of their mission, which were identified as relevant use cases to start a European Space Data Space. With data integrity, providers and users are assured of the quality and consistency of the data that are injected into the system, which is key to rendering a Space Data Space more secure. Certification practices could be a tool to this end and reinforce trust among participating stakeholders.

Traceability is a key factor to confirm data integrity. In today's world, where data and information are ubiquitous, the origin and journey of specific data often go unnoticed, especially when systems function smoothly. Therefore, traceability is fundamental as it allows the user to identify the source of the data as well as the processing steps they underwent, and therefore to confirm the reliability of the data they will exploit to support their activities. Traceability is also a key element to strengthen accountability in data management.

Accreditation and authentication imply the definition of clear criteria to regulate who has access to data and who can contribute to data provision. This enables controlling the pool of involved stakeholders and therefore prevents some risks to materialise, such as the dissemination of fake data through the Space Data Space for instance. One solution could be to appoint intermediaries in charge of authenticating prospective users and providers without having access to the exchanged data.

<u>Takeaway 4:</u> A proper governance framework is necessary to address the diversity of stakeholders' backgrounds and interests and ensure smooth public-private collaboration.

An appropriate governance structure is a key factor to ensure the success of a European Space Data Space. Indeed, participants in such a system are very diverse and even one single actor can play different roles (e.g., data provider, service provider, information processor...).

Such a structure will reinforce the security of the system if it suits both users' and providers' needs, through different mechanisms. For instance, the establishment of Data Space 'stewards' who control and monitor the provision of data was suggested by participants. There was a clear call for the development of 'facilitators', who would coordinate with various stakeholders within the Data Space to ease and moderate data-sharing and make sure that data management practices are aligned with prevailing standards and regulations.

Beyond ensuring security, **a proper governance structure for the Space Data Space will also foster coordination and cooperation between public and private actors** for the implementation and development of this data-sharing ecosystem. Even though private actors will lead the provision and processing of data, public actors will maintain an important role within the Space Data Space in terms of high value open data suppliers, regulations and governance notably. Moreover, participants agreed that coordination of a Space Data Space should be performed at the European level, in particular considering the key role of the European Commission.

In addition, the selected governance framework should consider existing concerns, especially those of private actors. Indeed, current market dynamics do not fully support the free exchange of commercial space data. This complexity is compounded by the absence of a clear framework protecting the rights of data owners. Therefore, there is a need to find the right incentives to convince data owners to contribute to a Space Data Space, which could be remuneration (such as payment) or other forms of compensation including recognition or access to other data sources and/or resources. It is important to remember that a Space Data Space is not about making data free, instead the objective is to make access to data easier.

Although free data can exist within a Space Data Space, other solutions proposed by participants included situation-based or time-specific free data, whereby the data would be free for certain hours, users, situations, or based on their properties. In addition, the framework should allow for the creation of an additional layer, from which added value

products created from the data retrieved through the Space Data Space could be commercialised.

Finally, multiple governance frameworks can be envisaged for a Space Data Space, and useful lessons (both positive and negative) can be learned from initiatives taking place in other areas (e.g., the SWIFT system and its cooperative in finance).

Takeaway 5: Standardisation and harmonisation between existing data, products, services and methodologies should be promoted over the development of new ones.

The need for standardisation to underpin the creation of a Space Data Space was a key element raised by most participants, as a requirement for interoperability.

The Space sector already has numerous standards in place when it comes to data and a number of running initiatives related to space data workflows harmonisation (i.e. Horizon Europe collaborative research projects such as DOMINO-E and MESEO), therefore the Space Data Space must find a way to connect and harmonise these standards across the board. Moreover, there is a need to standardise not only the way data is accessed but also how it is certified. These standardisation practices form the blueprint for the development of the space data ecosystem, but standards should also be implemented between Data Spaces.

The support to standardisation was therefore massive, but it was repeated multiple times that **the objective is not to define brand new standards, but instead to promote and uphold current ones**. Overall, the creation of a Space Data Space should rely as much as possible on existing mechanisms, processes, standards, and infrastructure. Following this principle when connecting the Space Data Space to other Data Spaces, this would eventually allow connecting different sectors with different standards through one single framework. But this would be even more facilitated if standards for sharing space data were converging towards those currently being developed in other sectors, and especially within the forum of the Data Spaces Support Centre (DSSC) established by the European Commission.

Conclusions from the ESA-ESPI Madrid kick-off workshop 2023:

Outcomes of the Workshop will support ongoing ESA efforts aimed at tackling urgent civil security challenges, such as the Civil Security from Space (CSS) programme and the Rapid and Resilient Crisis Response (R3) Accelerator (see 5§ for further details). Indeed, a continuously growing Space Data Space could expedite data-sharing initiatives and better support security missions by ensuring high data quality and ease of access to users and all involved stakeholders.

When establishing the Space Data Space, several challenges will need to be addressed. First, **defining the specificities of a Space Data Space compared to other Data Spaces will be essential to determine its scope**. Should the Space Data Space focus on improving access to space-based data or should it facilitate data-sharing within the

Space sector? Second, there was debate about the nature of data that should be accessible through a Space Data Space: should only space-based data be included or also non-space data? Furthermore, the openness level of the Space Data Space remains an open question. For instance, should American and Chinese providers and users be allowed to access a European Space Data Space if they abide by established standards, although it may create risks for European data security?

The Workshop revealed that technical issues are not the primary hurdle and can be readily resolved if stakeholders are willing to collaborate on establishing a European Space Data Space. Therefore, the main focus should be on use cases, governance and defining the Space Data Space promoter's role. Given the wide range of stakeholders involved, it is essential to reach agreement on a coherent governance model that caters to their diverse interests. While users care most about where the data comes from and its quality, providers want oversight of how their data is used and must be motivated to join the Data Space.

The ESA-ESPI Madrid workshop summary is provided in §14.7.

2.2.5. SDS-Next community meetings in 2024

In Q4 2023, ESA mandated aNewGovernance ASBL (Belgium), in partnership with Space Cooperative Europe SCE (Germany) and Onecub SAS (France) to undertake a follow-up activity (SDS-Next) for starting the implementation of a Space Data Space, with a focus on Civil Security, leveraging the ESA Civil Security from Space (CSS) programme .

During 4 months, between the 4th of March and 1st of July 2024, **a series of 14 meetings** on Monday at 5pm CET gathered 60+ people from 31 entities (public, private, NGO) across Europe (10 countries) for contributing to the *Space Data Space Blueprint*.

Figure 2 - SDS-Next community meetings 2024 participant organisations

Participants addressed in the meetings **the following topics:**

- **Use cases**
- **Governance**
- **Technical architecture**
- **Legal aspects**

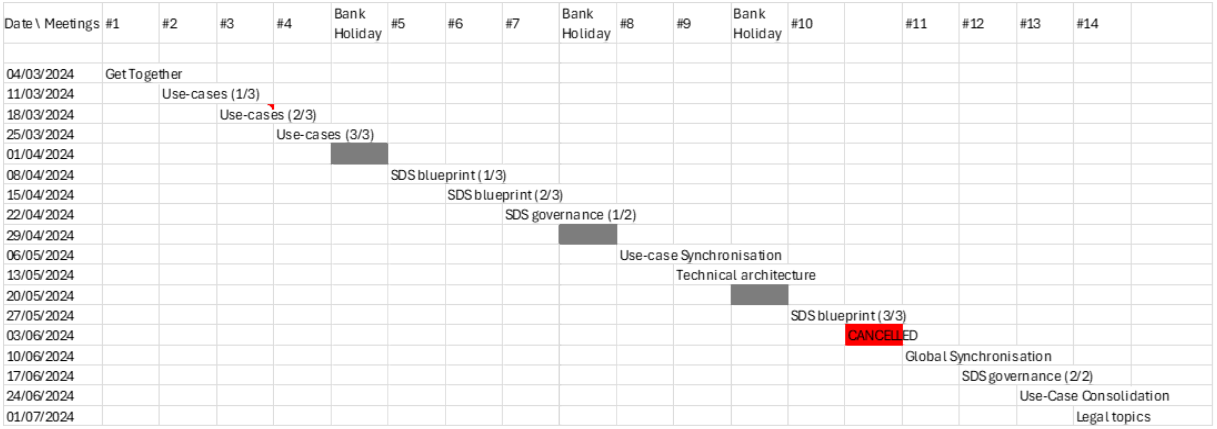

Figure 3 - SDS-Next community meetings 2024 sessions

In addition to Monday meetings, 3 groups met in April, May and June 2024, for working on **various use cases:**

- **#1 Natural disaster management (with focus on floods):** 14 entities expressed interest - 5 meetings were held
- **#2 Drivers for migration:** 9 entities expressed interest - 7 meetings held
- **#3 Impact of pollution on health:** 10 entities expressed interest - 3 meetings held

The use cases developed during the workshops are detailed in §5.5. of the Blueprint.

2.2.6. ESA-ESPI second SDS workshop in Brussels in October 2024

Hosted by ESA, ESPI, and aNewGovernance, the second Space Data Space workshop took place on 29 October 2024 in Brussels. Its goal was to present the latest developments of the Space Data Space initiative to a diverse range of stakeholders, including government representatives (EU commission and ESA/EU member states), industry, EU and international organisations, as well as participants from European data programmes and projects, other sectoral Data Spaces, and Data Space support organisations. The event provided a forum for exchanging ideas on practical steps toward Space Data Space implementation and explored options for integrating the Space Data Space into Europe's broader data ecosystem and strategy.

Figure 4 - ESA-ESPI Brussels Space Data Space 2024 workshop attendees

Takeaways from the ESA-ESPI Brussels Space Data Space 2024 workshop
Source ESPI

<u>Takeaway 1:</u> Learning from other initiatives

Extensive discussions took place between Space stakeholders and representatives from other sectors (e.g., Mobility, Skills, Smart City, Agriculture, etc.) as well as Data Space support organisations (e.g., DSSC, Gaia-X, Simpl) regarding key aspects of Data Spaces such as use cases, governance, legal, technical and business. The wider European Data Spaces community shared valuable lessons with the Space sector and stands ready to support the further developments of the Space Data Space initiative.

<u>Takeaway 2:</u> Building cross-sectoral use cases
Several cross-sectoral use cases—such as Space for Agriculture and Space for Smart Cities—were discussed among participants from different industries, generating significant interest on all sides.

<u>Takeaway 3:</u> Clarifying the complex governance framework

At this stage, the multi-layered governance structure of the Space Data Space—both top-down and bottom-up—remains unclear and requires further discussions between industry and the public sector (EU Commission and EU/ESA member states levels).

<u>Takeaway 4:</u> Reusing technical building blocks

The Space Data Space initiative should not only draw on the technical and interoperability expertise of other sectors, but also leverage cross-sectoral standards (e.g., Gaia-X labels) and available technology stacks (e.g., Simpl Open).

<u>Takeaway 5:</u> Lack of maturity regarding the business framework

Business aspects received less attention and appear underdeveloped across all sectors.

<u>Conclusions from the ESA-ESPI Brussels workshop 2024:</u>

Participants see the Space Data Space initiative as a valuable addition to Europe's data ecosystem and strategy. Success will require collaboration among all stakeholders, without replacing existing initiatives, to integrate the Space Data Space fully within Europe's data-sharing infrastructure.

3. European context

To determine whether the Space sector should take advantage of the 2020 EU data strategy and other upcoming regulations outside of EU/ESA member states, it is essential to understand what those strategies entail and advocate.

This chapter also examines the EU Space strategy as it stands today. Again, future steps toward establishing a Space Data Space must account for pending legislation in this area.

Finally, this chapter explains why Data Spaces—and specifically a Space Data Space—are important.

3.1. The 2020 EU data strategy

3.1.1. Data Spaces as the cornerstone of the strategy

The European Union, founded on the principles of free movement, extends these principles to data since 2018 with the GDPR, acknowledging the pivotal role of data in the 21st-century economy. The ability to compete globally requires a digital dimension built on various data activities, and access to data is considered essential for the data economy's success.

This historic challenge for Europe necessitates a swift standardisation effort against American and Chinese tech giants, emphasising common standards. The goal is to build independence from external technological solutions and proactively address innovation challenges. **The creation of a sovereign data-sharing infrastructure, such as the 'Common European Data Spaces' or simply 'Data Spaces', is essential for fostering innovative business models aligned with the paradigm shift of decentralisation.**

The EU aims to establish **a single market for data** with fair, practical, and transparent rules for access and use, while respecting privacy, data protection, and competition laws. Launched in February 2020, ***the European data strategy***[14] **introduces Data Spaces**, where public and private organisations can share private and commercial data, while remaining in control, to create value within a decentralised and federated soft infrastructure, and a common governance framework.

3.1.2. An ambitious program

In pursuit of this goal, **the EU makes substantial investments** in digital initiatives, allocating funds through programs such as the Digital Europe Programme (DEP - €7.6 billion), Connecting Europe Facility - Digital (CEF - €2.07 billion), and various key programmes, representing at least 10% of the €95.5 billion budget of Horizon Europe and

[14] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en

the €26.2 billion budget of Invest EU[15]. **Member states are also significant contributors** to the funding of this ambitious program.

3.1.3. Key sectors for the Common European Data Spaces

A key focus is on creating Data Spaces in critical industries—initially spanning 14 sectors such as Mobility, the Green Deal, Agriculture, Finance, and Industry—although Space is notably absent so far. The EU's goal is to enable secure data-sharing within and across these sectors, ensuring that data from public, open, and other sources is included. In support of this objective, the EU encourages Data Spaces initiatives and fosters sectoral governance bodies responsible for coordinating vital sectors to facilitate data-sharing under common standards.

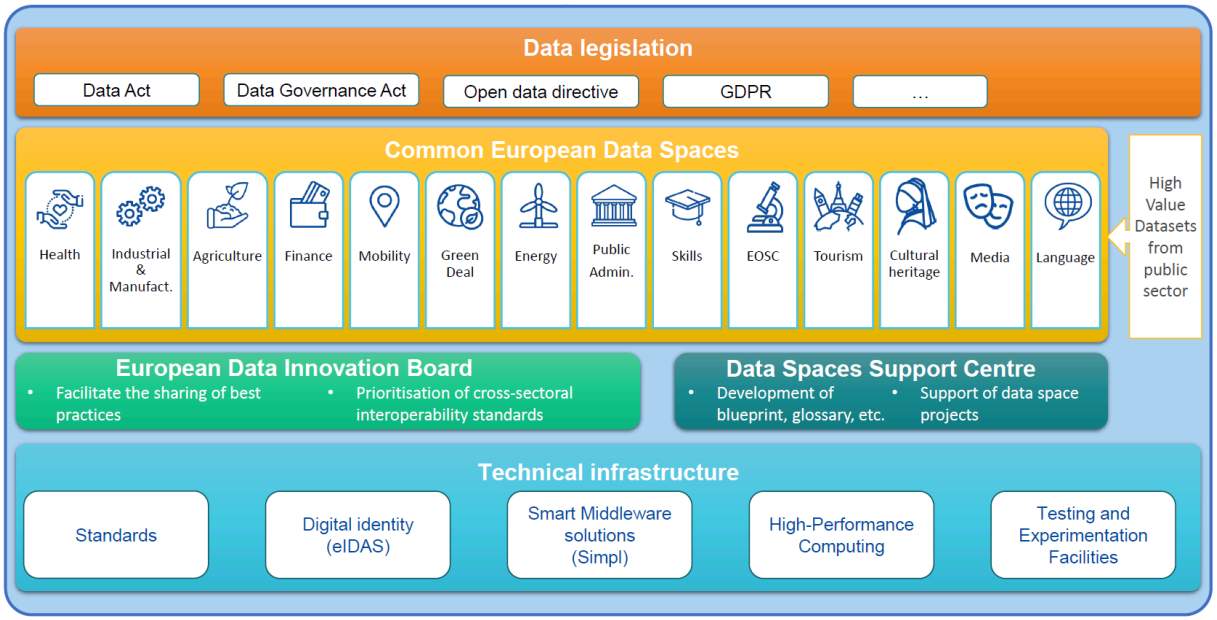

Figure 5 - European Single Market for Data
Source: DG CONNECT

3.1.4. The role of the European Commission in the data strategy

The European Commission is engaged in every phase of Data Spaces implementation, coordinating many stakeholders at different levels, proposing relevant regulations and policies, and funding core components and business-focused projects.

[15] https://digital-strategy.ec.europa.eu/en/activities/funding-digital

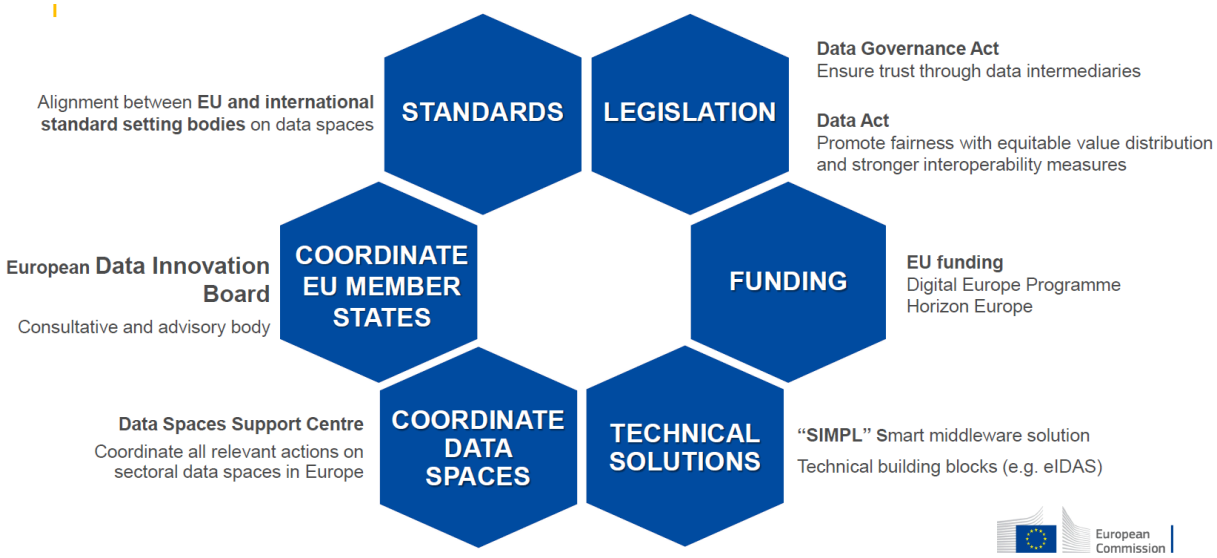

Figure 6 - European Commission support for Data Spaces
Source: DG CONNECT

The primary actions undertaken by the EU Commission for the 2020 European data strategy implementation are as follows:

- **Regulation:** The Data Governance Act (DGA)[16] proposes a comprehensive governance framework for the EU data strategy. At the same time, the Data Act (DA)[17] sets out rules governing the access, sharing and utilisation of data generated by connected products and related services, for specific purposes. Additional regulations will gradually enhance the EU data strategy 'regulatory package', including sector-specific rules, such as those for the health sector[18].

- **Governance:** The DGA introduces a new governance body at the EU level for data-sharing called the European Data Innovation Board (EDIB). This board comprises a wide range of stakeholders from the data-sharing ecosystem, such as the European Commission, EU member states, regulators, industry representatives, academia, civil society, standardisation organisations, relevant European Data Spaces, and other pertinent stakeholders. The EDIB is an expert group offering general guidelines for the effective execution of the EU data strategy. It is at the border between regulation and support.

- **Projects:** The EU supports various projects under the Digital Compass and the Digital Europe Programme (DIGITAL). Digital Compass derives from the European Commission's vision and targets a successful digital transformation of Europe by 2030. Both encompass overarching standardisation and support initiatives such as the Data Spaces Support Centre (DSSC), technological advancements such as the smart middleware for Data Spaces (Simpl), sector-specific Data Spaces' preliminary studies (CSA studies and associated sectoral Blueprints), and actual Data Space initiatives, as well as the new EDIC (European Digital Infrastructure Consortium)

[16] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32022R0868&qid=1738953478046
[17] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202302854&qid=1738953478046
[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022PC0197

framework which is supporting the implementation of the Common European Data Spaces by sector. The **various projects and initiatives related to one or another Common European Data Space are listed here**[19].

Figure 7 - Funding plan for Common European Data Spaces
Source: DG CONNECT

Data Spaces	2021-2022	2023-2024	2025-2027
Health	38.0	27.0	25.0
Language	6.0	5.0	
Mobility	9.0	15.0	
Media	8.0		
Manufacturing	17.0	13.0	10.0
Tourism	2.0	8.0	8.0
Green Deal	2.0	8.0	
Energy		8.0	
Agriculture	2.0	8.0	15.0
Skills	1.0	3.0	4.0
Total	**85.0**	**95.0**	**62.0**

Figure 8 - Breakdown of 2021-2024 DEP funding for sectoral Data Spaces
Source: DG CONNECT

[19] https://digital-strategy.ec.europa.eu/en/policies/data-spaces

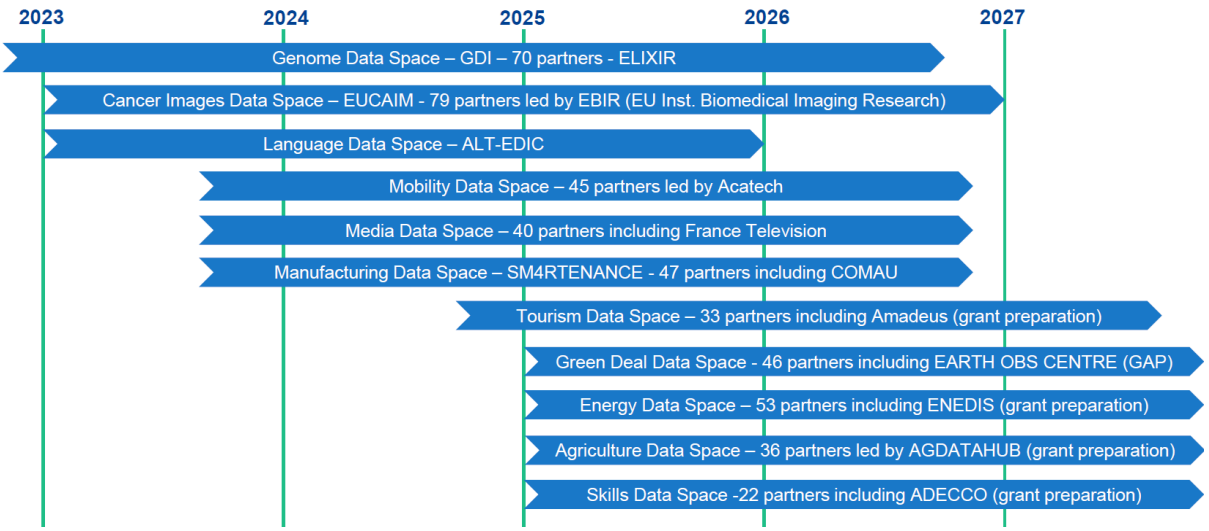

Figure 9 - Common European Data Spaces roll-out
Source: DG CONNECT

3.2. Framework of EU Space activities

3.2.1. Policy of EU Space activities

The **Space Policy of the European Union**[20] aims to tackle some of the most pressing challenges today, such as **fighting climate change, supporting public health enhancement and helping to stimulate technological innovation**. It includes EU Space Programme and Space Research and innovation.

3.2.2. Programme of EU Space activities

In April 2021, the Council and the European Parliament adopted a regulation establishing the new EU space programme for the years 2021 to 2027 which sets an ambitious agenda for a more dynamic, innovative and resilient European Space ecosystem. **The EU Space Programme**[21] implements **space activities in the fields of Earth Observation, Satellite Navigation, Connectivity, Space Research and Innovation**. It encourages and supports innovation and competitiveness through investments in critical infrastructures and disruptive technologies.

While striving to strengthen European space assets and services, it also **drives space entrepreneurship and innovative solutions based on space technologies, data and services** with targeted investments towards European start-ups and SMEs via the development of initiatives such as CASSINI[22].

[20] https://defence-industry-space.ec.europa.eu/eu-space-policy_en

[21] https://defence-industry-space.ec.europa.eu/eu-space/eu-space-programme_en#:~:text=The%20European%20Space%20Programme%20implements,Connectivity%2C%20Space%20Research%20and%20Innovation

[22] https://www.cassini.eu/cassini-initiative

The EU Space Programme is backing the European space industry and research by bringing together existing stakeholders and **contributing to the emergence of a European 'New Space' ecosystem**.

The EU Space Programme is implemented in close cooperation with the EU member states, the European Union Agency for the Space Programme (EUSPA), the European Space Agency (ESA), EUMETSAT and many other stakeholders. Ensuring effective and efficient cooperation and coordination between these actors is essential to optimise the impact of European policies and investment in space. The Programme's main targets are decision-makers, public authorities, EU commercial and private users and others, such as researchers and nongovernmental organisations. Ultimately, the programme serves the needs of EU citizens. The information gathered by the EU-owned satellites and the services which they provide are a public good, freely accessible to all.

In 2022, EU leaders identified Space as a strategic sector in the Strategic Compass[23] and called for an EU Space Strategy for Security and Defence. Building on this political momentum, the Commission and the High Representative have developed the **first-ever EU Space Strategy for Security and Defence[24]**.

In November 2023, the Council approved conclusions on the first EU Space Strategy for Security and Defence[25]. The Strategy proposes actions to strengthen the resilience and protection of space systems and services in the EU. For this purpose, the Commission will consider proposing an **EU Space Law** to provide a common framework for security, safety, and sustainability in Space, that would ensure a consistent and EU-wide approach.

3.2.3. Governance of EU Space activities

Ministers of the Council of the European Union and of the ESA Council at Ministerial level are meeting at regular intervals in so called **EU/ESA Space Councils[26]**.

The 9th high-level EU/ESA Space Council, with the theme **'Space as an enabler'**, took place on Tuesday, 28 May 2019, in the Lex Building of the European Commission in Brussels. Brussels. Ministers discussed European Space Policy, strengthening Europe's role as a global actor in the field of space, and highlighted how research and innovation are a driving force for a more competitive European Union.

The 10th high-level EU/ESA Space Council took place on Friday 20 November 2020 with the topic **'Orientations on the European contribution in establishing key principles for the global space economy'**.

The latest high-level EU/ESA Space Council (11th) was held on 23 May 2024 in Brussels (Belgium) with conclusions on space contributions to European competitiveness.

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[23] https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698057/EPRS_BRI(2021)698057_EN.pdf

[24] https://defence-industry-space.ec.europa.eu/eu-space-policy/eu-space-strategy-security-and-defence_en

[25] https://www.consilium.europa.eu/en/press/press-releases/2023/11/14/space-council-approves-conclusions-on-the-eu-space-strategy-for-security-and-defence/

[26] https://www.esa.int/About_Us/Law_at_ESA/Space_Council_Meetings

On top of the organisation of Space Councils, two meetings called **high-level 'Space Summit'** were held in 2022 and 2023. On 16 February 2022 in Toulouse (France), government ministers and their representatives from EU member states attended an informal EU Competitive Council Meeting on space, discussed the European Commission proposal for secure connectivity and space traffic management and exchanged views on ESA's three 'accelerators'. On 7 November 2023, during the Space Summit in Seville (Spain), a joint meeting of the ESA Council at Ministerial level and the Space Ministers of the European Union was held where coordinated advance has been made for **Space supporting the European Green Transition, sustainability in space, increased commercialisation in the European space ecosystem and securing autonomous, reliable and cost-effective access to space for Europe.**

ESA Agenda 2025[27] defines five immediate priorities as well as the vision for the coming years. The first two priorities are related to Space Data Space as the first priority is to **strengthen ESA–EU relations** and the second priority is related to **commercialisation**. ESA will closely work with the European Commission to develop a joint ambition for Space in Europe and to implement space programmes for European citizens.

In 2040, the market of Space, or the space economy is about $1 trillion, according to external estimates. **Can Europe afford not to participate? Of course we cannot.** European space companies should be among the biggest and best space companies, strongly contributing to a greener and more digital economic recovery.

3.3. Why a Data Space in general?

3.3.1. The untapped potential of data

The European Union (EU) unveiled its data strategy in 2020, anticipating that **the data economy in Europe will reach €829 billion by 2025**, a notable increase from the €301 billion valuation in 2018[28].

Despite a substantial daily production of data, **a large portion of the terabyte data produced (93%) remains underutilised**. Transforming data into actionable information depends on efficient and user friendly exploitation systems. The EU recognises that unlocking the full potential of data is crucial for becoming a leading force in the world emerging data landscape.

3.3.2. Beyond open data

Currently, the concept of open data serves as the main paradigm for accessing large amounts of data provided by public, and even private, organisations.

[27] https://www.esa.int/About_Us/ESA_Publications/Agenda_2025

[28] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en

Simultaneously, **a substantial amount of data, 'private data' or 'commercial data' (both personal and non-personal) remains inaccessible** due to privacy concerns, security, or commercial strategy considerations, and is not intended to be open data.

Enabling the sharing of such private, and potentially commercial, data among organisations (and citizens), beyond open data, **could foster the creation of new data value chains that are currently unreachable**. This would span across various sectors, opening up opportunities for novel use cases and delivering new benefits to a diverse range of stakeholders, including citizens.

3.3.3. The need for a paradigm shift in data-sharing

Establishing smooth connections between private data and services is a **complex task due to the scattered distribution across diverse organisations**, ranging from large to small, and involving both public and private entities. The paramount requirement is to **ensure that all stakeholders, including organisations and citizens, maintain control over their data**, fostering trust and enabling resilient ecosystem business models.

Achieving this requires **a collaborative approach**, and **the scale of this collaboration needs to be unprecedented** for seamless data-sharing across sectors and borders. **This aligns precisely with the goals outlined in the 2020 European data strategy** and the Common European Data Spaces[29].

3.4. Why a Space Data Space?

3.4.1. Unlocking the potential of space data for Europe

Space is a pivotal sector with profound implications for our economy, research, and citizens. Currently valued at $350 billion, **the global space industry could surpass $1.7 trillion by 2035** according to McKinsey[30], a significant figure, yet one that should not overshadow the $4 trillion value of the health industry in the USA alone or the $9 trillion it represents globally, constituting 11% of global GDP according to the World Health Organization (WHO).

Simultaneously, as Data Spaces emerge, **the Space sector experiences rapid growth**, leading to an exponential increase in data produced by public, institutional, and private actors. More companies are utilising space services, driving users to leverage space data for solutions and market development. Realising the full potential of space infrastructure and the data they generate is widely recognised as a catalyst for economic growth.

In this context, **establishing trustworthy data-sharing mechanisms with proper governance which avoids abusive market power lock-in** from any supplier is crucial. The creation of a Space Data Space is fundamental to achieving this goal. However, its success depends on addressing the needs of users and providers from the outset, fostering their participation, and accelerating the adoption of space data by the market and society.

[29] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en

[30] https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/space-the-1-point-8-trillion-dollar-opportunity-for-global-economic-growth

Additionally, the strength of a Space Data Space lies in **facilitating the integration of various space data types** (e.g., remote sensing, PNT, satellite communications, weather forecast) with other data sources (social media, in-situ, open data, Internet of Things, etc.).

The Space sector is experiencing notable developments, both in space-for-Earth applications facilitating terrestrial activities and space-for-space applications confined to orbital activities. Lower costs and enhanced technological capabilities are driving new developments and applications, attracting more companies and investors to the space economy. On the data front, advancements such as higher-resolution sensors have significantly improved image capture, data processing, and other functions. Satellites can now collect, analyse, and transfer much larger amounts of data than they could just five years ago, leading to the development of new use cases. Key applications for space-for-Earth include internet services in remote locations, Mobility, Agriculture, Energy, Insurance, and more.

A 2024 report by EUSPA[31] analysing the global market for Earth Observation and GNSS reveals **Europe ranking third with a 14% market share in Earth Observation data revenues, behind the USA (44.1%) and Asia-Pacific (20.4%).** Despite Europe's position as the largest provider of Earth Observation open data, there is a surprising disparity in shared data and added-value information, reflected in a forecast to 2031 projecting a slight erosion in market share for Europe. **Europe cannot be the champion of open data while others reap the benefits of it.**

Addressing this challenge **requires strategic efforts to enhance Europe's position in space data valorisation and ascend the space data value chain**. The Data Space concept and approach will complement open data efforts by helping space industry players better disseminate and monetise their space data assets across all sectors.

Reco 1: Europe should leverage Data Spaces to unlock the potential of space data.

Reco 2: Europe should leverage Data Spaces to avoid abusive market power lock-in.

Reco 3: Europe should leverage Data Spaces to create value with private and commercial data, beyond open data.

3.4.2. Should Space take part in Data Spaces?

The Space Data Space will unify fragmented and dispersed data from various space assets (such as Earth Observation (SatEO), Navigation (SatNAV), Communication (SatCOM), and Space Safety), integrating both private and public sectors. It will provide an interoperable, federated, and trusted IT environment for data processing, while establishing legislative, administrative, and contractual rules to ensure fair access and usage rights in accordance with existing EU data directives.

Given that all client industries of Space (e.g., Health, Finance, Mobility, Agriculture) already have or will have their own Data Spaces following the 2020 EU data strategy, it

[31] https://www.euspa.europa.eu/sites/default/files/euspa_market_report_2024.pdf

logically follows that the space industry should have its own Data Space. The Space Data Space would enable the space industry to influence decision-making regarding data policy. Space data is crucial to sectors prioritised by the EU data strategy, offering a chance to leverage investments in the EU data economy to foster the development of the Space downstream sector in Europe. This expansion could diversify the client base, stimulate cross-fertilisation, and inspire new use cases and business models.

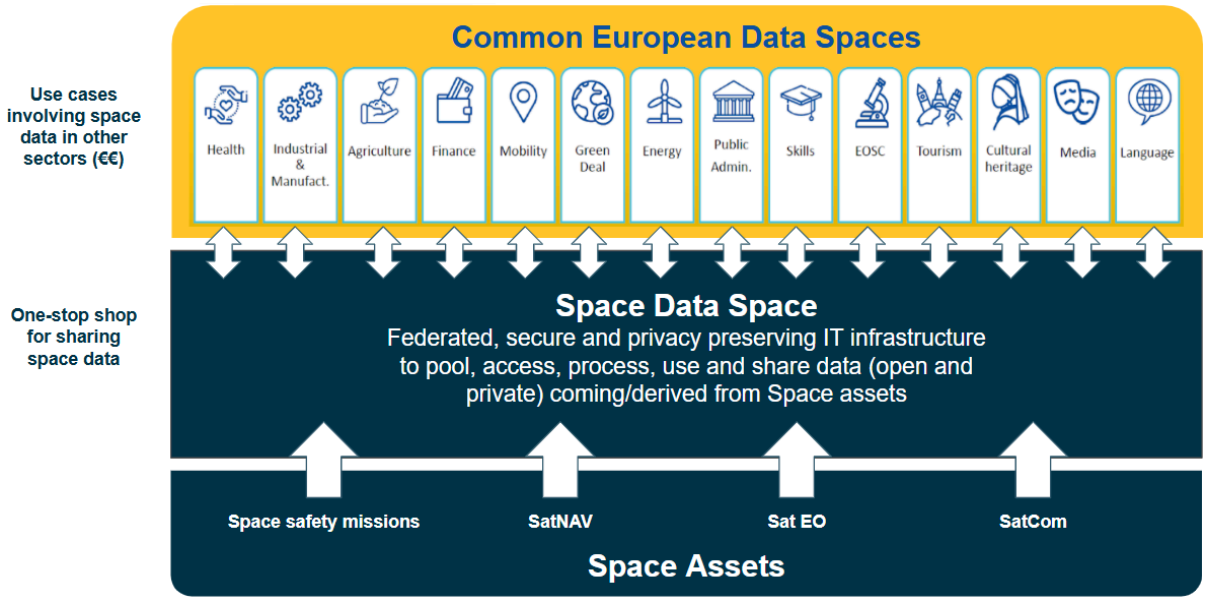

Figure 10 - Space Data Space and other sectoral Data Spaces

A Space Data Space, build on a secure IT infrastructure that preserves intellectual property and privacy, will help share, access, pool, process, and reuse vast amounts of data from or derived from space assets. This initiative bridges the current gap between non-space users with real use cases and the infrastructures of space assets providing data. Additionally, it will enhance operational efficiency by **offering a unified environment ('one-stop shop') for accessing and analysing data**. Such a Space Data Space will **bring together other emerging Data Spaces** in Europe, particularly around **geo-intelligence** services, fostering **new business development for the entire downstream value-chain** at a European scale.

The Directorate-General for Defence Industry and Space (EC DG DEFIS) has published a comprehensive Staff Working Document[32] that sheds light on the significant achievements and future potential of the EU Space Programme. This document, which aligns with the recommendations from the European Court of Auditors, emphasises **the importance of leveraging space data and services** across various sectors to enhance innovation, competitiveness, and sustainable development within the EU.

The **Conceptual Framework for the assessment of benefits of the EU Space Programme**[33] provides a structured approach to evaluate the economic, social, and

32 https://defence-industry-space.ec.europa.eu/commission-staff-working-document-eu-space-programme-user-uptake-status_en

33 https://defence-industry-space.ec.europa.eu/conceptual-framework-assessement-benefits-eu-space-programme_en

environmental impact of the use of the EU Space Programme data and services. It was developed in close cooperation with EUSPA and validated by the OECD, Eurostat, the Joint Research Centre (JRC), the European Space Agency and Member States' experts. These initiatives **underline the EU's commitment to maximising the exploitation of space assets**, fostering innovation, and driving sustainable development across EU/ESA member states and beyond.

Reco 4: The Space Data Space should help unify fragmented and dispersed data from various space assets.

Reco 5: The Space Data Space should offer new market opportunities with other sectors having their own Data Spaces.

4. What is a Data Space?

This chapter introduces the concept of Data Space, emphasising that it is not just a technological framework but also an organisational model. Data Spaces differ significantly from concepts like data lakes and open data. Moreover, while some data-sharing initiatives may claim to be Data Spaces, they often fall short of meeting the necessary criteria.

Why does this distinction matter? For a Space Data Space to achieve seamless interoperability within the Space sector, it must adhere to well-defined principles. To unlock its full potential for value creation, these principles should align with those governing Data Spaces in other sectors.

These foundational principles enable a network effect, supported by a strong trust framework. Indeed, organisations are more likely to share data when they retain control over what data is shared and for what purposes, ensuring their sovereignty is maintained.

4.1. Definition and characteristics of Data Spaces

4.1.1. Main definitions and glossary elements

Definition of a Data Space by the DSSC

"A Data Space is a distributed system that enables the secure and trusted exchange and sharing of data. The idea is that individuals, businesses and other types of organisations (collectively called 'parties') can share data in a manner that respects privacy, security and intellectual property rights. Thus, Data Spaces enable data sovereignty.

Data spaces help data users know where to get the data they need and reassure them that the data is valid for their purposes. This seemingly simple concept is, in practice, rather difficult to organise. Data space participants may not know and trust each other, and parties must be enabled to find the data they need. Such data come with the required assurances and policies. Also, there are various interoperability concerns at the technical, procedural, informational and legal levels."

Data Spaces Support Centre (DSSC) - Data Spaces Blueprint | Version 1.0

In other words:

A Data Space is **an ecosystem of organisations wanting to share private data** (personal and non-personal) **on a voluntary basis** and with **control over data reuse**, wherein they collaborate to establish a suitable **technological data-sharing infrastructure** and implement a **shared governance framework**, with the ultimate goal to **generate new added value** (financial, social, societal).

The concept of Data Space is evolving, and the term has slightly different definitions in different contexts. While there are different definitions of Data Spaces, they all share the same basic objective – to **facilitate trusted data flows in a fair and transparent manner, across sectors and borders,** for the parties involved in data-sharing.

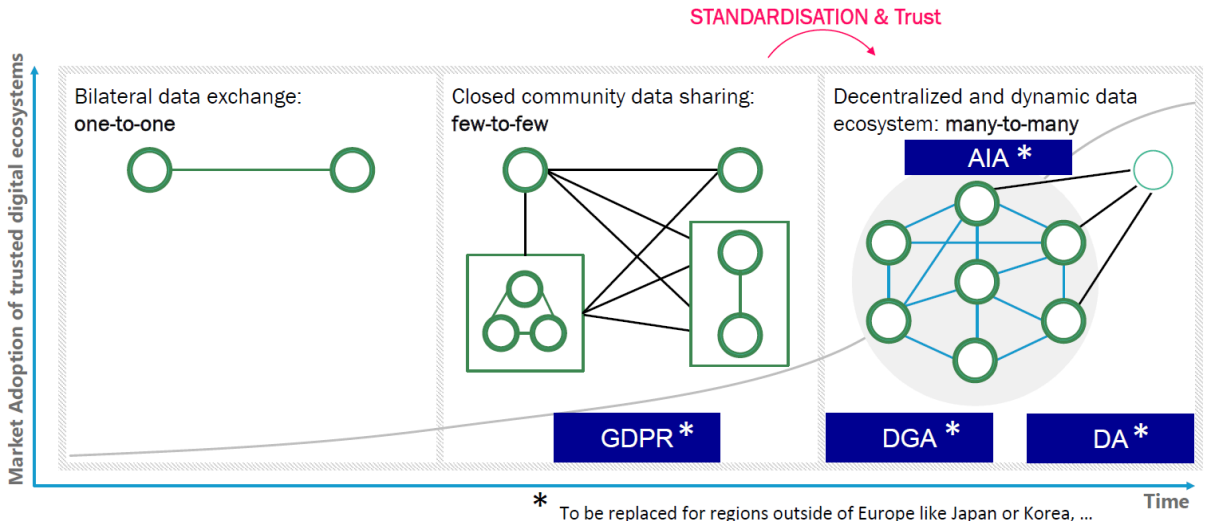

Figure 11 - From one-to-one to many-to-many
Source: Data Spaces Business Alliance

In Data Spaces, individuals and organisations, as data rights holders, control who can use their data and under what conditions. Control by participants within a Data Space is crucial for protecting privacy, safeguarding intellectual property, pursuing data monetisation opportunities, ensuring security, and other aspects.

Data Spaces enable data assets sharing among a network of different organisations, such as SMEs, public authorities, private companies, NGOs, and research institutes.

Data Spaces usually provide both organisational and technological resources for participants. Data Spaces, envisioned as a one-stop shop for data, form a level playing field in the European data strategy. They facilitate interoperability within a federated network of data ecosystems and services, reducing negotiation and transaction costs for their participants by standardising and federating metadata visibility/discoverability (e.g. via interoperable catalogues) and ensuring the interoperability of data formats and interfaces used to exchange data. The following table presents key DSSC glossary terms for the Data Spaces:

Table 1 - DSSC Glossary elements V2.0, Sept. 2023, Core Concepts
Source: DSSC

Term	Description
Data space	A distributed system defined by a **governance framework** that enables secure and trustworthy **data transactions** between **participants** while supporting trust and **data sovereignty**. A Data Space is implemented by one or more **infrastructures** and enables one or more **use cases**.

Data space participant	A party that has committed to the **governance framework** of a particular **Data Space** and may have one or more **roles** in it.
Data space role	A distinct and logically consistent set of responsibilities within a **Data Space**, that encompass associated rights and duties required to perform specific tasks, and that are designed to be fulfilled by one or more **participants**.
Data space governance	The processes to develop, maintain and enforce the **governance framework** of a particular **Data Space**. *Explanatory text: Data space governance includes organisational governance and data governance, whose scope is within a particular Data Space.*
Data space governance framework	The set of principles, standards, policies (rules/regulations), agreements and practices that apply to the governance, management, and operations (including business and technology aspects) of a **Data Space** as well as to the enforcement thereof, and the resolution of any conflicts.
Data space rulebook	The documentation of the **Data Space** governance framework for operational use. The rulebook can be expressed in human-readable and machine-readable formats.
Data space infrastructure	A technical, legal, procedural and organisational set of components and services that together enable actual **data transactions** to be performed in the context of one or more **Data Spaces**.
Data transaction	The result of an interaction between two participants with the purpose of sharing, accessing, exchanging or processing data.
Transaction participant	A **Data Space participant** that directly participates in a **data transaction** in a **Data Space** by providing data, providing permissions/consent related to the data or by receiving data and/or permissions/consent to use the data. **[role]**
Data space governance authority	The **Data Space participant** that is accountable for creating, developing, operating, maintaining and enforcing the governance framework for a particular **Data Space**, without replacing the role of public enforcement authorities. **[role]**
Data rights holder	A party that has (legal) rights and/or obligations to use, grant access to or share certain personal or non-personal data. Data rights holders may transfer such rights to others. **[role]**
Data provider	A **transaction participant** that, in the context of a specific data transaction, technically provides data to the **data recipients** that have a right or duty to access and/o*(service) provider.*
Data recipient	A **transaction participant** to whom data is, or is to be technically supplied by a **data provider** in the context of a specific **data transaction**. **[role]**

4.1.2. Key principles

A Data Space serves as a comprehensive framework facilitating the creation of an ecosystem through organisational, technological, regulatory, and governance measures. The Data Spaces, regarded as **'soft digital infrastructures'**[34], are designed to offer accessible and reliable data-sharing across diverse stakeholders and boundaries within a unified governance framework. It emphasises principles such as:

- **A secure and privacy-preserving infrastructure** to pool, access, share, process and use data.
- **A clear and practical governance structure for access to and use of data** in a fair, transparent, proportionate, and non-discriminatory manner and clear and trustworthy data governance mechanisms.
- **European rules and values**, in particular personal data protection, consumer protection legislation and competition law, are fully respected.
- **Data holders have the possibility to grant access** to or to share certain personal or non-personal data under their control.
- **Data that is made available can be reused** against compensation, including remuneration, or for free.
- **Participation of an open number of organisations/individuals** as long as they comply with the rules defined collectively.

4.1.3. Key features

The main features of Data Spaces are the following:

- **The federated catalogue:** which functions as a registry of all resources available on the network, such as data and services. Catalogue entries include resource descriptions, as well as regulations to which services adhere (e.g., GDPR, Data Governance Act, Data Act), and the conditions under which resources may be used by other participants in the network (e.g., rules, policies, code of conducts).
- **Trustworthy exchange:** which allows the definition, exchange, processing, and monitoring of data usage policies.
- **Identity Management:** which guarantees trust between suppliers and network users (organisations and individuals).
- **Compliance services:** which guarantees regulations (e.g., GDPR, DGA, DA) as well as user expectations translated into labels expressing levels of trust (from self-description to third-party audits).

4.1.4. What a Data Space is not?

It is crucial to **distinguish Data Spaces from :**

- **Open data,** where data producers/holders have minimal control over data reuse;

[34] Soft digital infrastructure refers to the non-physical elements that support and enable digital ecosystems, data flows, and technological functions. Unlike hard digital infrastructure, which includes physical components like data centres, cables, and servers, soft digital infrastructure comprises the systems, frameworks, and protocols that manage data, enable interoperability, and maintain cybersecurity. *Source: ChatGPT*

- and from **data lakes or hubs,** where data is either highly centralised or not easily accessible to a wide range of users, and where data-sharing rules are not defined collectively.

It is also important to emphasise that not all decision-making bodies or authorities that are involved in establishing data-sharing rules can be considered Data Spaces. Entities like member states parliaments or sectoral associations, along with standard and support organisations, contribute significantly to formulating rules for sharing data. However, their primary emphasis is on coordination and decision-making, rather than the development of data-sharing infrastructure or specific use cases, so they are not Data Spaces.

4.1.5. Building a network effect

Data-sharing introduces a range of challenges that necessitate interoperability through negotiations across multiple topics encompassing governance, technical, semantic, legal, business, and design considerations, and involve a variety of stakeholders. The purpose of a Data Space is to address these challenges and enable the development of a **'network of networks'. Ultimately, Data Spaces contribute to digital urbanisation.** This network effect unfolds in two phases:

1. **Intra Data Space sharing:** A Data Space initiative serves as **a platform for participants to share data among themselves**. Each Data Space initiative operates under its own governance framework, which defines a shared set of agreements documented in the Data Space Rulebook. It also provides technical tools to ensure participants can share data in compliance with these agreements.

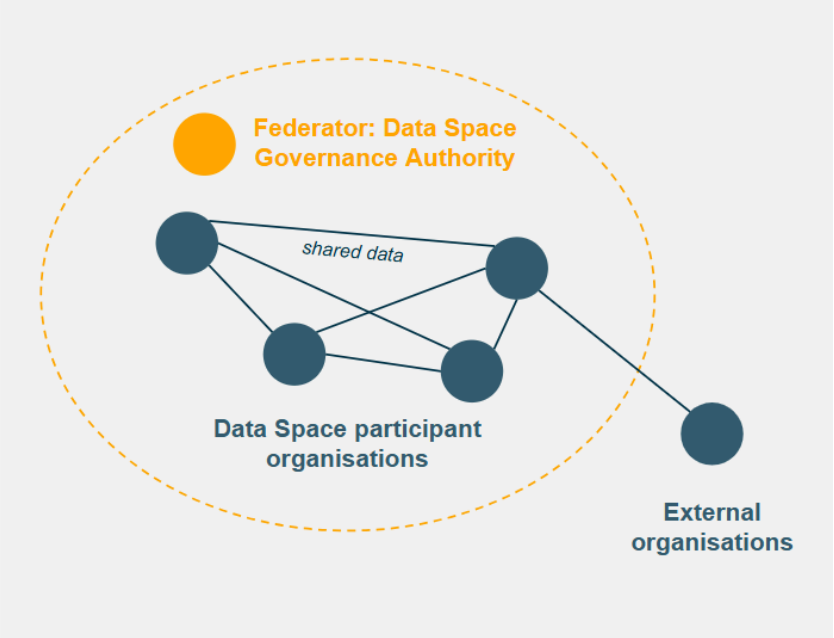

Figure 12 - Intra Data Space

2. **Inter Data Spaces sharing:** A Data Space initiative also streamlines interactions with external entities, whether individual organisations or other Data Spaces. Instead

of requiring participants from different Data Spaces to negotiate separately, the governance authorities of the respective Data Spaces engage in collective negotiations. Over time, **the proliferation of Data Spaces across various sectors creates a 'network of networks'**, enabling seamless data exchange across Europe and beyond.

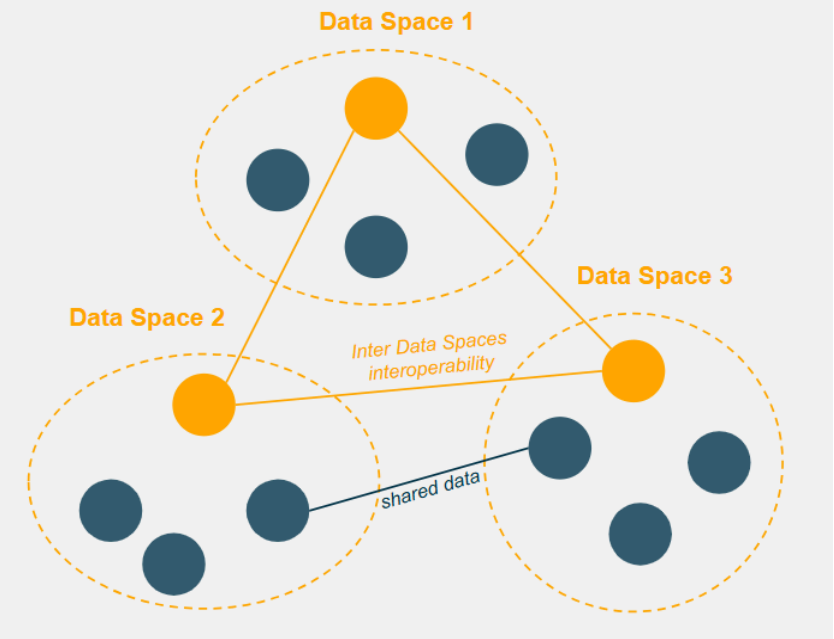

Figure 13 - Inter Data Spaces

4.1.6. Building sovereignty and trust

Sovereignty and trust for all participants of the Data Spaces, at an individual or collective level, are based on:

- **Clear governance frameworks:** The Rulebook of a Data Space outlines the rules, policies, and practices governing data-sharing, aligning participants and protecting them of unwanted risks (strategic, business, technical, legal, etc.). The decision-making process of a Data Space ensures representation of interests of all participants, transparency and accountability.
- **Compliance with European values:** Ensure that the Data Space adheres to European values and regulations (e.g., GDPR, Data Governance Act, Data Act, AI Act, competition regulation), including data protection, privacy, consumer protection legislation and competition law. Align data-sharing practices with the legal and ethical standards set by the European Union. Engage an ecosystem of trust with European or member state institutions (Data protection authorities, etc.).
- **Compliance with labels and quality:** Promote the use of labels and data quality processes by Data Spaces, and Data Spaces' participants (ex: Data Governance Act notified data intermediaries, Gaia-X labels, MyData operator certification, etc.).
- **Secure and privacy-preserving infrastructure:** This infrastructure should prioritise data security, confidentiality, and the protection of individuals' privacy rights.
- **Fair and transparent access rules:** Establish clear and practical rules for onboarding a Data Space, access to and use of data. These rules should be fair, transparent, proportionate, and non-discriminatory, fostering trust among participants.

- **Empowered data holders:** Provide data holders with the ability to control access to and sharing of their personal (through contracts and consent) or non-personal data (through contracts and authorisations). Empowering data holders contributes to building trust and ensures that shared data assets remain under their control.
- **Standardised protocols:** Encourage participants to use common technical infrastructure and open or standardised protocols (such as Gaia-X, IDSA, FIWARE, Simpl, MyData, etc.) for efficient and coordinated development.
- **User and community engagement:** Cultivate an environment that is open and inclusive, urging diverse organisations and individuals to actively participate. The inclusion of a varied participant base enriches and diversifies the Data Spaces, preventing monopolistic behaviours and promoting counter powers.
- **Value generation:** Emphasise the creation of new added value, both financial, social and societal, from data. Develop use cases that demonstrate the transformative potential of shared data and encourage innovation.

4.1.7. The Data Space Cookbook

The establishment of Data Spaces can take various forms, depending on **the will of stakeholders of a same 'community of practice' (CoP) to collaborate directly**. A Data Space initiative **typically encompasses a mix of private and public organisations**, manifesting in diverse structures, such as:

- **Sectoral or cross-sectoral collaborations;**
- **EU-level, national, or local initiatives;**
- **Public and/or private-driven endeavours;**
- And more.

The Data Space Cookbook

Once an initial group of organisations agrees to establish a common Data Space initiative, they should follow these steps:

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1. Define a common scope and Mission Statement

- Clearly articulate the **purpose and objectives** of the Data Space initiative.
- Identify the **scope and boundaries** of data-sharing use cases that align with the initiative's goals.

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2. Create a governance structure

- Form a **Data Space Governance Authority (DSGA)**, potentially backed by a legal entity (e.g., an association, a cooperative).
- Determine **decision-making processes** for the governance authority.

- Establish a **governance framework** that specifies the roles, responsibilities, and rules for participants in a **machine-readable Rulebook**.
- Identify and integrate **relevant sectoral and cross-sectoral regulations** into the Rulebook.
- Incorporate **soft-law measures** (e.g., codes of conduct) into the Rulebook.
- Implement **robust data governance mechanisms** ensuring trust, privacy, security, and transparency.
- Define **conditions for participation** and the **onboarding process** for new participants.
- Set out an **access rights framework** and **data management practices**.
- Establish **mechanisms for monitoring** and **dispute resolution**.
- Specify **rules and practices for sharing data externally**, with individual organisations or other Data Spaces (Inter Data Spaces).

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3. Identify the landscape

- Engage with **EU-level governance and regulatory authorities**.
- Work with **sector-specific coordinating bodies and authorities**.
- Connect with **other Data Space initiatives within the same sector**.
- Identify and liaise with **Data Space initiatives in adjacent or partner sectors**.
- Collaborate with **Data Space standards and support organisations**.

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4. Develop Use Cases

- Adopt a clear and practical **methodology for co-designing use cases** among Data Space participants (Intra Data Space) or with other Data Spaces (Inter Data Spaces).
- Foster an **open and inclusive environment** to attract a diverse range of participants, including public and private organisations and user communities.
- Facilitate **communication and agreements on use case co-design** among participants.

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5. Develop a Business Model

- Determine how participants will **monetise data and services** and **compensate each other**.
- Determine a business model to **support the maintenance and upgrading the technical infrastructure**.
- Determine a business model to **support the Data Space Governance Authority**.
- Define the **incentive framework** encouraging participation of all stakeholders.

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6. Develop a Technical Infrastructure

- Identify **cross-sectoral standards** (e.g., identity, contracts, consent, rules).
- Determine **sector-specific standards and ontologies** relevant to the sector.
- Evaluate **existing technological stacks**, whether open source or proprietary, prioritising open standards and protocols for interoperability within and across Data Spaces.
- Build and implement the **core building blocks of the Data Space's data-sharing infrastructure**, adhering to established Data Space standards and protocols.
- Create a **data collaboration platform** with user interfaces (UI)—including features like a marketplace, use case factory, contract negotiation, and billing—that can be operated by multiple organisations within the Data Space or by a single **Data Space Operating Company** appointed by the DSGA.
- Develop additional **middlewares** for specific use cases (e.g., digital twins, AI agentic frameworks, new data sources, etc.).

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7. Funding

- **Pool resources** from founding organisations.
- Seek **public and private funding** for infrastructure development.
- Seek **public and private funding** for use case development.

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8. Operate

- **Run the data-sharing infrastructure** and any additional components.
- Support participants in **deploying Data Space Connectors** on their own infrastructure **'self hosted'**, or provide them with **'Connectors as a Service'**.
- **Oversee governance activities**, such as managing semantic hubs.
- **Recruit new participants** to expand the ecosystem.
- **Develop use cases** within the Data Space (Intra) and in collaboration with other Data Spaces (Inter).
- **Monitor performance** against predefined objectives to ensure ongoing progress.
- Continuously **evaluate the impact** of the Data Space on data-sharing, innovation, and the achievement of its overall goals.

All the topics presented in the Data Space Cookbook will be developed further in the following parts of this document.

4.2. Main benefits of a Data Space

4.2.1. Types of benefits

Data Spaces creates multiple benefits for their participants, such as:

- **Expansion of market and audience:** Improved access to a wider and more diverse customer base through expanded channels for selling data or services. For instance, initiatives within the Space Data Space will enhance business opportunities by engaging with participants from Data Spaces in various sectors such as Agriculture, Mobility, Tourism, Green deal, Health, Energy, and more.
- **Diversification of income streams:** Development of innovative products and services, including the sale of valuable data products, advancements in AI services (enhanced by more comprehensive, higher-quality, or diverse datasets), and the creation of cross-sectoral services.
- **Scalability:** Data operations can grow without significant increases in complexity as Data Spaces lower transactions costs, allowing businesses to expand smoothly without facing major obstacles.
- **Economies of scale:** The Space Data Space will enable organisations to share the costs of technical infrastructures and data-sharing services, leading to cost efficiencies and increased profitability. This includes reductions in data storage expenses through efficient organisation, compression, and removal of redundant data.
- **Collaboration effectiveness:** Reduced time and effort required for collaborative data projects due to collaborative platform features and streamlined sharing.
- **Data quality:** A decrease in data errors or inaccuracies due to improved data governance within and across Data Spaces.
- **Security:** Cost savings from preventing data breaches or unauthorised access to sensitive data through enhanced security features.
- **Compliance with regulations:** Reduced fines and legal risks by adhering to data governance and protection standards within Data Spaces.
- **Innovation and data insights:** Accelerated extraction of insights from data, enabling quicker recognition of trends and opportunities, as well as a higher rate of innovative projects and solutions derived from recombined data.

4.2.2. Benefits for all kinds of participants

Data Spaces represent a major opportunity for all kinds of participants:

- **Organisations** will be able to:
    - (re)take control of their digital distribution channels from Big Tech,
    - Increase efficiency for internal processes involving external organisations,
    - increase their data and services visibility,
    - enable a seamless end-to-end user experience,
    - foster greater interoperability and innovative cross-platforms use cases between multiple digital services,
    - certify data and services products,

- benefit from fair redistribution of value (including the long tail of small actors),
- benefit from larger spectrum data analytics.

- **Individuals** (Digital Services Users, Citizens) will benefit from:
  - a seamless end-to-end user experience independent from large platforms,
  - a high degree of services personalisation.
  - ways to control the flow of their data (through the management of identity, consent & secure communications tools and protocols).

4.2.3. An enabler for Artificial Intelligence and vice versa

AI development thrives in data-rich environments, where companies often leverage data from Web public sources, open data, or proprietary assets. This has given Big Tech a significant advantage. The European Commission's data strategy aims to democratise data accessibility. **Data Spaces enable organisations to confidently share and pool vast amounts of private and commercial data across sectors and organisations for AI development.**

Data Spaces embody a new era of data sovereignty, providing **a Europe-centric alternative to vertically integrated cloud, data, and AI solutions currently dominated by non-European providers**. Specifically designed for the European market, they are pivotal in building a unified digital ecosystem that supports the European cloud infrastructure and **delivers essential data resources for training and deploying AI systems**, particularly in the context of new networks of AI services, or 'Agentic AI', involving contributions from a wide range of organisations.

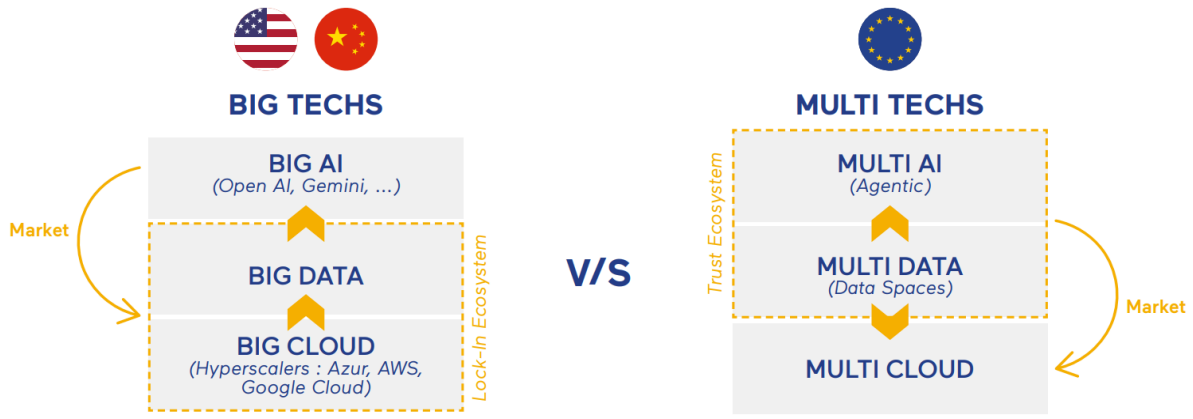

Figure 14 - Data Spaces as an alternative to cloud/data/AI Big Tech
Source: Digital New Deal[35]

Regarding the Space sector, AI plays a crucial role in **structuring, analysing, and synthesising vast amounts of data from diverse sources**, creating a collaborative and cohesive space data ecosystem. This includes integrating data from various sensors (e.g., radar, optical, infrared) and multiple space missions, such as Earth Observation and

[35] Generative AI: Unite or submit. Using corporate data to strategically enrich AI models. *Digital New Deal, 2024*. https://www.thedigitalnewdeal.org/wp-content/uploads/GenAI-DND-Medef-EN.pdf

planetary exploration, unlocking smarter, faster, and more efficient ways to process and analyse the massive datasets generated by space activities. Through automation, predictive analytics, and enhanced global collaboration, **AI facilitates the potential of the Space Data Space to be fully realised**.

Generative AI, in particular, extends these capabilities by **enabling the creation of new insights, models, simulations, and synthetic data**. One of the main challenges in managing space data lies in its diverse sources—spanning national space agencies, private enterprises, and international research institutions—where sharing raw data is often restricted due to privacy concerns or national security. Generative AI can address this issue by **supporting federated learning, allowing models to train on decentralised datasets without exposing raw data**. Additionally, synthetic data generated by AI retains essential characteristics while safeguarding sensitive information, enabling secure and unrestricted sharing among stakeholders. **By adopting generative AI, the EU can bolster its space capabilities**, drive technological innovation, and enhance global sustainability and security. This also sets the stage for new EU-centric policies that open pathways for economic growth while ensuring ethical and fair practices.

As a platform for trustworthy AI, Data Spaces align with European values, ensuring compliance with regulations while fostering a fair environment for all stakeholders. They play a vital role in shaping AI systems by utilising extensive data and industry expertise while influencing infrastructure governance. The federated structure of Data Spaces helps level the playing field, allowing AI technologies, including Generative and Agentic AI, to be developed using large datasets indirectly accessed through Data Space agreements. Data, which is currently fragmented across public and private information systems, can now be harnessed effectively.

Reco 6: Data Spaces, and the Space Data Space, should become Europe's key differentiator in the race for AI.

4.3. From data lakes to Data Spaces

4.3.1. Data-sharing classification model

Data-sharing is not new and the Data Space paradigm is one of the many concepts supporting it. **There are multiple forms of data-sharing initiatives in the Space sector today**, it is important to categorise it before understanding how to integrate it in a Data Space. Here below we present a data-sharing classification model.

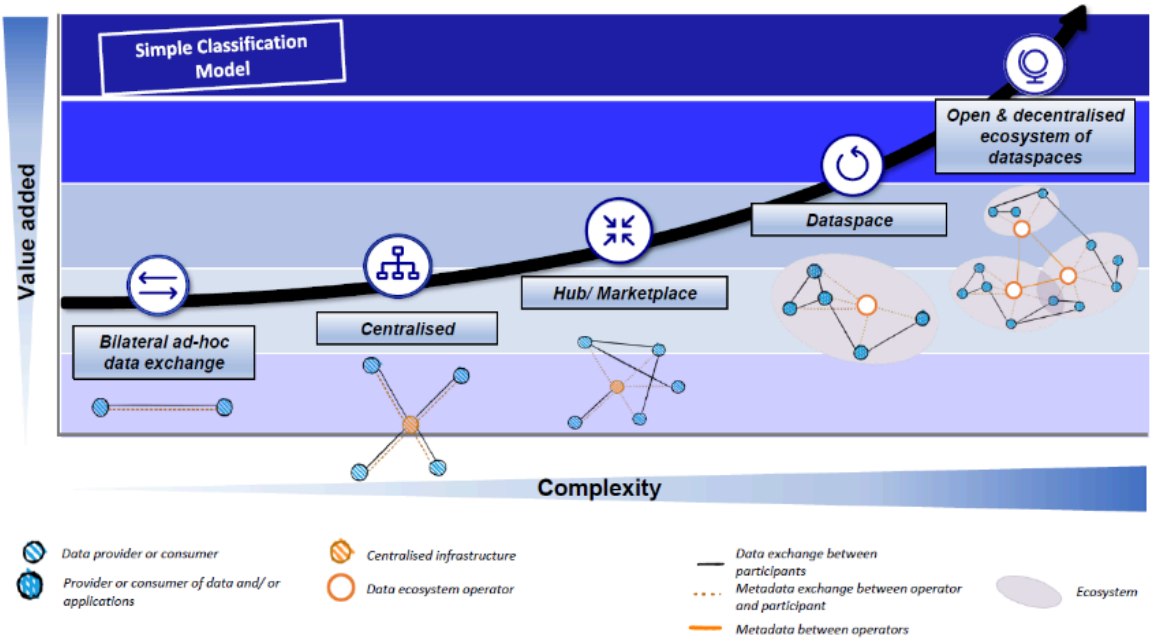

Figure 15 - Data-sharing classification model
Source: Alberto Palomo, Chief Strategy Officer Gaia-X, former Chief Data Officer of Spain

The suggested model for classifying data-sharing ways introduces various approaches, ranging from low to high complexity:

- **Bilateral ad-hoc data exchange:**
  - **Description:** This method involves direct data-sharing between two parties where participants need to negotiate rules for sharing data (technical, semantic, business, etc.) between each other.
  - **Characteristics:** Point-to-point communication, minimal structure, often manual or semi-automated, low complexity, very limited scalability, specific and ad-hoc agreements.
- **Centralised data exchange:**
  - **Description:** Data exchange occurs through a centralised platform or entity that defines all the necessary rules for sharing data (technical, business, etc.) on its own. The platform provides a certain level of technological standards and components for data exchange.
  - **Characteristics:** Centralised repository, standardised protocols, moderate complexity, centralised control, moderate potential for scalability.
- **Marketplaces:**
  - **Description:** Platforms connecting multiple data providers with potential consumers. Allowing participants to negotiate certain aspects of data-sharing between each other (peer-to-peer) but the centralised platform defines the general rules.
  - **Characteristics:** Centralised coordination, standardised interfaces, may involve pricing and transaction mechanisms, moderate to high complexity, increased flexibility and scalability, facilitated interactions.
- **Single Data Space:**

    - **Description:** A dedicated environment where participants collectively define the necessary governance rules for sharing data (Intra Data Space), and benefit from a shared technical infrastructure.
    - **Characteristics:** Common data standards, supports various data-sharing use cases, supports high complexity and scalability, collective governance, shared rules and infrastructure.
- **Data Spaces open & decentralised ecosystem:**
    - **Description:** An interconnected network where diverse Data Spaces federate and allow their respective participants to share Data across the boundaries of each Data Space.
    - **Characteristics:** Federated architecture, interoperability standards, cross-sector collaboration, allows for shared services and data exchange, highest complexity, extensive scalability, high interoperability among various ecosystems.

This classification model provides a spectrum of data-sharing approaches, allowing stakeholders to choose the level of complexity that aligns with their specific needs and objectives. Within the data-sharing model, **Data Spaces offer the benefits of mutualising infrastructure efforts, enhancing interoperability alignment, and reducing transaction and negotiation efforts among parties.**

4.3.2. Advantages of Transitioning from data lakes to Data Spaces

Following Google definition: *"A data lake is a centralised repository designed to store, process, and secure large amounts of structured, semi structured, and unstructured data. It can store data in its native format and process any variety of it, ignoring size limits.*[36]*"*

In the suggested classification model for data-sharing, **a data lake would be categorised as centralised data exchange**, exhibiting a moderate level of complexity. However, **it comes with scalability limitations when contrasted with the capabilities of Data Spaces**.

Transitioning from a data lake to a Data Space requires a detailed assessment of organisational needs, infrastructure, and long-term objectives, taking into account factors such as implementation complexity, data migration challenges, training requirements, and potential vendor lock-in.

A number of data-sharing initiatives and data lakes are already under development across Europe, including several within the Space sector. **The Space Data Space does not aim to compete with these existing efforts**; rather, its purpose is to break down silos in space industry data projects and maximise the potential for downstream reuse of space data. **The main challenge** in connecting these initiatives with Data Spaces **lies in aligning interoperability standards and governance practices.**

36 https://cloud.google.com/learn/what-is-a-data-lake?hl=fr#:~:text=A%20data%20lake%20is%20a,of%20it%2C%20ignoring%20size%20limits

Reco 7: The Space Data Space should help existing data lake of the Space sector to transition to Data Space initiatives or federate with it.

4.4. State of progress of the Data Spaces

Data spaces are emerging across various sectors in Europe, with **most initiatives still in early development stages** and only a few advancing beyond pilots. Each initiative recognises the importance of common rules for data-sharing. As Data Spaces become more available, **the market demand for trusted data-sharing solutions is growing**, supporting the shift towards viewing data as a product.

Despite the ongoing business transformation emphasising data as a reusable product, **many organisations still hesitate to share data due to concerns about losing control and the lack of clear incentives**. Some see regulations like the Data Governance Act merely as compliance issues, overlooking their potential for value creation. However, **early adopters willing to share data are driving the market demand for Data Spaces**, seeking to establish trust and common rules with their peers. While one-to-one data-sharing, data lakes, data marketplaces practices exist, challenges arise in creating common rules within multilateral contexts and unfamiliar relationships.

Additional details about the status of the Common European Data Spaces could be found in the second Staff Working Document (SWD)[37], published in January 2024 by the European Commission.

Estimating a number of Data Space is possible however we consider more relevant information indicating the budgets already committed by the European Commission and some EU member states for supporting numerous data-sharing initiatives.

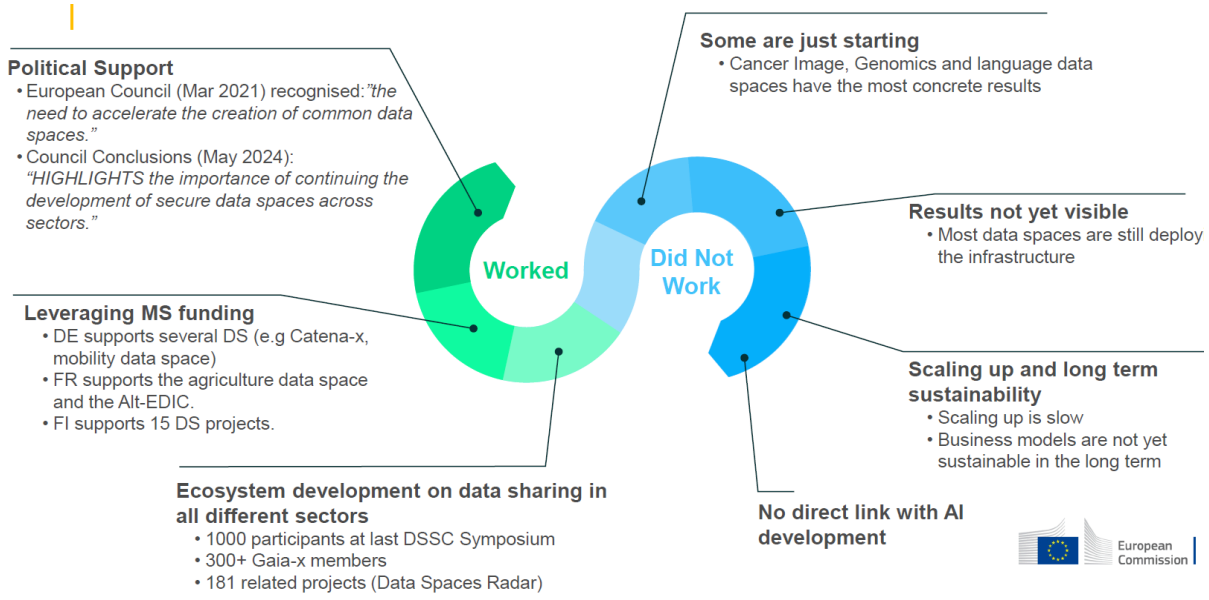

Figure 16 - Data Spaces status
Source: European Commission

[37] https://digital-strategy.ec.europa.eu/en/library/second-staff-working-document-data-space

Gaia-X AISBL has collected in June 2024 the information listed in the following picture.

Source	Programme	€	comment
Germany	National Funding	435 M	Data Ecosystems: Gaia-X Funding Competition (11 Projects), Manufacturing-X, Catena-X, Gaia-X 4 Future Mobility, EuProGigant, Energy data-X, GXFS-DE
Spain	National Funding	202 M	150 M for Industrial Data Spaces Open Call, 50 M for Tourism Data Spaces Open Call, 1 M for Gaia-X "Data Economy Association" Hub, 0.9 M for sovereign data technologies DEV project
France	National Funding	124 M	40 M Data4industry-X , 70 M for new call for tender, 14 M GFXS-FR
Luxembourg	National Funding	20 M	National funding for Gaia-X projects
Austria	National Fundning	23 M	Data space Technologies, Digital Product Passport, Production, Mobility, Energy and Healthcare
Denmark	National Funding	5 M	Gaia-X Hub
Flanders	Regional Funding	32 M	Flemish Smart Data Space, Athumi (Flemish Data Utility Company)
The Netherlands	National Funding	217 M	69 M Health-RI (health data sharing for secondary usage), 85 M DMI (Dutch Metropolitan Innovations ecosystem), 51 M DIL/BDI (Digital Infrastructure Logistics/Basis Data Infrastructure), 12 M CoE-DSC (Center of Excellence for Data Sharing and Cloud)
Finland	Sitra	3 M	Sitra invested 2,6 M of which EUR 625.000 was used to co-finance 5 pilot projects related to data spaces. The co-financing rate covered by Sitra per project was 70%, the rest 30% was covered by project consortia members.
EU	Digital Europe Work Programme 2021- 2024	657 M	300 M for topics supporting the deployment of the cloud-to-edge infrastructure and services, including the Testing and Experimentation Facility for Edge-AI; 357 M for topics deploying the sectorial data spaces and the related support activities, including the High Value Data Sets and Digital Product Passport. **This set of calls includes the DSSC (14 M) and the procurement for Simpl (106 M).**
EU	EU4Health	280 M	Implementation of European Health Data Space
EU	Horizon Europe	100 M	Energy Data Spaces and R&I projects
EU	Digital Europe Work Programme 2021- 2024	240 M	Destination Earth initiative
SUBTOTAL		**2,338 M**	**Public investment for interoperable Data spaces based on European Values**
France, Germany, Hungary, Italy, the Netherlands, Poland, Spain	IPCEI-CIS	1,200 M	The Member States will provide up to €1.2 billion in public funding, which is expected to unlock additional €1.4 billion in private investments.
SUBTOTAL		**1,200 M**	**Public investment for a federated Cloud infrastructure**
TOTAL		**3,538 M**	**Public investment for a data driven European economy**

Figure 17 - Public funding for Data Spaces & Cloud Infrastructure in Europe
Source: Gaia-X

5. Use cases for Data Spaces

Before delving into the concrete use cases developed over the past few months by the same team who authored this Blueprint, we first outline the process that enables organisations to create one. It begins, once again, by clarifying essential elements (a glossary) and then addresses scenarios, end-user journeys, and use-case development.

5.1. Glossary elements

Table 2 - DSSC Glossary elements V2.0, Sept. 2023, Data space use cases and business model
Source: DSSC

Term	Description
Data space use case	A specific setting in which two or more participants use a Data Space to create value (business, societal or environmental) from data-sharing.
Data space usage scenario	A potential use case envisaged to solve societal, environmental or business challenges and create value. The same usage scenario, or variations of it, can be implemented as a use case multiple times in one or more Data Spaces.
Use case orchestrator	A Data Space participant that represents and is accountable for a specific use case in the context of the governance framework. The orchestrator establishes and enforces business rules and other conditions to be followed by the use case participants.
Use case participant	A Data Space participant that is engaged with a specific use case and may have one or more roles in it.
Use case development	A strategic approach to amplify the value of a Data Space by fostering the creation, support and scaling of use cases.
Data space pilot	A planned and resourced implementation of one or more use cases within the context of a Data Space initiative. A Data Space pilot aims to validate the approach for a full Data Space deployment and showcase the benefits of becoming a participant of the Data Space.
Data space value	The cumulative value generated from all the data transactions and use cases within a Data Space as Data Space participants

	collaboratively use it.
Synergy between Data Spaces	The gained efficiency, increased impact or other benefits of two or more Data Spaces working together that are greater than if the Data Spaces were working separately. The synergies between Data Spaces can be enabled by common practices, communication concepts, services and/or components, which increase Data Space interoperability and enable harmonised processes of using different Data Spaces.

5.2. What are Data Spaces use cases?

5.2.1. Difference between usage scenario and use case

As defined by the DSSC[38], **usage scenarios provide general and theoretical descriptions of how a Data Space is used**, while **use cases are practical implementations of these scenarios**. It is crucial to design usage scenarios with scalability in mind to accommodate potential future expansions, ensuring continued value for participants.

Thorough examination and mutual agreement on usage scenarios by all involved parties are essential. **The detailed definition of usage scenarios involves:**

- establishing objectives,
- potential benefits,
- identifying functionalities,
- and detailing enablers for development, including stakeholders, roles, and interconnections.

This process helps illustrate the importance of connecting service and data providers, showcasing why Data Spaces are necessary and how they prevent data fragmentation, encourage data standardisation on data interfaces and/or metadata, and enhance data security and privacy.

5.2.2. Characterisation of a use case

Characterisation of a Data Space use case

To maintain a consistent structure and scope, the Space Data Space should document use cases by including at least the following elements:

- **Title:** a concise and descriptive title that captures the essence of the use case.

[38] https://dssc.eu/space/BBE/178422021/Use+Case+Development

- **Problem(s)/need(s):** explain the key stakeholders' need(s) or problem(s) that could be addressed by the use case, paying particular attention to resilience and sustainability.
- **Desired solution:** describe the application/use of the Data Space conceived to address the aforementioned problem(s)/need(s).
- **Needed data types:** macro-categories of the data needed to solve the aforementioned problem(s)/need(s).
- **Needed datasets per data type:** main needed datasets grouped by data type and mentioning the level of granularity needed.
- **Stakeholders and roles:** main stakeholders' categories involved in data-sharing and their roles as data provider, data consumer or data intermediary.
- **Stakeholders' relations and type of data exchanged:** which datasets are provided and consumed by which category of stakeholders within the context of the use case and under which exchange conditions (added value for both parties).
- **Application of the solution:** specification on whether the same use case could be adapted to a different context or purpose and whether it can be scalable at different geographical levels.

5.2.3. Selecting use cases

For the DSSC, **a key source of inspiration for new use cases comes from understanding the needs of both current and potential Data Space participants**. **Ideas may also originate from outside the Data Space, such as other Data Spaces** or different data-sharing contexts. The Data Space should track the progress of use cases, monitoring successful implementations, potential (yet unrealised) scenarios, and those that have been abandoned. Successful use cases provide inspiring examples and best practices. By analysing this information, the Data Space can identify archetypes that capture the core elements of various successful cases. Additionally, tracking which use cases were attempted but abandoned, along with the reasons (such as lack of market demand or implementation challenges), helps prevent the repetition of unsuccessful approaches.

A set of principles and criteria has been established to provide guidance for identifying and selecting use cases in the initial deployment of the Space Data Space. Key considerations include:

- **Consulting space stakeholders**, especially during two critical phases:
  - identifying needs that the Data Space could address and developing the use case, which involves defining the datasets for exchange;
  - identifying stakeholders engaged in data-sharing, and delineating their roles.
- **Involving other sectors** directly or indirectly related to Space, such as Mobility, Tourism, Agriculture, Health, Energy, etc.

Reco 8: The Space Data Space should identify data-sharing use cases by consulting Space stakeholders as well as Data Spaces from other sectors.

5.2.4. The Participant Journey

Effectively conveying the Data Space concept, especially to non-technical participants, is a primary challenge. Despite detailed overviews provided by the DSSC conceptual model and building blocks approach regarding trust, data sovereignty, interoperability, business models, and data governance, **there is a need for a non-technical understanding of the operational processes within the Data Space**. While key concepts are clear, their practical application at an operational level remains less transparent. The challenge lies in articulating the unique aspects of the Data Spaces paradigm and showcasing its tangible benefits for data valorisation within and outside a company/organisation.

The participant journey within a Data Space typically involves several key steps, reflecting the main phases of the Data Space engagement life cycle. These steps are designed to guide participants, including data providers, consumers, and intermediaries, through the process of sharing and accessing data in an interoperable and standardised way.

Main steps in a participant journey within a Data Space

1. **Onboarding of participants:**
    a. The entity (organisation or individual) seeking to engage with the Data Space and become a participant onboards on the Data Space portal.
    b. The participant declares key data products (or services) it wants to primarily offer or seek within the Data Space.

2. **Publishing data products and creating new use cases:**
    a. A participant can publish data products (or services) it wants to provide to other participants. In this context the participant becomes a data provider that will provide data to potential data recipients.
    b. The data provider publishes a data-sharing use case and defines conditions for sharing data products (business or technical rules) that need to be compliant with the Data Space rulebook. In this context the data provider becomes a use case orchestrator.
    c. The data provider engages with interested parties (data recipients) that it has accepted, and starts co-design the use case with them.

3. **Searching for existing data products and use cases:**
    a. A participant can search for data products (or services) by entity, type of data, or existing use cases already published, and involving one or more other participants.

b. The participant declares its interest in a data product and becomes a data recipient.
c. The data recipient engages in a use case with the use case orchestrator and potential other use case participants for co-design.

4. **Co-designing a use case:**

    a. The use case participants (involving the use case orchestrator, data provider(s), data recipient(s)) define and negotiate all aspects (technical, business, UX, etc.) or the use case, following the rules established in the Data Space Rulebook.

5. **Contractualisation:**

    a. After the co-design phase (involving the use case orchestrator, data provider(s), data recipient(s)), the use case participants establish a use case contract that is compliant with the rulebook of the Data Space.
    b. The participants of the use case negotiate the use case contract.
    c. The participants of the use case sign the use case contract.

6. **Implementation:**

    a. The participants of the use case put in place the technological means to realise the use case ('self hosted' connectors on their information system or 'Connector as a Service' tools provided by a third-party infrastructure player).

7. **Monitoring & billing:**

    a. The system allows use case participants to monitor/track data flows and ensures that contractual agreements have been fulfilled.
    b. The system allows use case participants to bill each other.

5.2.5. Example of a use case co-design framework

Designing new use cases involving two or more Data Space participants is complex, as it involves challenges like identifying opportunities, defining scope, and assessing value for stakeholders. In this context, **the Data Sharing Coalition**[39], which is an open and growing, international initiative in which a large variety of organisations collaborate on unlocking the value of (cross-sectoral) data-sharing, proposed **a use case design framework called the Use Case Playbook**[40]. This playbook facilitates the quick and structured generation, assessment, and realisation of scalable use case ideas. It comprises five steps:

[39] https://nlaic.com/en/partner/data-sharing-coalition/
[40] https://datasharingcoalition.eu/our-approach-and-tools/use-case-playbook/

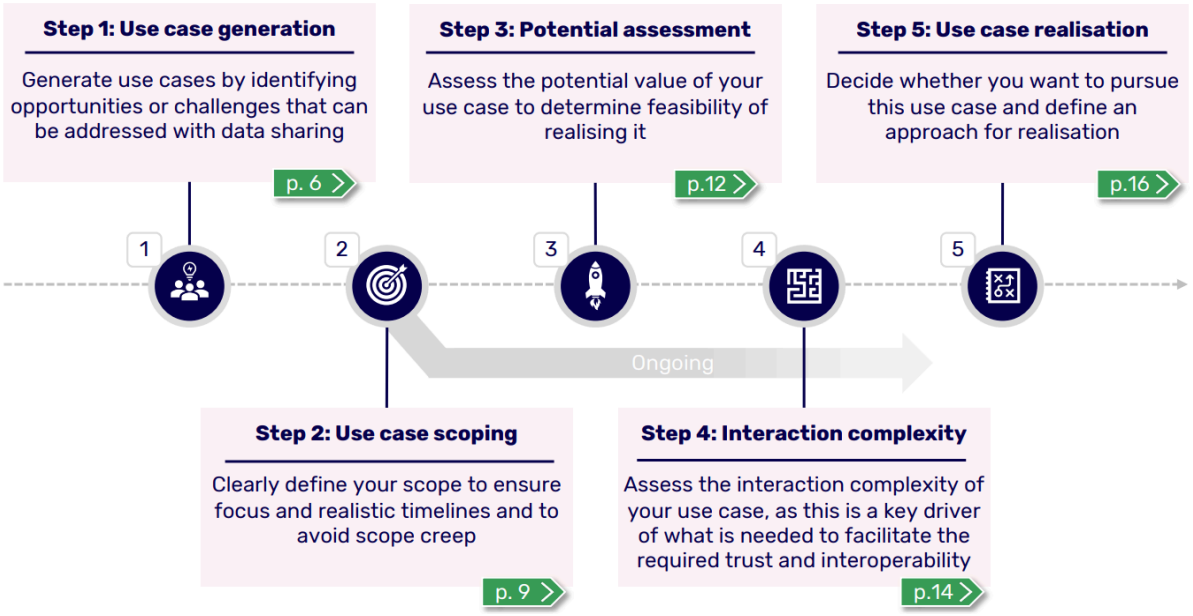

Figure 18 - Data Spaces Use Case Playbook
Source: Data Sharing Coalition

Example of a co-design framework
With the Use Case Playbook

Step 1 - Use case generation:

- **How to approach this step?:** Examine existing processes, products and services on whether they can be improved by consuming or providing certain data. Explore existing available data that might be useful to other organisations.
- **Questions to answer during this step:**
  - How can data-sharing help my business by solving current challenges or realising opportunities?
  - How can my data help organisations that we currently collaborate with?
  - What other organisations would benefit from gaining access to my data?
  - Which processes, products or services can we improve with the use of external data sources?

Step 2 - Use case scoping:

- **How to approach this step?:** In this step, start with a rough use case idea and transform it to a clear description of who is involved and what

interactions need to happen. The first step is to identify and describe the actors, types of data and applications of data for a clear instance of the use case. Next, describe the interactions happening between the actors. It is often feasible to start with a small scope and expand it later. Moreover, in order to get a clear view of the stakeholder's involvement and of the data flow of the sharing, a modelling activity could help the use case description and scoping.

- **Questions to answer during this step:**
  - What data is shared?
  - Who supplies data and who consumes data?
  - Who has the rights over the data?
  - Who enables the sharing of data?
  - What is the smallest set of actors which are needed
  - to enable a minimal version of this use case?
  - What interactions take place between the actors?
  - What is specifically out-of-scope for this use case?
  - With which frequency is the data shared?

Step 3 - Potential assessment:

- **How to approach this step?:** Start with a clearly defined scope from the previous step, this is essential for assessing the value. Clearly define the value drivers for different roles involved in the use case. Use the template on the next page to assess this. If necessary, iterate and refine your results in the Use case scoping step using new insights gained in this step.
- **Questions to answer during this step:**
  - Is there sufficient value for the Entitled party?
  - For all actors involved, is there value in the use case?
  - What is the potential societal impact of the use case?

Step 4 - Interaction complexity:

- **How to approach this step?:** Start with a clearly defined scope from the previous step, this is essential for assessing the value. Clearly define the value drivers for different roles involved in the use case. Use the template on the next page to assess this. If necessary, iterate and refine your results in the Use case scoping step using new insights gained in this step. The complexity could be evaluated with the models built on step 2.
- **Questions to answer during this step:**
  - Is there sufficient value for the Entitled party?
  - For all actors involved, is there value in the use case?
  - What is the potential societal impact of the use case?

Step 5 - Use case realisation:

- **How to approach this step?:** Start with a clearly defined scope as discussed in Use case scoping (Step 2), this is essential for assessing the interaction complexity. Assess the interaction complexity. Iterate and refine on your result from Use case scoping (Step 2) using new insights gained in this step if necessary.
- **Questions to answer during this step:**
  - How different are the actors involved in your use case?
  - How many types of data are shared in your use case?
  - How sensitive is the data shared in your use case?

5.3. Use cases overview for the Space Data Space

5.3.1. Main usage scenarios in non-space sectors

The Space Data Space offers multiple opportunities for providing information, derived from data generated by space assets, with Data Spaces in other sectors, fostering high-value cross-sectoral use cases. Before delving into the intersections between the Space and non-space sectors, we have identified, through our desk study, **non space Data Spaces currently under construction and their respective key usage scenarios**:

- **Green Deal:** Monitoring carbon impacts across all sectors as part of achieving Net Zero goals.
- **Skills & Jobs:** Aggregating skills data, personal attributes, and preferences to guide individuals in lifelong learning, including localised training and job recommendations.
- **Tourism & Mobility:** Personalised tours, augmented tourism experiences, support for disability and accessibility, green travel options and subsidies, and connected vehicles.
- **Administration:** Applying the ‘Once Only’ principle to streamline data reuse, leveraging administrative data in private services (e.g. finance, insurance, healthcare), and enhancing citizen services through augmented interfaces.
- **Health:** Digital medical records, simplified administrative processes, data-driven research, 5P medicine (personalised, preventive, predictive, participative, proof-based), new medical devices (IoT), and Digital Twin Health solutions.
- **Energy:** Monitoring consumption, managing electric vehicle charging, improving network flexibility, optimising energy mixes, integrating renewables, and advancing related research.
- **Agriculture & Food:** Ensuring traceability ‘from farm to fork’, promoting healthy eating, supporting sustainable food production, managing water and soil resources, collecting livestock genetic data, and fostering agricultural research.
- **Smart Manufacturing:** Streamlining supply chains, facilitating data flow between manufacturers and suppliers, and supporting industry decarbonisation efforts.
- **Construction:** Collecting and analysing data to enhance environmental management practices in building projects.
- **Finance & Insurance:** Implementing Know Your Customer (KYC) measures, developing insurance products, detecting fraud, managing budgets, simplifying

administrative tasks, and supporting various life projects (housing, education, automotive, etc.).
- **Media:** Detecting misinformation, tracing content origins, sharing press services, exploring Metaverse applications, and developing decentralised social profiles.
- **Digital Territories:** Implementing Smart City initiatives, creating regional Data Spaces, and building digital twins for urban areas.
- **Sea Activities:** Focusing on marine permaculture, environmental monitoring, maritime navigation, research, digital twin oceans, and digital twin Earth projects.
- **Language:** Sharing of language data and other language resources (e.g., language models) through a single platform.
- **Location:** The 'two-way bridge' between (i) the geospatial and space Communities and (ii) the various Data Spaces which are requiring information based on location data i.e. X, Y, Z, t. Space Data Space has tight links with Location Data Space.

5.3.2. Which space data for the Space Data Space

Data collected by space-borne, Earth-orbit monitoring equipment, such as satellites and space shuttles, is known as 'space data'. Hence, **space data refers to any data collected from space or related to space, primarily involving information about Earth, celestial objects, the Earth's atmosphere, and space environments**. It can come from a variety of sources, including satellites, telescopes, space probes, rovers, and space stations. This data is used across multiple disciplines such as astronomy, Earth science, climate research, navigation, telecommunications, and more.

Key categories of space data include:

1. **Earth Observation (EO) data**: Information collected from Earth-monitoring satellites, including weather patterns, land use, climate data, and natural disaster monitoring. Common sources include remote sensing satellites.
2. **Navigation and positioning data**: Information collected by GNSS (Global Navigation Satellite System) like GPS (Global Positioning System) and Galileo, which help in positioning, navigation, and timing (PNT).
3. **Space weather data**: Measurements related to solar activity, cosmic radiation, and space environments. This is used for understanding the impact of solar flares and radiation on satellites, astronauts, and Earth's technology.
4. **Satellite telemetry and communications data**: Data related to the health, status, and functioning of satellites and spacecraft, including tracking data, fuel levels, temperature readings, and other technical information.
5. **Astronomical data**: Data about stars, galaxies, black holes, and other celestial bodies. This could involve optical, infrared, or radio telescope observations.
6. **Spacecraft data**: Data from space probes, rovers, and landers, such as those sent to other planets, moons, and asteroids. For example, NASA's Mars rovers provide detailed data of the Martian surface.

Over the last two decades, the Space sector has expanded, significantly fueled by major European and institutional satellite programmes for navigation, communication, and Earth observation, along with both traditional and disruptive 'New Space' commercial ventures.

Consequently, **the volume of space-generated data has surged**. **This data is indispensable for tackling a wide range of societal, economic, and scientific challenges.** Thanks to its vantage point beyond Earth, space data allows us to monitor, understand, and respond to various changes and events on our planet and beyond, including weather patterns, natural disasters, agriculture, urban development, and climate change.

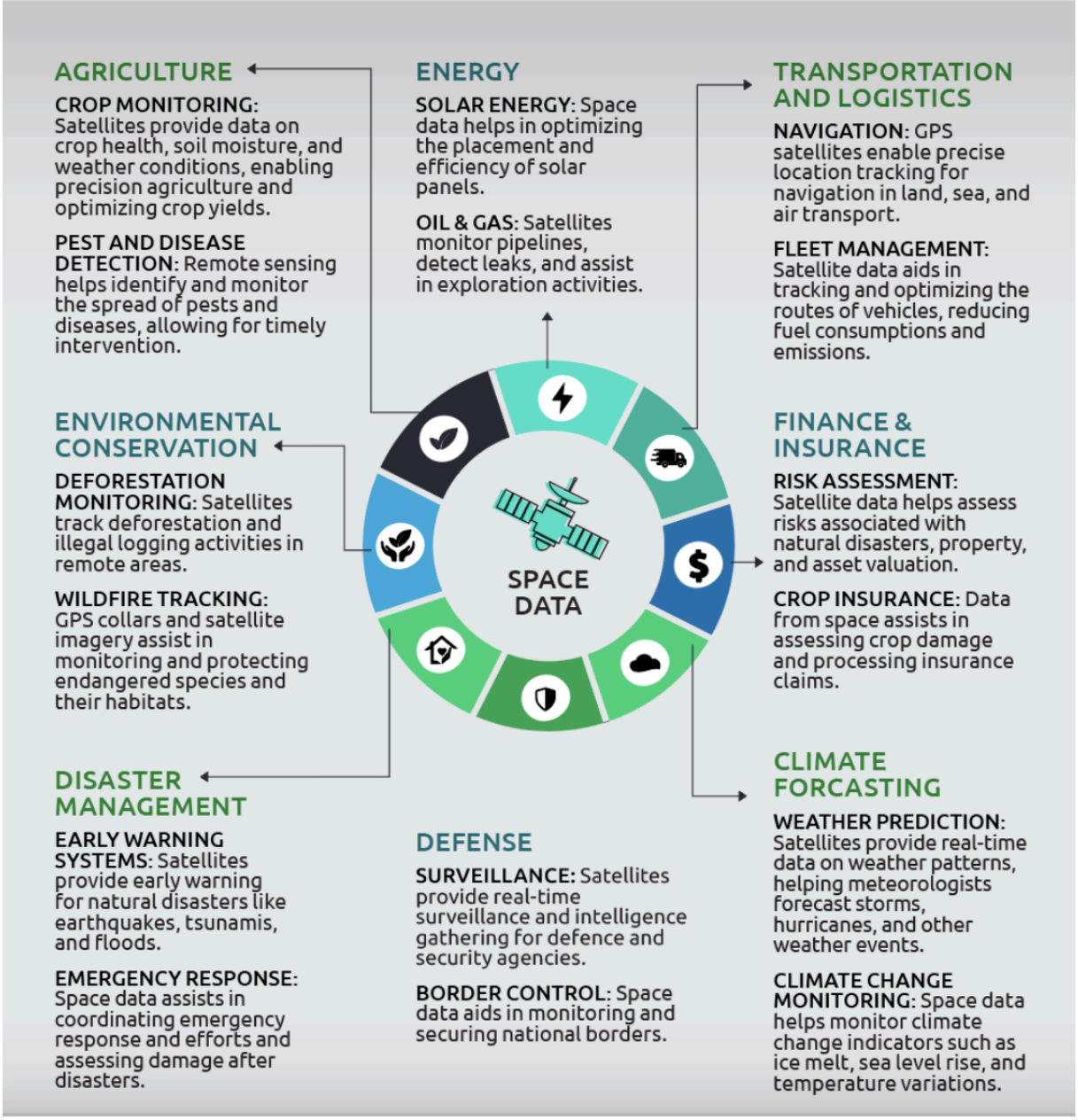

Figure 19 - Key Applications of space data across various Industries
Source Capgemini

Space data underpins many of our everyday consumer and professional applications and use cases. Given our growing reliance on this data and the insights it provides, it must be managed securely, reliably, accurately, and efficiently, while preserving European sovereignty. **Multiple cloud-based initiatives already facilitate access to space data**

such as Copernicus Data Space Ecosystem (CDSE) and Destination Earth (DestinE) to name only two. **The Space Data Space, as a federated approach, should ensure greater interoperability, interconnection, and synergy among these existing efforts and beyond.**

5.3.3. Potential usage scenarios between Space and other sectors

By conducting our desk study and engaging in interviews with Space stakeholders, we have pinpointed potential primary usage scenarios that involve collaboration between the Space sector and other industries, here are a few:

- **Digital Twins Earth, Smart Cities, Smart Building, Ocean, Energy, Forest:** DS (Data Space) Energy, Smart Cities, Smart Building, Sea activities, Forestry, automotive, media.
- **Risk assessment:** DS Finance, Agriculture, Energy, Smart Building, Smart territories.
- **Climate risk management**: DS Green Deal, Finance.
- **Estimation of emission GHG reductions**: DS Green Deal.
- **Results-based climate financing:** DS Finance.
- **Interventions in areas with limited access:** DS Digital Territories, Security.
- **Monitoring of illegal resources exploitation:** DS Digital Territories, Security, Customs.
- **Monitoring of the evolution of structures and urban extent:** DS Digital Territories.
- **Water quality & pollution**: DS Sea activities.
- **Maritime disasters:** DS Sea activities.

Discussions were specifically initiated with relevant stakeholders from the following Data Spaces, and associated projects or initiatives:

- **DS Agriculture:** From GPS/Galileo use for equipment use and yield improvement, to Copernicus use in the Common Agriculture Policy, Space is already used in this sector. It is therefore interested in multiplying usage and improving accessibility by tapping on commercial space data and making space datasets interact with non-space datasets.
- **DS Cultural Heritage:** The common European Data Space for cultural heritage[41] supports the digital transformation of Europe's cultural sector. It allows cultural heritage institutions across Europe to share digitised cultural heritage content, with high-quality metadata, including in 3D. The Space sector combined with cutting edge technologies such as AI can help protect the world's cultural heritage[42].
- **DS Energy:** This Data Space will broaden access to data needed to develop innovative energy services that will help to balance and optimise the electricity grids and improve the energy efficiency of the built environment, closely linked to other sector-specific Data Spaces (e.g. mobility and smart communities). Digitalisation,

[41] https://digital-strategy.ec.europa.eu/en/news/deployment-common-european-data-space-cultural-heritage
https://www.dataspace-culturalheritage.eu/en

[42] https://commercialisation.esa.int/2021/03/space-for-cultural-heritage-workshop/
https://eo4society.esa.int/event/eo-for-cultural-and-natural-heritage/

satellite connectivity and space applications provide a range of opportunities to enhance energy security and the green energy transition, addressing many of the challenges faced by nations and by the energy sector[43]. ESA has launched in October 2022 the 'Task Force for Innovation in Energy Through Space' (Energy Task Force). Its main purpose is to leverage space applications in innovative, sustainable services that foster a clean, green energy ecosystem and support the growth of a sustainable green economy[44].

- **DS Green Deal:** This Data Space implements very concrete use cases. One of the first ones is around monitoring of deforestation. Space data (which can be confirmed by ground data) is going to be more and more useful. Otherwise, Space data can be a great asset to ESG monitoring. The EU's Galileo, EGNOS and Copernicus programmes continuously and accurately gather data that contributes to the production of essential climate variables monitoring the state of the climate. Not only can space data help to adapt to climate change but also mitigate its effects in Europe[45].
- **DS Health:** On the 24th of April 2024, the Members of the European Parliament (MEPs) approved the creation of the European Health Data Space (EHDS)[46]. The EHDS will:
    - empower individuals to take control of their health data and facilitate the exchange of data for the delivery of healthcare across the EU (primary use of data);
    - foster a genuine single market for electronic health record systems;
    - provide a consistent, trustworthy, and efficient system for reusing health data for research, innovation, policy-making, and regulatory activities (secondary use of data).

  By doing so, the EHDS will enable the EU to fully benefit from the potential offered by a safe and secure exchange, use and reuse of health data to benefit patients, researchers, innovators, and regulators. The Copernicus Atmosphere Monitoring Service (CAMS)[47] provides daily air quality forecasts worldwide that public and private entities can use to identify citizens' exposure to pollutants such as aerosols and particulate matters but also inform air traffic control in case of major aerosols ejected from volcanoes. Copernicus also monitors the air quality for health prevention and provides daily air quality bulletins in the news for citizens.
- **DS Media:** Trusted European Media data Space (TEMS)[48], the flagship European initiative to build a resilient data-driven ecosystem in the media sector. TEMS needs geo-referenced data and unbiased information/reports using satellite data provided by independent third-parties to check facts. Space data could help there as well. We are interacting with the TEMS Team related to features and requirements addressing location.

[43] https://business.esa.int/energy
[44] https://business.esa.int/energy-task-force
[45] https://defence-industry-space.ec.europa.eu/supporting-european-green-deal_en
[46] https://health.ec.europa.eu/ehealth-digital-health-and-care/european-health-data-space_en
[47] https://atmosphere.copernicus.eu/
[48] https://tems-dataspace.eu/

- **DS Mobility and tourism:** We have initiated discussions with EONA-X, a Data Space comprising mobility and tourism key industry players in France and Spain. The first envisioned use cases pertain to security issues and crowd monitoring.
- **DS Construction:** Digital Ter-X 2050 project[49]. Space could support Construction progress monitoring. See presentation from Juan Beneytez Salvadores, Corporate Innovation Manager at Ferrovial[50].
- **DS Automotive:** Catena-X[51]. See the study made for ESA on space-enabled applications in the automotive sector[52] and the ESA mini-report *Space for Automotive: Use cases and market opportunities*[53].
- **High Value Datasets (HVD):** According to the Directive on open data and the re-use of public sector information (PSI)[54], 'high-value' means data with the potential to:
    - generate significant socio-economic or environmental benefits and innovative services;
    - benefit a high number of users, in particular small to medium sized enterprises (SMEs);
    - assist in generating revenues; and
    - be combined with other datasets.

  Six thematic categories of high-value datasets are identified in the Directive:
    - Geospatial
    - Earth observation and environment
    - Meteorological
    - Statistics
    - Companies and company ownership
    - Mobility

  4 categories being space-related (Geospatial, Earth observation and environment, Meteorological and Mobility). The 4 projects funded by EC DG CNECT related to DEP call - Public Sector Open Data for AI and Open Data Platform (Budget: 20M€ - TOPIC ID: DIGITAL-2022-CLOUD-AI-02-OPEN-AI)[55] are :
    - **BeOpen**[56]: an Open framework for boosting EU High ValueDatasets from Public Sector,
    - **MareGraph**[57]: towards an interoperable MARinE knowledge GRAPH,
    - **OME2**[58]: Open Maps for Europe 2,
    - **RODEO**[59]: The Provision of Open Access to Public Meteorological Data and Development of Shared Federated Data Infrastructure for the Development of Information Products and Services.

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[49] https://digitalter-x.eu/

[50] https://business.esa.int/sites/business/files/ESA%20BASS%20Space%20for%20Construction%20Monitoring%20Webinar%20with%20Ferrovial.pdf

[51] https://catena-x.net/en/

[52] https://www.einstein-iv.space/space-enabled-applications-in-the-automotive-sector

[53] https://commercialisation.esa.int/2024/06/space-for-automotive-use-cases-and-market-opportunities/

[54] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1561563110433&uri=CELEX:32019L1024

[55] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/digital-2022-cloud-ai-02-open-ai

[56] https://beopen-dep.eu/about/

[57] https://eurogeographics.org/app/uploads/2024/06/05.-20241119_Tyberghein_MAREGRAPH.pdf

[58] https://eurogeographics.org/app/uploads/2024/06/04.-Victoria-Persson-OME2.pdf

[59] https://eurogeographics.org/app/uploads/2024/06/06.-RODEO-FEMDI-HVD-GroupWebinarpresentation_Timo-Kyntaja.pdf

- **Location:** The Space Data Space could support a Location Data Space so it is important to liaise with initiatives related to Location and data-sharing such as:
    - **POSSIBLE project**[60]
    - **InGeo-X project**[61]
    - **Location Innovation Hub (LIH)**[62]

For liaising with the initiatives mentioned here above, **the Space Data Space will join soon the DSSC Community of Practice (CoP)**[63] which is a set of existing and emerging Data Space initiatives in all sectors and the set of 'potential' data space building block implementers. These are organisations, project consortiums, and networks of committed partners who work together to develop and implement data spaces in various sectors.

5.3.4. Space Data Space Use Cases Radar (SDS-UCR)

Following the recommendation of the 2nd ESA-ESPI Space Data Space Workshop, held in Brussels on the 29th of October 2024, in this Blueprint, **we introduce the first Space Data Space Use Cases Radar (SDS-UCR).**

This knowledge base will assist the Space Community of Practice in mapping **all relevant data-sharing use cases for the Space sector**, encompassing both intra sector use cases and those that connect with other sectors. The modelling activity of paragraph §5.2 can help to generate automatic use cases radar.

All members of the Space Community of Practice (CoP) — including industry participants, ESA, EUSPA, and ESA/EU member states — are encouraged to contribute ideas and entries to the radar.

The initial version of the radar can be found in Appendix §15.3. of this document.

5.4. Civil Security from Space (CSS) as a starting point for an operational SDS

5.4.1. Why is Civil Security a good starting point for the Space Data Space?

Civil Security stakeholders already rely on a variety of space assets — Earth Observation (EO), Navigation, and Telecommunications among them — making it inherently dependent on diverse space data resources. **Civil Security also spans multiple sectors**, intersecting with Agriculture (in the context of natural hazards), Finance and Insurance (for disaster response), Health, and beyond. It encompasses both personal data related to

[60] https://www.possible-gaia-x.eu/en/

[61] https://geodataspace.org/

[62] https://locationinnovationhub.eu/en/home/

[63] https://dssc.eu/space/DC/27983886/Community+of+Practice

citizens and industrial data. As a result, we identified Civil Security use cases as particularly relevant to initiate the Space Data Space.

Furthermore, **the ESA Civil Security from Space Programme (CSS)**[64], approved at the last ESA Ministerial in November 2022 in Paris, **stands as the first cross-Directorate and multi-domain initiative at ESA**. Since its implementation is just beginning, it holds considerable potential for collaboration with the Space Data Space.

5.4.2. Civil Security from Space Objectives

Europe is encountering a rise in security and crisis incidents, both from within and beyond its borders, which threaten citizens' safety and prosperity. Although space-based technologies already support European governments and security stakeholders, further efforts are needed. **The Civil Security from Space (CSS) programme aims to establish a sustainable European Security and Crisis Management System** by developing a secure, sovereign, and resilient response framework. This system will integrate telecommunication and Earth observation (EO) capabilities, ensuring a rapid and robust solution that benefits all European citizens.

CSS is focused on connecting and expanding space-enabled capabilities across Europe to address security challenges more effectively, including swift responses to natural disasters and other crises. It features Professional Mobile Radio (PMR) tools, such as push-to-talk and dedicated group communication, to streamline emergency coordination.

In addition, CSS supports initiatives to validate priority crisis scenarios—such as **wildfires, floods, earthquakes, maritime safety, and the protection of critical infrastructure** (e.g., transport and energy grids)—and to develop related solutions. Several Partnership Projects are underway to test key enabling technologies, including AI processing, cloud computing, high-speed and secure networks, seamless integration with terrestrial and aero systems, and enhanced application platforms. Currently the following Partnership Projects are being carried out:

- **SMART-CONNECT**[65]**:** Leveraging space technology and artificial intelligence (AI) to provide reliable connectivity and rapid communication in times of crisis. Smart-Connect is a consortium with European and Canadian industry, led by satellite-based land monitoring company GeoVille[66].
- **Safety Platform for Crisis and Emergency (SAFEPLACE)**[67]**:** Safeplace's primary strength lies in its ability to deliver detailed, accurate, and situation-specific information to first responders as quickly as possible during a crisis. By integrating advanced Earth observation (EO), satellite-based positioning, Internet of Things (IoT)

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64 https://connectivity.esa.int/civil-security-space

65 https://www.esa.int/Applications/Connectivity_and_Secure_Communications/Advanced_space_tech_for_disaster_response_with_Smart-Connect

66 https://www.geoville.com/news/newsdetail/smart-connect-critical-information-anywhere-anytime/

67 https://connectivity.esa.int/news/esa-enhance-spaceenabled-crisis-management-safeplace#:~:text=The%20industry%2Dinitiated%20project%2C%20named.safety%20stakeholders%20during%20crisis%20events.

data, and satellite communications, Safeplace ensures that crisis managers and first responders have critical information—even when terrestrial (ground) communication networks are not available. The project involves the creation of a digital platform that serves as a secure portal to multiple data sources and services. Through a single interface, operators can gain more precise situational awareness, for example by overlaying real-time responder locations on the latest satellite imagery or employing AI to analyse drone footage for search and rescue. The European Space Agency (ESA) is supervising the project's implementation and is making its European Space Security and Education Centre (ESEC) available as a 'CSS Hub'. In doing so, ESA provides cybersecurity for the Safeplace system and ensures data quality for sensor operators and emergency control centres.

- **Crisis Observations and Management from Space (COSMOS)[68]:** ESA has partnered with ICEYE, a Finnish microsatellite manufacturer, to improve early warning systems for floods and wildfires and extend their geographical coverage globally.
- **Responsive Civil Services (CISERES):** CISERES is a small satellite mission that leverages artificial intelligence (AI) to markedly reduce crisis response times. As part of ESA's Civil Security from Space (CSS) programme, it aims to improve satellite capabilities to notify first responders and government officials within minutes when disasters—such as floods, fires, or landslides—occur. The project is led and co-funded by Deimos, a European space technology company specialising in small satellite missions.

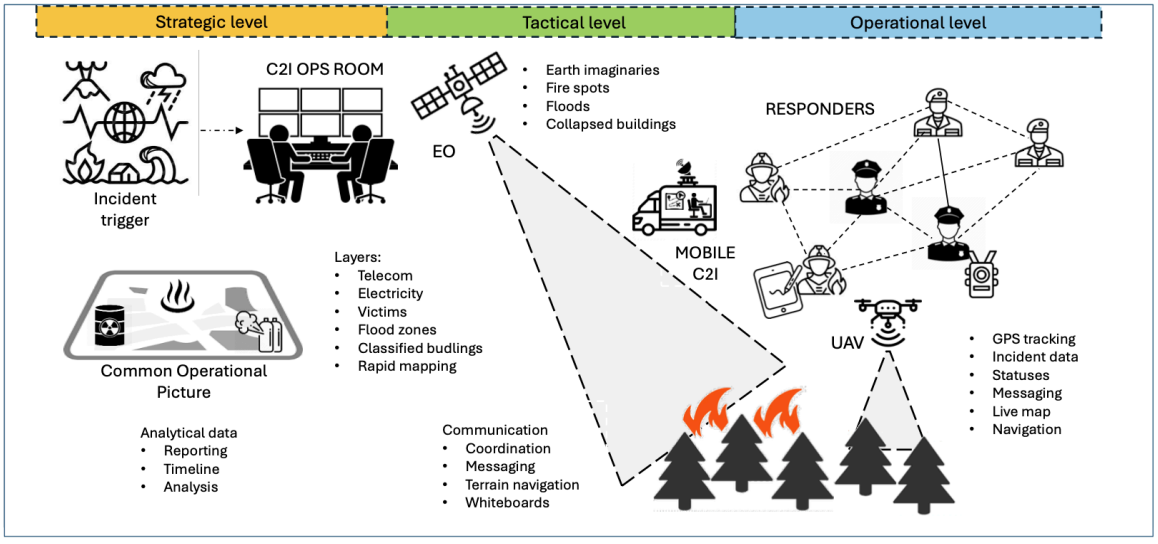

Figure 20 - CISERES Concept
Source ESA

- **SERENITY[69]:** In times of crisis and security events, it is a matter of urgency to have the necessary **actionable information swiftly and wherever needed**. This need is met through the development of national CSS Portals linked through a European

68 https://www.esa.int/Applications/Connectivity_and_Secure_Communications/Space_set_to_keep_people_safer_during_emergencies

69 https://connectivity.esa.int/news/esa-leverage-aienabled-satellite-disaster-response

network called SERENITY (**Se**curity and Crisis **Re**sponse **N**etwork **I**nfrastructure for Socie**ty**). The SERENITY collaborating network will offer a **resilient** system that enables through several Portals the **access** to space resources (national, commercial, institutional, satcom, EO and navigation data) and ensures the **rapid** distribution of **trusted** information in **close to real time**, to end users located anywhere (national, European and international).

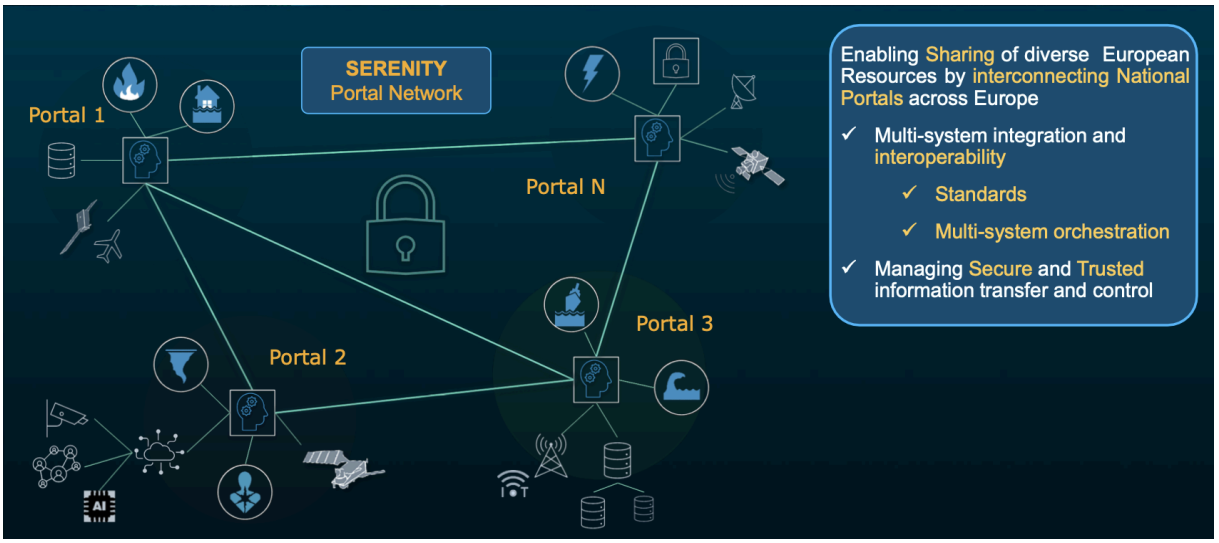

Figure 21 - SERENITY Collaborating Network
Source ESA

SERENITY is meant to enable access to actionable information, and broadly follows these steps:

- **Data Collection:** Interfacing to multiple data sources and connectivity solutions,
- **Data Transformation**: For converting data into information ready for distribution,
- **Data Distribution**: Reaching the user through connectivity, applications & services.

Figure 22 - SERENITY Development areas
Source ESA

As evidenced in the figure below, the foreseen architecture of SERENITY is very close to a Space Data Space architecture.

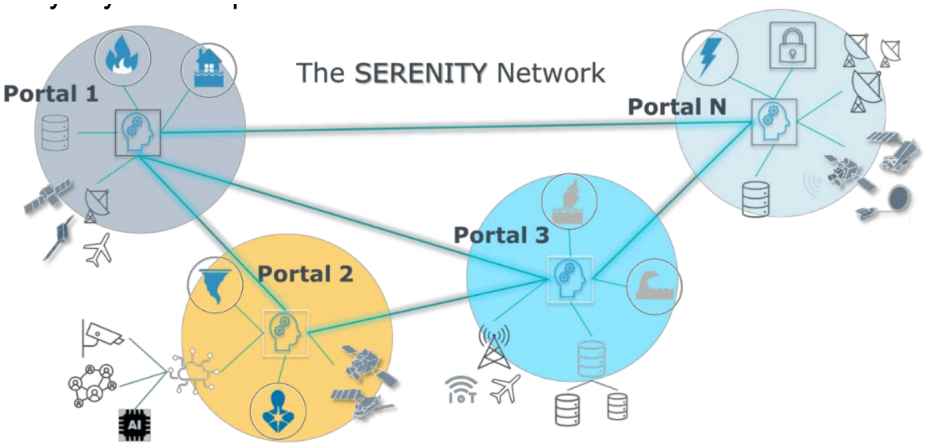

Figure 23 - The SERENITY Network of Portals - A collaborative approach to space resources
Source ESA

5.4.3. Identified Civil Security from Space potential key usage scenarios

The ESA-ESPI Space Data Space kickoff held in Madrid in 2023 underscored the relevance of building a Space Data Space initiative dedicated to Civil Security use cases.

During the ESA-ESPI Space Data Space workshop held in Brussels in 2024, a key data use case of the CSS/SERENITY Polish Portal response was presented.

Central Europe 2024 Flood Disaster
- example of the CSS/SERENITY Polish Portal response

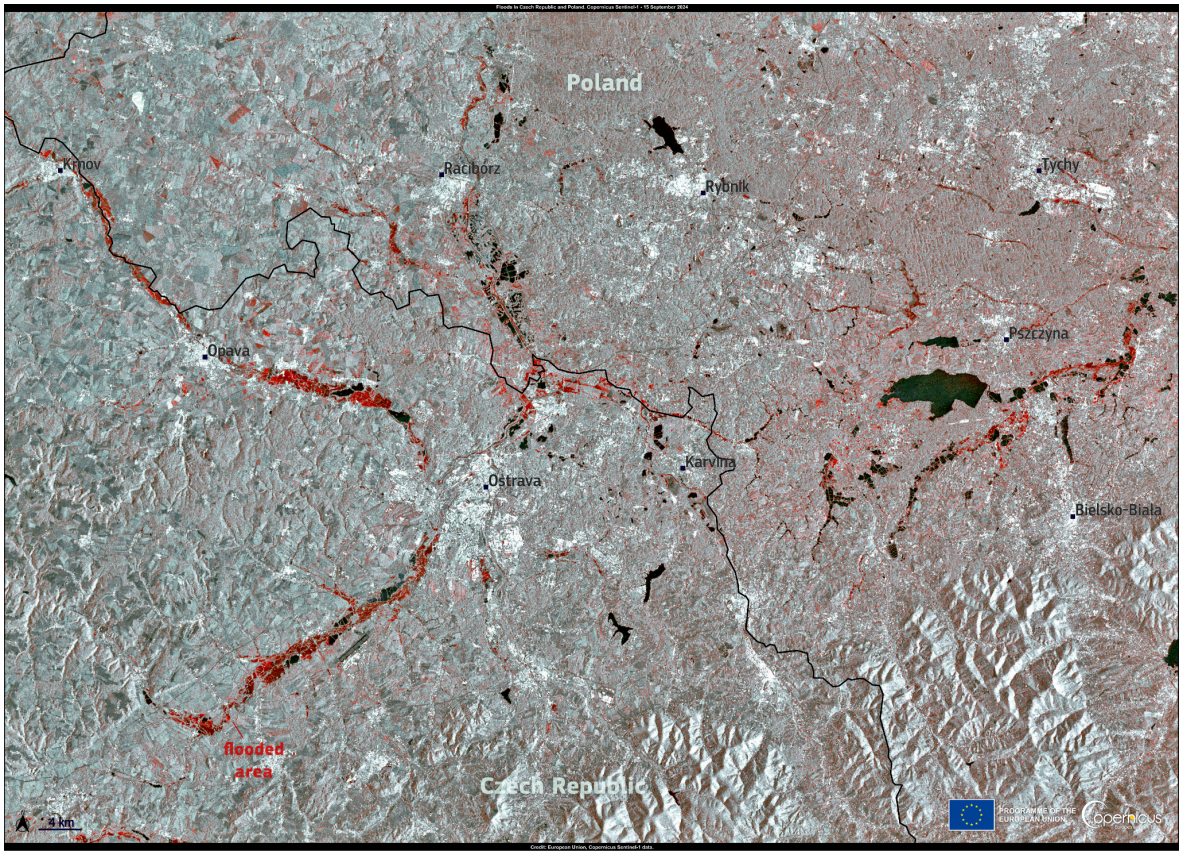

Figure 24 - Central Europe 2024 Flood Disaster
Source Copernicus

The flooded areas along the Polish-Czech border are visible in this image acquired by the Copernicus Sentinel-1A radar satellite on 15 September 2024.

Responding to the flood crisis in Poland in September 2024, the Crisis Information Centre of the Space Research Centre of the Polish Academy of Sciences (CIK CBK PAN) initiated a dedicated satellite monitoring. For two weeks, information on the extent of flood water has been provided every few hours to the State Fire Service, crisis management centres and other institutions. The swift access to information, compiled using mainly data from the ICEYE constellation of radar satellites, helped these agencies

better understand the evolving situation on the ground and direct resources where they were needed most.

This activity marked the inaugural operation of the Civil Security Hub in Poland, a project under the European Space Agency (ESA) aimed at enhancing crisis response capabilities. Originally initial testing of the satellite information delivery system was planned for spring 2025, but due to the severity of the floods it was launched immediately in experimental 'invent-as-you-go' mode. The approach proved to be a major success, offering precise, rapid, and reliable information. Continuous access to very fresh information enables better decision-making during emergency situations, such as floods, where understanding the scale of the event and forecasting its development is essential. Building upon this data, the Hub was also working on providing enhanced analysis, including damage assessment in collaboration with the Main Statistical Office and water removal recommendations with IMGW. Evaluation of the operation led to the formulation of the following conclusions:

- The Civil Security Hub in Poland has proven to be an **effective bridge between innovative pre-operational solutions and the operational world** of civil protection and crisis management.
- Rapid provision of satellite-based information may significantly **support efficiency of civil protection operations**.
- There is a clear **need for a coordinated use of Earth Observation (EO) data** from national constellations currently under development in Europe.
- **Solutions for effective integration of space and drone-derived information** should be developed and deployed.

The Hub played a vital role in facilitating the process of using space-related information during the crisis by defining needs, identifying critical observation areas, maintaining two-way communication with multiple users, and ensuring that space-based information was delivered efficiently to meet their needs.

Reco 9: Civil Security from Space could benefit from a dedicated Space Data Space initiative, that would be one of the first initiatives of the Space Data Space.

5.5. First identified scenarios and use cases for Civil Security from Space

The SDS-Next community meetings lasted for 4 months, between the 4th of March and 1st of July 2024, and consisted of a series of 14 meetings (15 to 31 attendees per meeting) on Monday at 5pm CET gathered 60+ people from 25+ entities (public, private, NGO) across Europe (10 countries) for contributing to the *Space Data Space Blueprint*. In addition to Monday's meetings, 3 groups met in April, May and June 2024, for working on various use-cases:

- **#1 Natural Disaster (Floods):** 14 entities expressed interest - 5 meetings
- **#2 Drivers for Migration:** 9 entities expressed interest - 7 meetings
- **#3 Impact of Pollution on Health:** 10 entities expressed interest - 3 meetings

Use case #3 was abandoned as it was deemed less relevant to CSS short term objectives.

5.5.1. Use Case #1 - Natural disaster (Floods)

Spain 2024 flood disaster[70]

Spain suffered its worst flood in decades after torrential rains struck the eastern province of Valencia. The death toll climbed and people remained missing.

In response, the Copernicus Emergency Rapid Mapping Service was activated to provide satellite imagery that can support rescue and recovery efforts.

According to Spain's national weather agency, Aemet, on 29 October 2024, Valencia received a year's worth of rain in just eight hours. This deluge caused devastating flash floods, turning streets into rivers, destroying homes, and sweeping away vehicles.

These images from the US Landsat-8 satellite vividly illustrate the scale of the disaster, with images from 8 October and 30 October showing the dramatic transformation of the landscape.

[70] https://www.esa.int/ESA_Multimedia/Images/2024/10/Valencia_flood_disaster

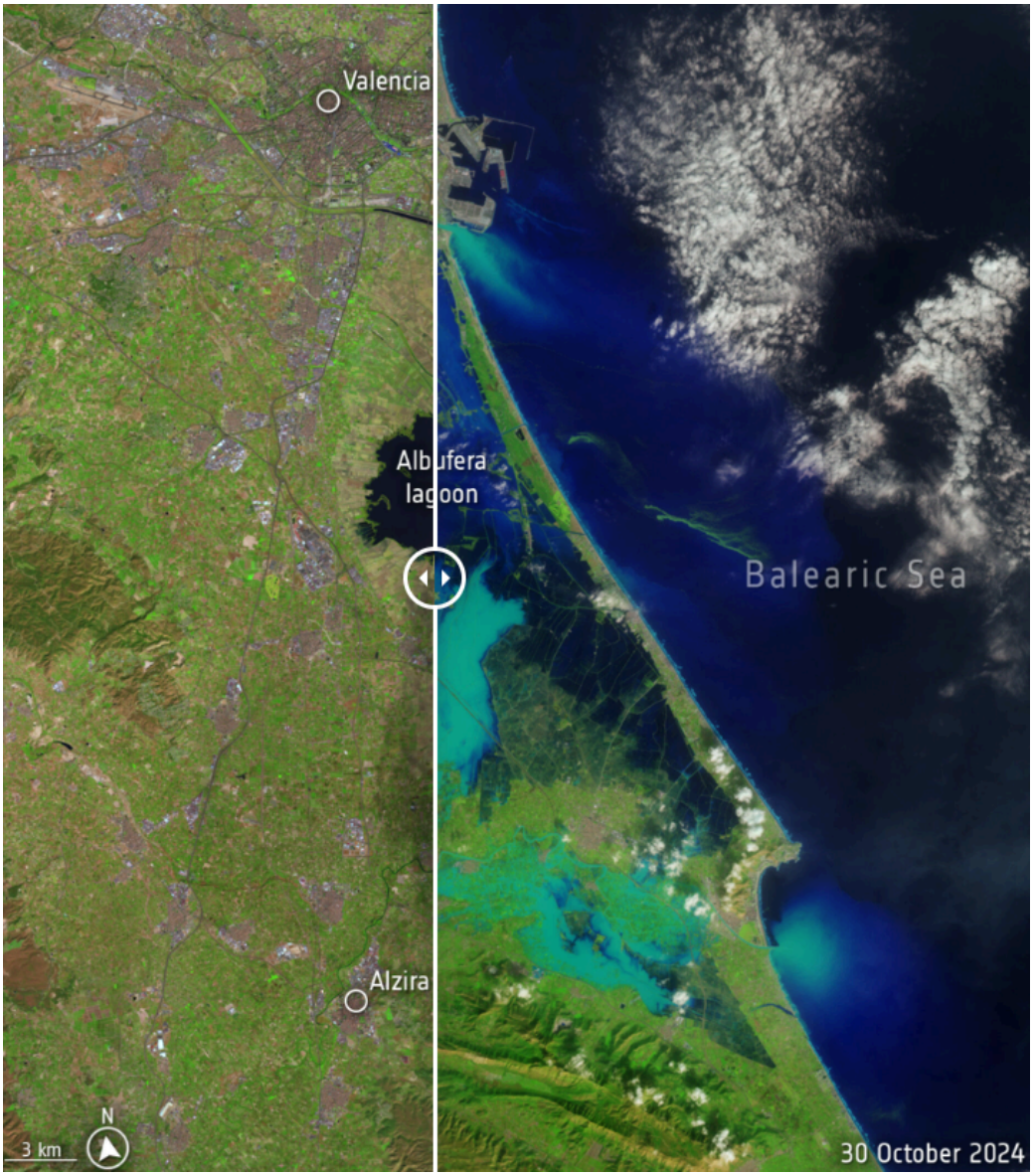

Figure 25 - Spain 2024 Flood Disaster
Source: ESA

Monitoring the occurrence and history of floods and extreme weather and determining the intensity and the potential effects on the urban environment and the population is among the challenges that civil security and public authorities have to increasingly deal with, in respect to climate change. **Extreme events (floods, cyclones, hurricanes) require constant monitoring from the time an alert is triggered until it is waved to allow civil security members**, public authorities and all other parties involved in crisis management to make appropriate decisions at the right moment. The need for situational data is particularly urging around the flood or extreme weather event peak when the crisis is at its worst.

Potentially, this is also the time when situational data is the most difficult to gather. Satellite optical visibility is likely to be obstructed by cloud coverage, defaulting the acquisition of satellite data on fewer capabilities such as radar satellites. Local in-situ

sensors might potentially be damaged or neutralised if not washed out or blown away by weather elements. Drone flights would become perilous as they would require operators to get physically sufficiently close to the areas stricken. Alternatively, strong winds would impeach drones from flying as exposed to crashes. Local surveillance cameras could potentially be out of usage due to power outages.

Therefore, **for all parties involved in crisis management (inc. public and civil security authorities), it is crucial to rely on a common architecture able to merge and fuse various sources of data** to mitigate risks of a single source data-dependency and to secure real-time monitoring over critical situations. Such a solution would also necessitate interfaces to predict extreme events impacts through projections and simulations, with the help of a digital twin for instance. For this reason, integration of historical data and models is also important. **The use of a Data Space applied to extreme weather events would definitely facilitate the monitoring and supervision of operational efforts on the ground.**

As a consequence, to guarantee the operating relevance of a Data Space applied to extreme weather events, **data from the following sources (without being exhaustive) would be highly considered and beneficial:** optical satellites, radar satellites, In-situ/terrain sensors, mobile network operating status and usage, CCTV camera, drones, weather forecast, historical data on floods, terrain data (composition and elevation), population related data (amenities, utilities), infrastructure location (power lines, sewage pipes, other networks, etc.), tidal variations, traffic information, etc.

To enhance the Data Space operating capabilities and relevance among stakeholders, the integration of catastrophe, hydraulic, hydrological, weather, tide models and associated datasets is key. **Active contributions from all actors involved in extreme events monitoring** such as research labs, civil security authorities, public actors and private entities affected by extreme events (service providers, insurers, utilities providers, etc.) is also essential to strengthen the Natural Disaster Data Space applicability.

Natural disaster Data Space applicability is not limited to the **crisis management response**. Crisis management also includes **Recovery** (or resilience), **Mitigation** (or prevention) and **Preparedness**. With this respect, the development perspectives of a Natural Disaster Data Space are numerous and can be applied to usage in the **Insurance sector** (parametric insurance facilitating resilience with fast payment), **urbanism** (construction of dams for example), **public awareness campaigns** (through drill exercises) to name a few.

Figure 26 - Natural disaster management cycle

In terms of market opportunity, according to the EUSPA market study published in February 2024, the global market for geospatial data services applied to emergency services was worth €223 million in 2022 and is expected to double by 2032. **Services related to crisis response alone** (excluding prevention, preparedness and resilience) account for 16% of this total, or an **estimated €71 million in 2032**.

Floods impact all ESA member states, affecting both rural and urban areas. Currently, floods cost around €7.6 billion annually and expose approximately 160,000 people each year to inundation. In a 3°C global warming scenario, without climate change adaptation, flood damage in Europe could rise to €44 billion per year, exposing nearly half a million Europeans annually.

The most acute needs are in real-time crisis management, when responders and assets are deployed, and when civilians and infrastructures are at risk. **What is needed is not just data (space-based or otherwise), but actionable information**. Life-saving decisions can be made by aggregating data-fed information from numerous sources.

The objective is to aggregate multi-sourced information into an easily readable and comprehensible format that is accessible, interoperable, requires no rework, and is as close to real-time as possible. This information should be complementary, support trend analysis, and leverage scenario-trained AI, which crisis responders can access on an interactive map. Furthermore, this gateway will be accessible to other stakeholders (with different authorisation levels) including public and private actors, network operators, companies with assets at risk, insurance companies, and citizens. These stakeholders will not only receive live advice but will also be able to upload pictures of what they experience, contributing to the information ecosystem.

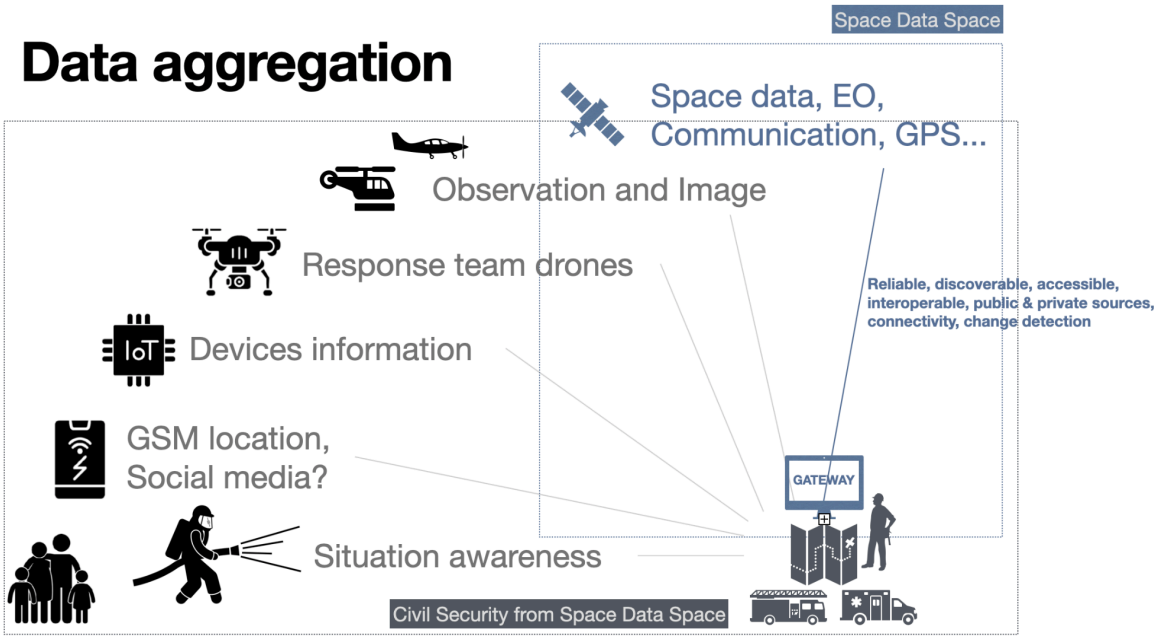

Figure 27 - Data aggregation for natural disasters

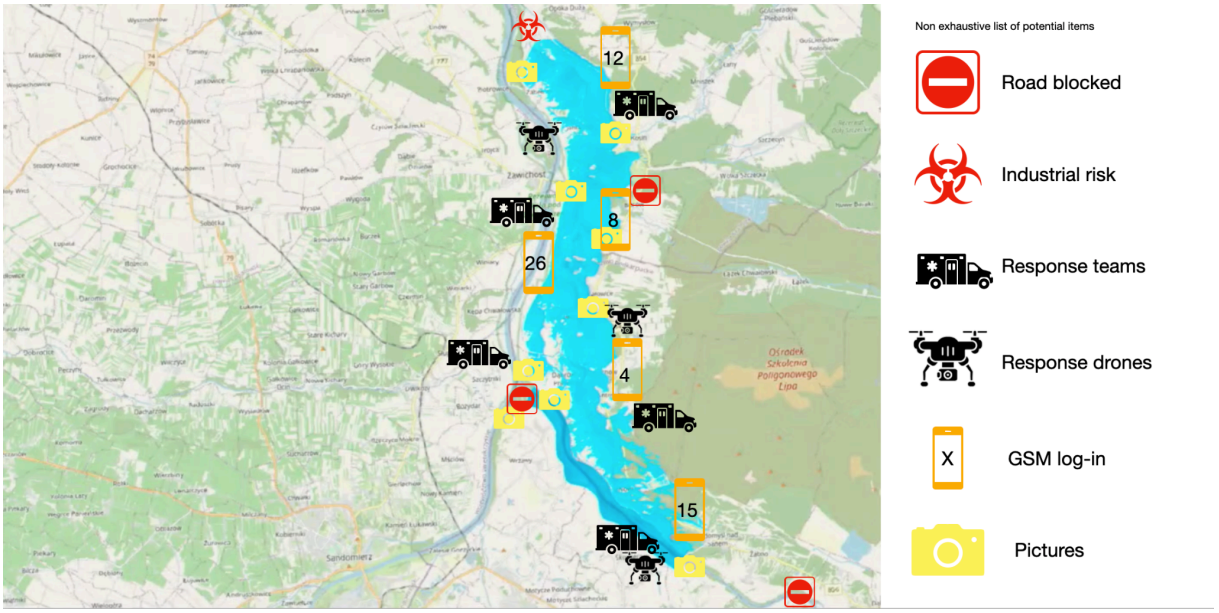

Figure 28 - Interactive real-time map

Notably, **the outcome of this Use Case, once developed, could be applied across various other contexts**. Its primary advantage lies in delivering relevant information directly to end-users, eliminating the need for extensive training to access information from multiple sources.

You will find details of the Use Case #1 in Appendix §14.8.

5.5.2. Use Case #2 - Drivers for Migration

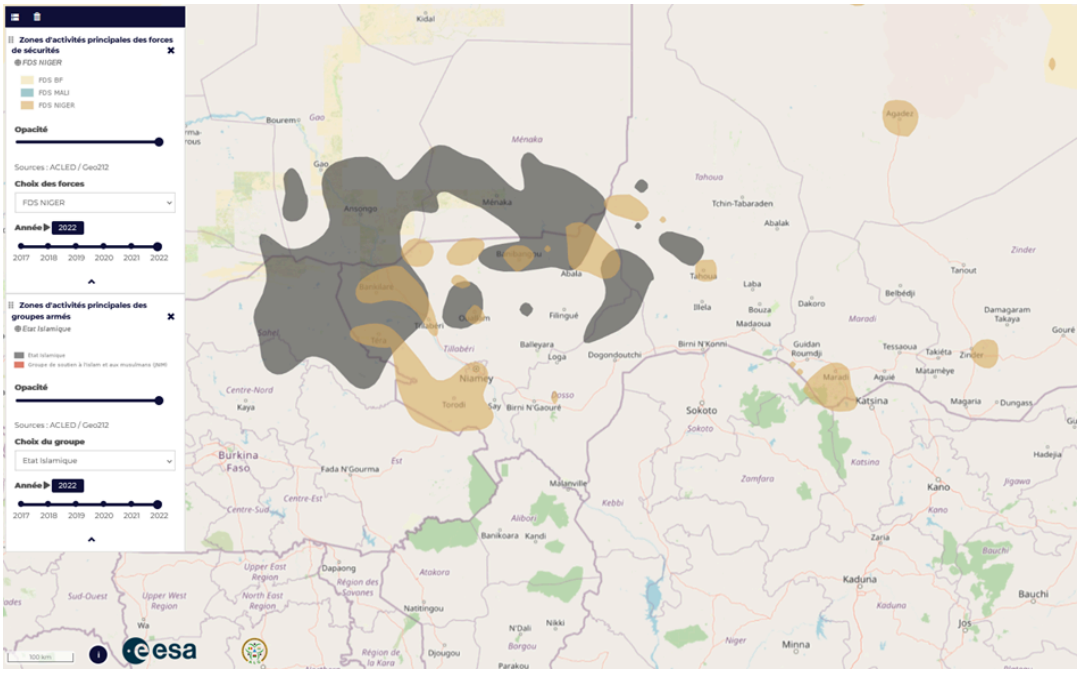

Figure 29 - Analysis of the fighting zone between Niger's security forces and the Islamic state in 2022
Source ESA

Migration is driven by a range of interconnected factors whose precise impacts and interactions are complex and often uncertain. Government agencies, NGOs, local communities, international bodies, and civil security authorities look to migration experts for insights on trends: will migration increase, where will it originate from, and what routes will be taken? Common causes of forced displacement include wars, conflicts, urbanisation, large infrastructure projects (like roads, dams, and power plants), and extreme weather events. Recently, environmental degradation, natural disasters, and climate change have become major migration drivers. While environmental migration has historically been a survival strategy, its urgency and scale have grown significantly over the past three decades and are expected to intensify further. To illustrate the magnitude of this trend **the International Centre for Migration Policy Development (ICMPD) mentioned in its March 2020 whitepaper[71], that "estimates vary widely from 25 million to 1 billion environmental migrants by 2050, moving either within countries or across borders (on a permanent or temporary basis), with 200 million being the most widely cited estimate (Kamal 2017)."** More recently, according to the *Internal Displacement Monitoring Centre 2024 report*, among the total of 46.9 million new internal displacements registered in 2023, 56 per cent were triggered by disasters.

However, quantifying migration flows is a complex and difficult task given the multiple and intricate drivers of such movements, the various estimation methodologies and above all, the

71 https://www.icmpd.org/file/download/51472/file/Policy%2520Paper%2520-%2520Geopolitical%2520Outlook%2520on%2520International%2520Migration.pdf

inconsistency or even the lack of data collection standards. In its June 2024 report, the Migration Data Portal corroborated this statement, indicating that **"while research methodologies are constantly being improved, and projection models for future mobility due to climate are being developed, data gaps still persist"**[72]. **Addressing the international migration data gaps is a persistent topic.** In their January 2021 paper[73], the HumMingBird, a European Union Horizon 2020 research programme aiming at improving the mapping and understanding of changing migration flow, was already describing the most common and persistent gaps within the international migration data portals and recommended some solutions, including "through alternative data sources and methodologies such as big data analytics".

The establishment of a Data Space supporting sharing international migration data would undoubtedly notch up the monitoring capacities of displacements. On one hand, the data processing would be facilitated through greater and timely data integration, data fusion, and data sanity checks. On the other hand, the Data Space would grant a solid governance aspect that would secure access to sensitive data as data could potentially be used against threatened populations, for example if used by rogue states or organisations with malicious intents. As drivers and reasons for migration are multiple and complex, it is important to consider various streams of data including mapping of resources, infrastructures, incidents, extreme events, climate change effects, human activities, etc., that are described in the following sections. During 7 meetings, 6 to 11 people worked on this topic, following the Data-Sharing Coalition (DSC, NL) Use-Case Playbook and its templates[74]. As 'Drivers for Migration' could encompass several use-cases, **we decided to identify 7 'blocks of information' listed below** which could be combined for addressing one or another use-case :

1. Mapping of resources (water, food, minerals)
2. Mapping of infrastructures (before) such as roads, airports, buildings, health services (hospitals, pharmacy, etc...), camps
3. Dynamic Mapping of actors (states, int'l organisations, NGO) and capacities (during)
4. Dynamic tracing of migrations
5. Detection of incidents (man-made disaster, conflicts)
6. Climate Change Impacts / Extreme weather events
7. Mapping of damages

One block of information could be made of several resources provided by one (for instance blocks 2 and 5) or several (for instance block 3) stakeholders and could even provide resources to additional use-cases such as block 6. During the various meetings, block 3 was addressed altogether. Outside the meetings, CS Sopra-Steria (France) addressed block 1, Geo212 (France) addressed blocks 2 and 5 while GMV (Spain) addressed blocks 4 and 6. We are presenting in Appendix §14.9 the first 6 blocks of information.

[72] https://www.internal-displacement.org/global-report/

[73] https://hummingbird-h2020.eu/images/publicationpdf/d2-3-eind.pdf

[74] https://coe-dsc.nl/wp-content/uploads/2023/05/data-sharing-coalition-use-case-playbook.pdf

Reco 10: Natural disasters management and drivers for migration are relevant initial usage scenarios for the Space Data Space initiative.

6. Landscape of the Space Data Space

The Space Data Space will draw on the valuable experience and datasets from existing space data programmes. Under a federated model, it is essential to unify these resources. This chapter lists them, highlighting their potential to become the first members of the Space Data Space.

It also provides an overview of the existing Data Spaces and supporting organisations that will play a key role in enabling the Space Data Space to exchange data and function effectively. Designing and implementing a Data Space for Space entails several prerequisites:

- *Identify relevant space-related initiatives and projects that could contribute to a Space Data Space (see §6.1).*
- *Become familiar with key organisations capable of supporting the Space Data Space (see §6.2).*
- *Interface with existing multi-sector Data Space initiatives (see §6.3).*

6.1. Current space data landscape

Numerous platforms and initiatives, financed either publicly (by the EC, ESA, and EU/ESA member states) or privately, already offer access to data from a range of space assets. Consequently, a Space Data Space will not have to start from scratch; instead, it can be developed by building upon and integrating as many of these existing platforms and initiatives as possible. The following section highlights several of them, though the list is not exhaustive.

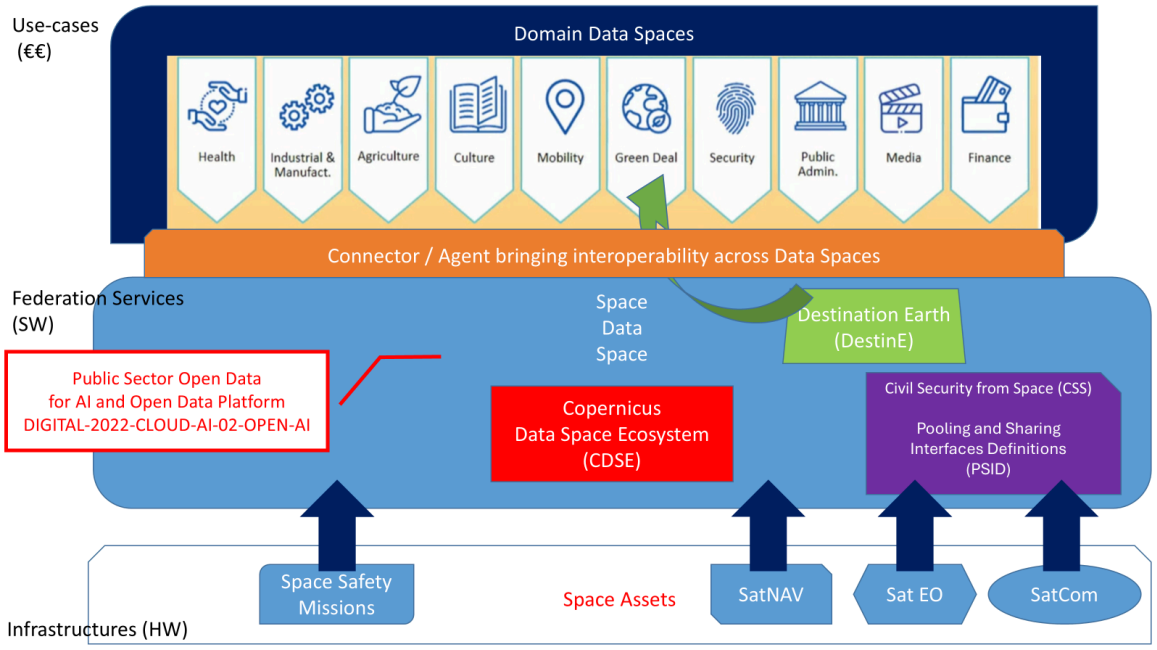

Figure 30 - Space Data Space and Space sector projects

6.1.1. Destination Earth (DestinE)

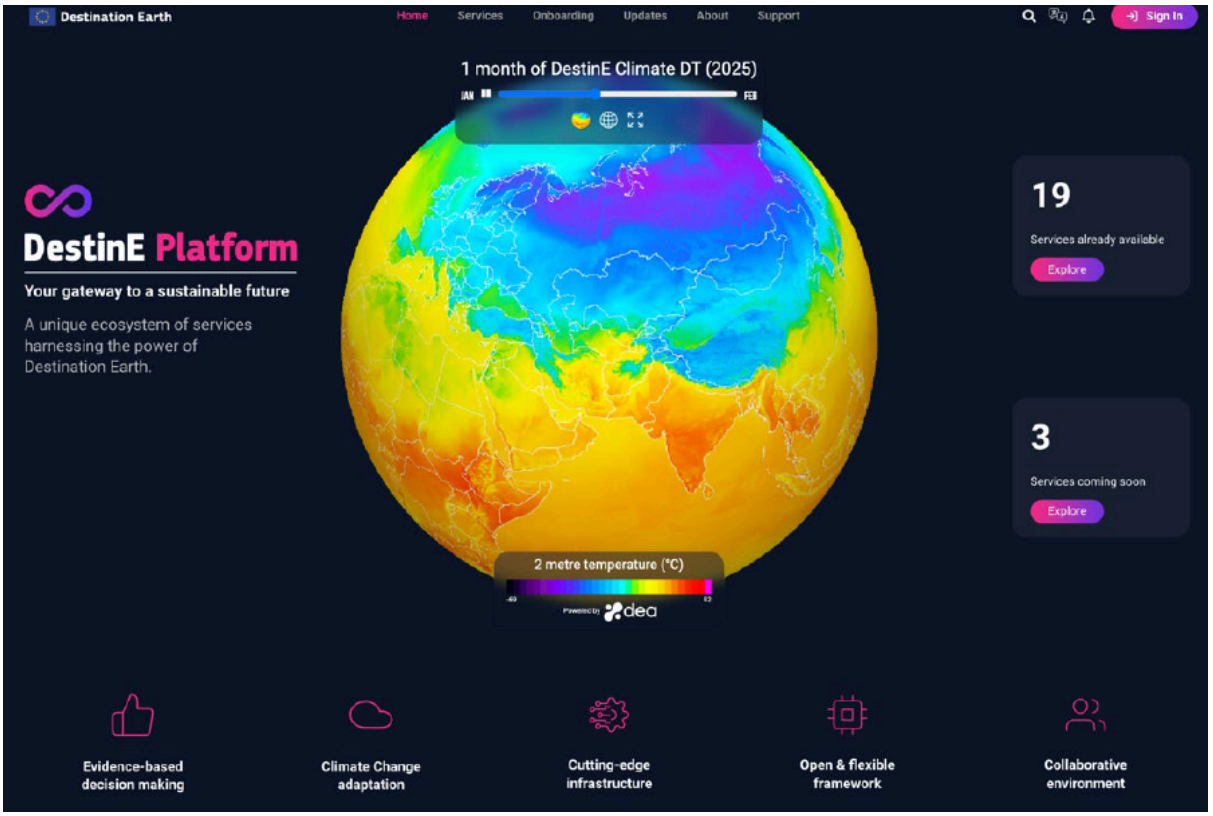

Figure 31 - DestinE platform

Destination Earth[75] is an ambitious initiative of the European Union to create a digital model of Earth that will be used to monitor the effects of natural and human activity on our planet, anticipate extreme events and adapt policies to climate-related challenges.

The European Commission's Directorate-General for Communications Networks, Content and Technology (DG CONNECT) leads the Destination Earth (DestinE) initiative, aimed at creating and providing access to a highly precise digital model of the Earth. This model will **enable the monitoring and simulation of both natural and human activities**, allowing for the development and testing of scenarios that foster sustainable development and support European environmental policies. It also underpins the European Commission's Green Deal and Digital Strategy.

The DestinE Core Service Platform (DestinE platform)—whose development and operations have been delegated to ESA—serves as the entry point for DestinE's users. Through this platform, users gain access to a continuous flow of data generated by the first two ECMWF (European Centre for Medium-Range Weather Forecasts)-managed Digital Twins (the Digital Twin on Weather-induced and Geophysical Extremes, and the Digital Twin on Climate Change Adaptation), as well as any future thematic Digital Twins integrated into DestinE. The DestinE data lake, developed and operated by EUMETSAT, is the primary component for archiving DestinE data, and for referencing and pre-processing additional external data.

[75] https://digital-strategy.ec.europa.eu/en/policies/destination-earth

By leveraging cutting-edge Earth system models, high-performance computing, satellite data, and machine learning, Destination Earth will **allow its users to examine the effects of climate change on various components of the Earth system, along with potential adaptation and mitigation strategies**. Specifically, DestinE will:

- Support the prediction of both natural disasters and man-made environmental damage with high precision.
- Enable the continuous and accurate monitoring of the health of the planet by focusing on the effects of climate change, for example on the oceans, water, Earth's ice caps, land use etc.
- Allow us to better understand the socio-economic effects of climate change and the occurrence of extreme natural disasters.

To address its challenges, Destination Earth is building on partnerships with:

- ESA
- DG CONNECT preparatory activities (DestinE engagement workshops, JRC survey)
- Horizon Europe Missions, research and innovation actions
- Copernicus and national hydro-meteorological services
- Earth-system and impact science, Earth observation communities
- Emerging Digital Twin communities (DTO, BioDT, InterTwin, GeoDT etc.)
- EuroHPC Joint Undertaking and partners (ETP4HPC, BDVA, etc.)
- Centres of Excellence and digital infrastructure research and innovation actions
- Technology providers (Atos, NVIDIA, etc.)
- Software and Cloud services providers
- International agencies (EUMETSAT, ECMWF, EEA, UNEP, WMO, etc.)
- Standards (OGC etc.)
- Etc.

During the initial phase of ESA's Digital Twin Earth (DTE) initiative, in coordination with DG CONNECT and following a broad, transparent consultation, ESA identified an initial set of thematic areas to guide the development of Earth Observation Digital Twin Components (EO DTCs) aligned with key scientific and sectoral priorities.

Through its Earth Observation (EO) programmes, ESA continues to advance cutting-edge EO science towards pre-operational applications, helping its member states make more effective use of new EO capabilities. In parallel, ESA is streamlining and validating EO Ground Segment activities, progressively constructing an EO data and operations framework.

This framework establishes a unified engineering approach to an ecosystem of EO services and integrates major European initiatives, such as Simpl, one of the major Data Space technological infrastructure projects proposed by the European Commission and detailed in §6.2.2. Simpl will serve as the foundation of a European Cloud Federation, enabling operations and interconnection within and between various European Data Spaces—particularly the European Green Deal Data Space, of which Destination Earth is a core element. **Destination Earth is already connected to the EU Data Strategy, having**

been designated as one of the first six projects under the Simpl initiative, which seeks to build the technological infrastructure for the Common European Data Spaces.

6.1.2. Copernicus Data Space Ecosystem (CDSE)

Building on the experience gained with the Copernicus DIAS-es (Data and Information Access Services) launched in 2017, the European Commission in December 2022 procured a new data access service from a consortium led by T-Systems, which has become operational in July of 2023: the CDSE (Copernicus Data Space Ecosystem)[76]. **The CDSE means a significant leap forward in the way users can access and work with Earth Observation (EO)data. The platform provides access to a large repository of open and free Earth Observation data from the Copernicus Sentinel satellites**, including new and historical Sentinel images, as well as CCM (Copernicus Contributing Missions)[77]. The CDSE works towards supporting users in accessing, viewing, using, downloading and analysing data, with the aim of improving access and exploitation of the EU's Copernicus satellites data. It is designed to be flexible and adaptable to the needs of different users, while ensuring continuity of the existing distribution services and DIAS-es.

The Copernicus Data Space Ecosystem offers:

- Largest EO data offering in the world, with discovery and download capabilities;
- Set of data processing tools to extract objective information and conduct public, private or commercial activities;
- An ecosystem to offer data, services and applications from public, commercial and scientific service providers;
- A service to benefit institutional users, research, commercial sector and citizens.

Figure 32 - Volume of Sentinel data immediately accessible on CDSE (June 2024) Source Copernicus

[76] https://dataspace.copernicus.eu/

[77] https://dataspace.copernicus.eu/explore-data/data-collections/copernicus-contributing-missions

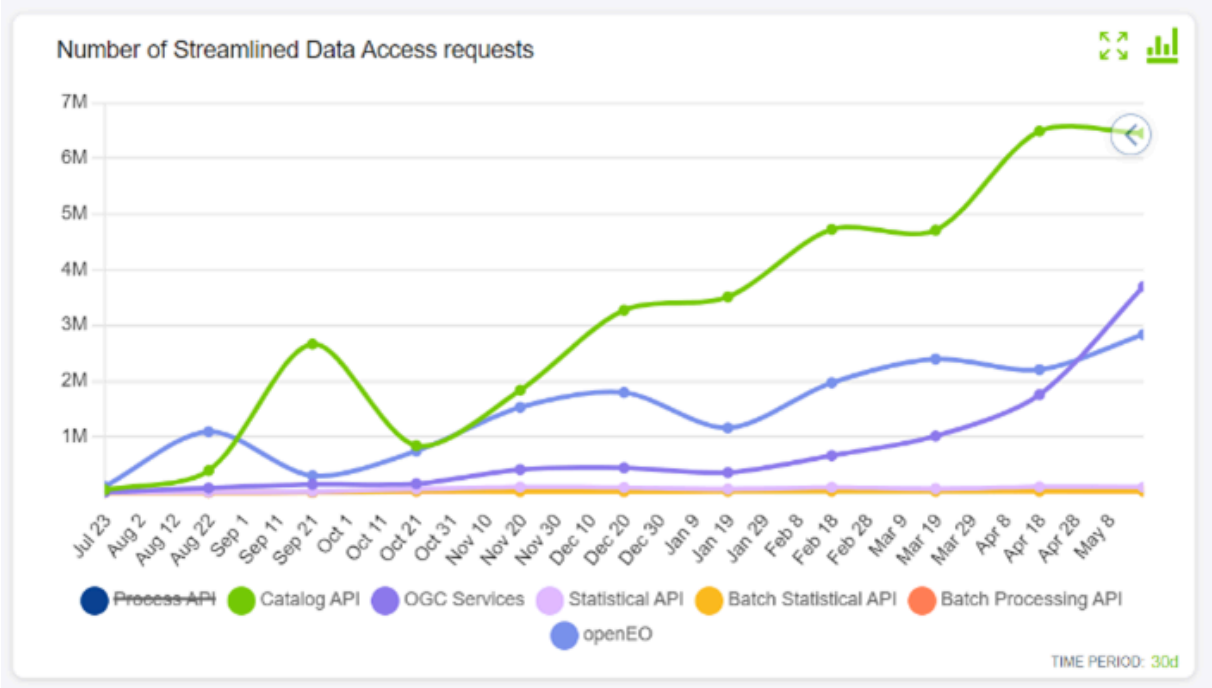

Figure 33 - Increase of streamlined data access APIs & OGC services (May 2024)
Source: Copernicus

Driven by the progress of CDSE, two DIAS platforms (CREODIAS[78] and Mundi[79]) have shifted to operating as third-party services built on top of CDSE. Other services—such as the ESA Collaborative Ground Segment, the Dunia Project for Africa, the Contributing Missions Rapid Response Desk, and various EU CAP and Copernicus Land Monitoring Services—have either migrated or are in the process of doing so. This transition underscores the value of an open Data Space with effective governance for both public and private sector applications and highlights the importance of achieving critical mass with long-term commitment.

6.1.3. European Union Agency for the Space Programme (EUSPA)

EUSPA provides secure and reliable European satellite navigation services, promotes the commercial use of Galileo, EGNOS, and Copernicus data and services, supports secure SATCOM (GOVSATCOM & IRIS2), and oversees the EU SST Front Desk. It also holds responsibility for accrediting the security of all EU Space Programme components. By driving innovation in the Space sector and collaborating with partners throughout the EU Space community, EUSPA contributes to the European Green Deal, digital transformation, and the safety, security, autonomy, and resilience of the European Union. EUSPA's mission is to serve as the EU Space Programme's user-focused operational agency, advancing sustainable growth, security, and safety across the EU. It achieves this through close cooperation with the European Commission, the European Parliament, Member States, the European Space Agency, and private-sector partners throughout Europe. EUSPA role is to

[78] https://creodias.eu/
[79] https://mundiwebservices.com/

foster market uptake of Space services and data, unlocking the Full Potential of Europe's Space #EUSpace infrastructure for economic growth:

- Leveraging Investment
- Untapped Economic Opportunities
- Fragmented space data Market
- Green and Digital Transitions
- Underutilised Potential Across Industries
- EUSPA Market Support

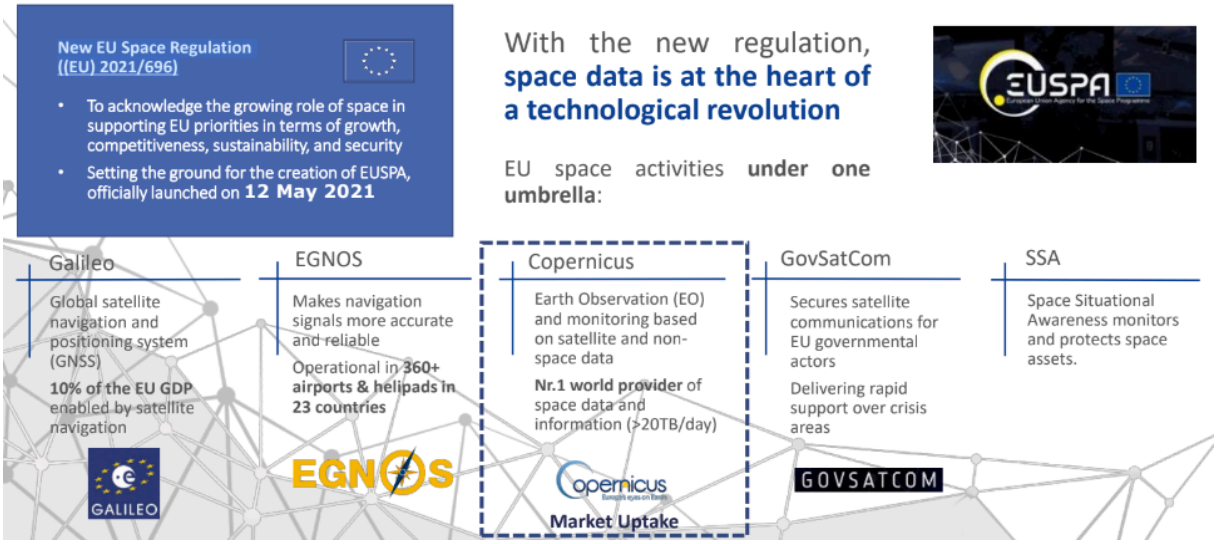

Figure 34 - Linking Space to user needs
Source: EUSPA

6.1.4. ESA Global Development Assistance (GDA)

The Global Development Assistance (GDA)[80] programme was approved at the ESA Council meeting at ministerial level in Seville in 2019 (Space19+). The duties include developing and growing ESA's collaboration with International Financing Institutions (IFIs) and additional key international and European national stakeholders in the field of global development assistance and cooperation.

The GDA Element is implemented by ESA in partnership with key IFIs - the World Bank and the Asian Development Bank - through a joint Cooperation framework called 'Space in support of International Development Assistance' (Space for IDA) carry out complementary activities (Capacity-building, Skills Transfer) using their own financial resources (i.e. new dedicated as well as existing programmatically aligned financing instruments).

[80] https://gda.esa.int/

Figure 35 - GDA thematic areas
Source GDA

GDA activity on Fragility, Conflict, and Security[81] is an initiative, conducted in collaboration with experts including e-GEOS, DLR, Hensoldt Analytics, Vito, Janes, and CGI.

6.1.5. ESA Accelerators

ESA's three Accelerators outline the agency's ambitions on the climate crisis, rapid crisis response and protecting Europe's space infrastructure in orbit:

- **R3 (Rapid and Resilient Crisis Response)** – aimed at supporting stakeholders to decisively act on crises facing Europe, at a moment when it is urgent and relevant for Europe to have the necessary tool sets at hand for taking effective decisions and actions.
- **S4GF (Space for a Green Future)** – aimed at 'bending the curve', of our society's carbon footprint, by leveraging the untapped potential of space solutions.
- **PROTECT (Protection of Space Assets)** – aimed at safeguarding and protecting European assets from space debris and space weather interference to ensure available and resilient infrastructure and services for our society and economy.

The Accelerators are action-based partnerships between space and user stakeholders fostering synergies around shared goals to solve global challenges. The Accelerators seek to address three areas of action: the identification of new use cases, the development and demonstration of New Space solutions, and the scaling of these solutions to new sectors and regions.

[81] https://gda.esa.int/2024/03/conclusion-of-esas-gda-activity-on-fragility-conflict-and-security-shaping-a-resilient-future/

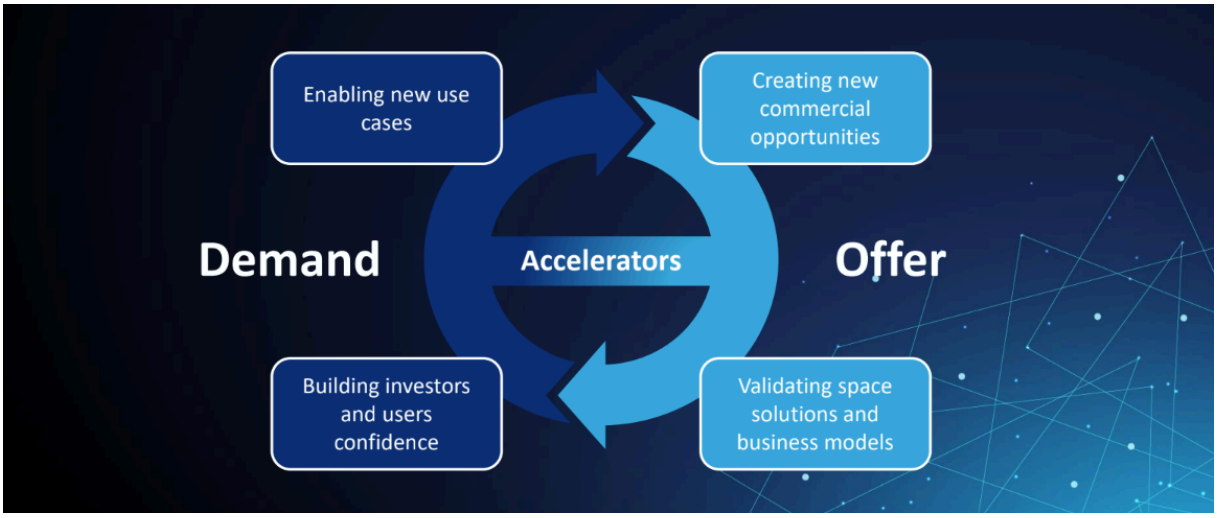

Figure 36 - Accelerators virtuous cycle
Source ESA

The CSS R3 seed activities engage and foster space-based solutions for governments, security actors, emergency responders, humanitarian relief entities and critical infrastructure owners, showcasing the innovations in over 10 planned demonstrations across several European countries.

6.1.6. Other ESA resources and initiatives

- **ESAC Science Data Centre[82]:** The ESAC Science Data Centre (ESDC), located at the European Space Astronomy Centre (ESAC), Madrid, Spain, provides services and tools to access and retrieve observations and data from ESA's space science missions (astronomy, planetary science and helio physics). The majority of ESA's space science mission archives are developed and maintained by the ESDC, in coordination with the science operations centres, the instrument teams and the consortia of the various missions. The strategy is the following:
  - Enable the maximum scientific exploitation of ESA space science data sets
  - Enable efficient long-term preservation of data, software and knowledge, using modern technology
  - Enable cost-effective archive production by integration in and across projects.
- **ESA Earth observation data products[83]:** Earth on line presents news and information on European Space Agency activities in the field of Earth observation. The website offers information about ESA's Earth Observation data, and the satellite missions and instruments that acquire this data. You can discover and download the Earth observation data you need from the broad catalogue of missions the European Space Agency operate and support here[84].

[82] https://www.cosmos.esa.int/web/esdc
[83] https://earth.esa.int/eogateway
[84] https://earth.esa.int/eogateway/catalog

- **Open science Catalogue[85]:** A catalogue of publicly available geoscience products, datasets and resources developed in the frame of scientific research Projects funded by ESA Earth Observation (EO).
- **Copernicus Contributing Missions (CCM)[86]:** CCM website provides full visibility of all Copernicus Contributing Missions delivering high resolution data complementary to the Copernicus Sentinels, in response to the needs of the Copernicus Services.
- **DISCOS database[87]:** Database and Information System Characterising Objects in Space (DISCOS) constitutes a recognised, reliable and dependable source of space object data that is regularly used by almost 40 customers worldwide. Apart from its use for standard database queries, DISCOS generates several automated 'products' − processed, refined data packages − which include a log of upcoming reentries and publication-quality status reports.

Reco 11: ESA should help build the Space Data Space by federating existing resources and initiatives.

6.1.7. Other non ESA initiatives

- **Open Geospatial Consortium (OGC)[88]:** OGC advances and refines existing standards through standards working groups, innovation programmes, collaborative solutions, and community contributions. Its spatio-temporal standards are widely adopted, particularly for brokering, but are not specifically tailored to European Data Spaces—though they do benefit from global support. With the shift to cloud-native formats, APIs, and global coverage reference systems like DGGS, OGC standards have incorporated community efforts such as STAC, COG, and Zarr. Initiatives like the Earth Observation Exploitation Platform Common Architecture (EOEPCA)[89] and openEO further demonstrate how these standards can be used alongside cloud processing, underpinning projects like EarthCode, CODE-DE, and UK EO Data Hub (see details below). Data quality is receiving increased attention through new working groups on Analysis Ready Data and Climate Indicators, with semantic support gaining traction in fields like Agriculture and Oceanography. While security concerns often remain separate, OGC test beds have shown that data-centric security approaches can tightly integrate access control with spatio-temporal parameters.
- **UK Earth Observation Data Hub (EODH)[90]:** Funded by UKRI and led by the National Centre for Earth Observation (in particular its Centre for Environmental Data Analysis - CEDA - team) and the University of Leicester, the UK EO Data Hub is a national project that extends Copernicus capabilities with UK-specific data access and processing. It prioritises high-quality CEDA ARD and QA workflows, national resources, advanced client applications, and commercial data access. A unified interface built on EOEPCA (OGC-based) and data stream providers' policies/APIs serves as an adapters layer to handle technical data ordering (excluding contractual

[85] https://opensciencedata.esa.int/
[86] https://spacedata.copernicus.eu/
[87] https://discosweb.esoc.esa.int/
[88] https://opensciencedata.esa.int/
[89] https://eoepca.org/
[90] http://eodatahub.org.uk

matters at this stage). The initiative will offer open-source components and technical specifications, fostering interoperability. Incorporating the Space Data Space's ready-to-use control plane could further support the Datahub while prompting a review of its overall strategy and unique value proposition.

- **WASDI[91]:** WASDI, established in December 2020 as a joint venture between FadeOut Software (an Italian software development SME) and the Luxembourg Institute of Science and Technology (LIST)[92], aims to foster an open Earth Observation (EO) community. By collaborating with universities, research centres, freelancers, companies, and governments, WASDI seeks to co-develop the next generation of EO applications to address real-world challenges. The WASDI platform is utilised by:
    - the Global Programme for Disaster Risk Analytics (GPDRA)[93]
    - the Global Programme for Nature-Based Solutions (NBS)[94] for flood detection
- **CNES Space Data Marketplace[95]:** Space Data Marketplace aims at facilitating access to space data to foster innovation and create value from strong data partnerships. Space Data Marketplace is a data exchange platform where data acquirers and data providers meet to source, distribute, exchange and monetise data securely, in compliance with regulations. The mission of the data marketplace is to facilitate access to space data and create value for the whole industry. Supported by the French Recovery Plan and the French space government agency CNES, the Space Data Exchange mission is to democratise access to data and encourage the development of innovative use cases with technological, scientific, economic, societal and environmental impacts.
- **New Space Portugal / Digital Planet[96]**: Digital Planet stands as a pivotal element in the New Space Portugal Agenda, with a primary focus on generating value-added products for the Earth observation market. Its core mission involves the integration and fusion of data from diverse sources, encompassing both 'in-situ' and remote datasets. The collaborative efforts of various co-promoters within Digital Planet aim to emphasise applications that leverage the unique characteristics of future constellations resulting from the Agenda, incorporating Very High Resolution (VHR), High Resolution (HR),Synthetic Aperture Radar (SAR), VDES/AIS, or Internet of Things (IoT) payloads across multiple verticals, including Defence and Security, Emergency Management, Agriculture and Forestry, Ocean, Energy, Smart Cities, and Sustainability, among others. All developed applications are tailored to address specific market needs, while also facilitating seamless integration into various commercial ecosystems. This necessitates alignment with requirements spanning different levels of interoperability, including data models and formats, APIs, and other standards related to quality, security, and scalability.

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91 https://www.wasdi.cloud/

92 https://www.list.lu/en/

93 https://www.gfdrr.org/en/disaster-risk-analytics#:~:text=The%20Global%20Program%20for%20Disaster.can%20facilitate%20evidence%2Dbased%20decisions

94 https://naturebasedsolutions.org/global-program-on-nbs#:~:text=The%20Global%20Program%20on%20Nature%2DBased%20Solutions%20(NBS)%20for.systems%20across%20regions%20and%20sectors

95 https://www.space-data-marketplace.eu/en/

96 https://www.newspaceportugal.org/en/atividades/digital-planet

- **SPACE4GEO Alliance[97]:** Promoted under the EC initiative Pact for Skills, launched by DG EMPL and DG DEFIS on 25th April 2023, SPACE4GEO is the Large-scale Skills Partnership for the space downstream and geoinformation sector dedicated to space data, services and applications. It promotes activities aimed to up-skilling and reskilling the work force and attract new talents to target a career in the downstream space and geoinformation sector. Leveraging on the results of the EO4GEO[98] Blueprint project on space geoinformation and its Sector Skills Strategy, adopting a wider sectoral coverage, SPACE4GEO embraces not only Earth Observation and geoinformation but also positioning, navigation, secure connectivity as well as the use of data for security and defence, namely the entire so-called downstream segment of space economy.
- **DOMINO-X / DOMINO-E[99]:** The Domino-X project was launched at the end of 2021 with 11 partners trying to build the best system architecture for future Earth Observation Ground Segments, with a central aim of making main interfaces within EO ground systems public and standardised. The goal is for these interfaces to be adopted by industry and institutions, by primes and providers of ground segment building blocks. Key to the future success of this initiative is the involvement of the largest number of players in the domain. Stabilising and agreeing interfaces of key building blocks increases competitiveness of the ecosystem, since the barrier to entry of build block providers is lowered, as the integration into end-to-end systems is facilitated. The European space industry is moving towards an architecture where satellites and ground sensors are integrated into a federation system to make Earth observation assets available to business and public services. The DOMINO-E project aims at solving the key challenges of availability and reactivity of Earth observation from space and contributes to independence in the development of Earth observation technologies, while at the same time fostering European competitiveness by supporting SMEs in the development of multi-mission services. Co-funded by the European Union[100], DOMINO-E project is implemented by a consortium of European organisations, including scientific institutes and SMEs, under the leadership of Airbus Defence and Space.
- **MESEO[101]:** The MESEO project, launched in Q4 2023, aims to establish a collaborative digital ecosystem based on a Data Space architecture. At its core is an EO (Earth Observation) Coordinator Centre, which acts as an orchestrator, federating space data from multiple missions and distributed, heterogeneous Processing Functions to execute various steps of an EO processing chain. The architecture leverages the concept of a Data Space connector to achieve interoperability via Data Sovereignty protocol interfaces. Under this framework, federated space data and EO Processing Functions are exported through harmonised interfaces that ensure data sovereignty. Participants in the EO ecosystem can register their products and services as exported Functions within the ecosystem. The EO Coordinator Centre then discovers and manages these registered resources, determining which data or Processing Functions to activate in a transparent manner to optimise End-to-End

[97] https://www.space4geo.eu/
[98] http://www.eo4geo.eu/
[99] https://domino-x.space/
[100] https://cordis.europa.eu/project/id/101082230
[101] https://cordis.europa.eu/project/id/101135067

performance, whether in terms of timing or quality, for a specific user request. MESEO addresses both the upstream and downstream segments of the EO data processing value chain, ensuring seamless integration and transparency. It serves as a critical reference for building a future Space Data Space that is interoperable with other Data Spaces. By demonstrating harmonised and transparent access to multi-mission space data and EO processing functions and services, while preserving data sovereignty for owners, MESEO facilitates trusted data exchange. Co-funded by the EU, MESEO is led by GMV, which plays a central role in guiding the project and coordinating numerous European SMEs that are partners in the initiative.

Reco 12: Space sector industry players should help build the Space Data Space by federating existing resources and initiatives, including non ESA.

6.1.8. Space Data Space Data Ecosystems Catalogue (SDS-DEC)

Following the recommendation of the ESA-ESPI Space Data Space workshop held in Brussels in 2024, in this Blueprint, **we introduce the first Space Data Space Data Ecosystems catalogue (SDS-DEC).**

This knowledge base will assist the Space Community of Practice in mapping **all relevant data-sharing ecosystems for the Space sector**, encompassing both intra-sector use cases and those that connect with other sectors.

All members of the Space Community of Practice—including industry participants, ESA, EUSPA, and ESA/EU member states—are encouraged to contribute ideas and entries to this catalogue.

The initial version of the SDS Data Ecosystems Catalogue can be found in Appendix §15.4. of this document.

6.2. Key Data Spaces organisations

6.2.1. EU Data Spaces governance

Table 3 - EU level Data Space governance organisations

The European Data Innovation Board (EDIB)
The European Data Innovation Board (EDIB), as outlined in the Data Governance Act, is a diverse body comprising representatives from all EU Member States, the European Data Protection Board (EDPB), relevant Data Spaces, and representatives of competent authorities in specific sectors. Its role is to provide expertise for decisions on data governance, advise the Commission on cybersecurity for data exchange and storage, and advocate for international standardisation and data portability. The EDIB is envisioned as a cross-sectoral entity emphasising interoperability, involving various stakeholders,

including industrial players, from the initial stages. It aims to foster dialogue and joint efforts among participants, promoting best practices in data intermediation, data altruism, and the use of public data that cannot be open. The Data Governance Act details the group's functions and structure in Chapter VI.
European Data Protection Board (EDPB)[102]
The European Data Protection Board (EDPB) is an independent body that provides guidance and recommendations on the implementation of data protection rules in the EU. It has issued numerous guidelines on various topics, such as data subject rights, transparency, and the use of cookies.[103] EDPB is also responsible for resolving disputes between national supervisory authorities.
European Digital Innovation Hubs (EDIHs)[104]
With the EDIH network, the European Commission wants to build a vibrant community of hubs and other stakeholders fostering networking, co-operation, and knowledge transfer activities between EDIH, SME and mid-caps, the public sector and the other relevant stakeholders and initiatives. The Digital Transformation Accelerator (DTA) is supporting the achievement of this goal, through managing the web presence of the network, and hosting appropriate software platform and tools, including the online catalogue of EDIHs.The EDIH network web portal includes tools to assess the performance of the EDIH network, gauging the impact that EDIHs have on the digital maturity of the organisations they support. To this end, the Joint Research Centre of the European Commission has developed a Digital Maturity Assessment tool which can be used by all EDIHs to measure the progress of Digital. There is one EDIH dedicated to Location, Location Innovation Hub (LIH)[105], which is very relevant for Space Data Space and with whom we are already in contact.

6.2.2. Data Space support organisations and initiatives

Data Space support organisations are independent entities, consortia, and collaborative networks that operate with the support of the EU, or outside official EU bodies. They develop cross-sectoral standards, architectures, and frameworks to facilitate the implementation of Data Space initiatives. These organisations offer reference models for Data Spaces, Rulebook frameworks, certification labels, standards, and open-source building block components essential for Data Space development.

Table 4 - Key Data Space support organisations

Data Spaces Support Centre (DSSC)[106]

[102] https://edpb.europa.eu/edpb_en

[103] https://edpb.europa.eu/search_en?search=guidelines&f%5B0%5D=publication_type%3A64

[104] https://european-digital-innovation-hubs.ec.europa.eu/home

[105] https://locationinnovationhub.eu/en/home/

[106] https://dssc.eu/

The Data Spaces Support Centre (DSSC), initiated in October 2022, plays a pivotal role in coordinating European Data Spaces for interoperability and facilitating the deployment of sovereign Data Spaces across various sectors. Recently releasing the final version of the 'Starter Kit for Data Space Designers', the DSSC outlines its work in five dimensions: Business, Legal, Operational, Functional, and Technical, following the 'BLOFT' approach. Notably, the DSSC focuses on promoting cross-sectoral interoperability and has established a Relationship Manager role for effective communication with Data Spaces like the Space Data Space. The Glossary and Conceptual Model, key outputs of the DSSC, aim to provide standardised terminology and a clear conceptual framework. Additionally, the DSSC collaborates with multiple Data Spaces and other Data Space support organisations, sharing experiences, and contributing to the development of common standards. The DSSC's ongoing work, outlined in its DSSC Blueprint, reflects a commitment to minimise duplication of effort and fostering alignment among diverse Data Spaces initiatives. The DSSC directly supports the action of the EDIB and links with all other Data Space support organisations, as well as with Data Space Blueprints from all sectors.

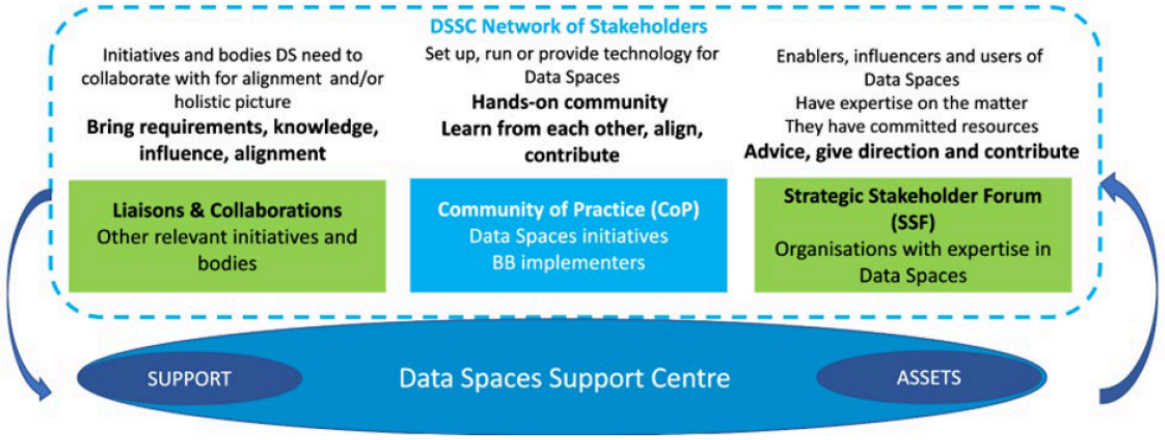

Figure 37 - DSSC Network of Stakeholders

Gaia-X[107]

Gaia-X, initiated in 2020 as a Franco-German project with international representation, aims to establish a federated data-sharing infrastructure aligning with European values on data and cloud sovereignty. Gaia-X emphasises common standards, best practices, tools, and governance mechanisms. Its technical pillars include Gaia-X Compliance, emphasising decentralised services for measurable trust; Data Spaces/Federations, promoting interoperable and portable cross-sector datasets and services; and Data Exchange, anchored in contract rules for access and usage. Gaia-X's ongoing developments include defining labels and addressing topics like data Usage Agreement, Policies, Vocabulary, and Observability.

International Data Space Association (IDSA)[108]

The International Data Spaces Association (IDSA) is a global nonprofit organisation

[107] https://gaia-x.eu/

[108] https://internationaldataspaces.org/

dedicated to advancing the concept of sovereign and secure data-sharing ecosystems. Established in 2016, IDSA brings together a diverse community of members, including businesses, research institutions, and government entities, with the common goal of fostering trusted and interoperable data exchange. IDSA promotes the development and implementation of International Data Spaces (IDS), which are frameworks designed to enable secure and standardised data-sharing across various domains and industries. The association plays a pivotal role in developing specifications, standards, and best practices for IDS, contributing to the establishment of a decentralised, user-centric, and privacy-preserving approach to data-sharing on an international scale. Through collaboration and innovation, IDSA aims to empower organisations to unlock the full potential of their data while maintaining control and sovereignty over their information assets.

FIWARE[109]

FIWARE is an open-source platform that provides a standardised framework for building and deploying smart applications and solutions in the context of the Internet of Things (IoT) and smart services. Developed by an international community of organisations, FIWARE offers a set of reusable components and generic enablers that facilitate the development of interoperable and scalable applications across different domains. The platform emphasises open standards, fostering a collaborative ecosystem where developers, businesses, and cities can create innovative solutions for diverse sectors, including smart cities, agriculture, healthcare, and more. FIWARE promotes the creation of a common framework that enables the seamless integration of data and services, accelerating the development of smart applications that leverage real-time context information.

Big Data Value Association (BDVA)[110]

The Big Data Value Association (BDVA) is a non-profit organisation based in Europe that serves as a leading industry-driven organisation in the field of big data and data-driven AI (Artificial Intelligence). BDVA aims to boost European competitiveness by supporting the development and deployment of big data technologies and solutions. It brings together industry, research, and policy stakeholders to collaborate on various aspects related to big data, such as technology roadmaps, research and innovation, and standards. BDVA plays a crucial role in fostering collaboration, promoting research and innovation activities, and advocating for policies that support the growth of the big data ecosystem in Europe. The association is actively involved in initiatives and projects that contribute to the advancement of big data technologies and their application across different sectors.

Data Space Business Alliance (DSBA)[111]

The DSBA convergence document is a publication from the Data Spaces Business Alliance (DSBA), a collaboration of four European associations dedicated to advancing Data Spaces globally (Gaia-X, IDSA, FIWARE, BDVA). This document outlines a unified reference technology framework for establishing Data Spaces by converging existing

[109] https://www.fiware.org/

[110] https://www.bdva.eu/

[111] https://data-spaces-business-alliance.eu/

architectures and models. It delves into critical technology aspects of Data Spaces, including data interoperability, data sovereignty and trust, and data value creation. The primary goal of this convergence is to prevent dependencies while allowing for interoperability. If a particular functionality or component is defined in multiple reference documents, updates will be made for compatibility, enabling each initiative to choose without affecting the overall Data Space architecture. The DSBA aims to foster technical convergence among major Data Space initiatives and defines roles each initiative can fulfil. It released the second version of its Technical Convergence Document in April 2023, focusing on achieving interoperability across Data Spaces by harmonising technology components. The DBA's efforts contribute to the development of a common framework for Data Spaces, allowing organisations and individuals to unlock the full potential of their data.

Simpl[112]

Simpl, an EU-funded initiative under the Digital Europe Programme, focuses on streamlining cloud-to-edge federation within major EU Data Spaces. Marking a significant advancement in technological infrastructure, SIMPL's main goal is to provide Data Space operators with a common technical foundation, ensuring trust, security, ease of access, adaptability, and interoperability. Positioned as a mandated requirement for all European sectoral Data Spaces, Simpl is closely aligned with the DSSC and committed to implementing DSSC compliance software. The Smart Middleware Platform (SMP) within SIMPL is designed around the SMP Agent concept, fostering interoperability between Data Spaces. Simpl aims to facilitate the creation of Common European Data Spaces, harmonise existing standards, support the trustworthy ecosystem, and play a crucial role in the European data strategy by ensuring a balance between regulation and innovation. While the project is yet to finalise, it holds promise within the Data Spaces domain and its proof-of-concept has been presented at the 1st Simpl Annual Community Event on the 30th of January 2025 in Brussels[113].

MyData[114]

MyData Global is an international nonprofit organisation that advocates for the ethical use of personal data and empowers individuals to have more control over their personal information. Founded in 2018, MyData Global is part of the broader MyData movement, which seeks to promote a human-centric approach to personal data and digital services. The organisation encourages the development and implementation of MyData principles, emphasising transparency, user empowerment, and the right to access and control one's own data. MyData Global engages with various stakeholders, including businesses, policymakers, and individuals, to advance a vision of a fair and sustainable digital society where individuals can benefit from the use of their data while ensuring privacy, security, and user autonomy. The organisation provides a platform for collaboration, knowledge-sharing, and the development of practical tools to enable the implementation of MyData principles globally.

[112] https://digital-strategy.ec.europa.eu/en/policies/simpl

[113] https://simplannualevent.uevent.eu/

[114] https://mydata.org/

SOLID[115]
SOLID, which stands for ‘Social Linked Data’, is a web decentralisation project led by Sir Tim Berners-Lee, the inventor of the World Wide Web. SOLID aims to give individuals more control over their personal data and how it is shared on the internet. The core idea is to separate data storage from applications, allowing users to store their data in ‘pods’ (personal online data stores) and grant permissions for specific applications to access that data. This approach ensures that users retain ownership and control over their information while enabling interoperability and data portability across various applications and services. SOLID promotes a user-centric model for the web, emphasising privacy, security, and user empowerment in managing their digital identities and personal information.
iSHARE Foundation[116]
iSHARE is an initiative that focuses on establishing a standardised and secure way for organisations to share data in B2B, across sectors active in Energy, Green Deal, Agriculture, Mobility, Building and Logistics.. Developed in the Netherlands, iSHARE provides a framework and set of agreements to enable trusted and controlled data-sharing between parties in any B2B ecosystem. It addresses challenges related to interoperability, security, and mutual trust by defining a common set of rules and standards for data exchange. iSHARE aims to facilitate seamless collaboration and information sharing, promoting efficiency and transparency in business operations. The initiative emphasises a user-centric approach, allowing organisations to share data based on agreed-upon permissions and policies, ultimately contributing to a more interconnected and efficient B2B ecosystem.

6.2.3. Sectoral preliminary studies and Blueprints

In 2022, various preliminary studies were initiated under the Digital Europe call ‘Preparatory actions for Data Spaces’ to create Data Spaces across different sectors such as Agriculture, Tourism, and Education.

[115] https://solidproject.org/

[116] https://ishare.eu/

Figure 38 - Sectoral Data Spaces Blueprints

These studies lay the groundwork for establishing multiple Data Spaces initiatives and sector-specific Coordination Authorities. Additionally, they promote sectoral standardisation, mutualisation, and coordination, and will serve as a conduit for inter-sector exchanges.

Table 5 - Sectoral preliminary studies and Blueprints

Smart Cities Data Space Blueprint (DS4SSCC)[117]
The European Data Space for Smart Communities (DS4SSCC-DEP) initiative is a pivotal deployment following the preparatory action for a Data Space for Sustainable and Smart Cities and Communities (DS4SSCC). Emphasising sustainability aspects and diversity in communities, DS4SSCC developed a multi-stakeholder data governance scheme, created a blueprint for the European DS4SSCC, delivered priority datasets, and developed a roadmap towards a mature DS4SSCC. DS4SSCC-DEP's vision revolves around creating a well-governed federated territorial, place-based data space for smart communities available for developers and infrastructure providers, aligning with the prospects outlined in Europe's Digital Decade objectives. This approach distinguishes itself from sectoral data spaces by encompassing diverse domains, and underpinning governance across all levels of society.
Green Deal Data Space Blueprint (GREAT)[118]
The GREAT project, funded by the Digital Europe program, aims to establish the Green Deal Data Space Foundation and its Community of Practice which builds on both the European Green Deal and the EU's Strategy for Data. The project will deliver a roadmap

[117] https://www.ds4sscc.eu/

[118] https://www.greatproject.eu/

for implementing and deploying the Green Deal Data Space, an infrastructure that will allow data providers and initiatives to openly share their data to tackle climate change in a multidisciplinary manner. The initiative was launched in September, 2022 and focuses on three areas: biodiversity, zero pollution and climate change adaptation. Space Data Space also participated in a workshop with GREAT to ensure that the development of both Data Spaces are aligned.

Mobility Data Space Blueprint (PrepDSpace4Mobility)[119]

PrepDSpace4Mobility lays the foundation for a secured and controlled way of pooling and sharing mobility data across Europe. The 12-month Coordination and Support Action (CSA) contributes to the development of the common European mobility Data Space by mapping existing data ecosystems, identifying gaps and overlaps within, and proposes common building blocks and governance frameworks found in existing Data Space architectures. The actions are carried out by a project team composed of leading experts from the private and public mobility sectors, with key competencies in mobility, economics, and digital technologies. Jointly, they are supporting a new European era of mobility data-sharing, centred around the principles of trust, interoperability, and sovereignty, where data can be made available, accessed, and securely exchanged across Europe. PrepDSpace4Mobility represents a vital pillar for the future deployment of a single market for mobility data. Space Data Space is in constant dialogue with Data Space for mobility to ensure that the Data Spaces are aligned.

Skills Data Space Blueprint (DS4Skills)[120]

DS4Skills aims to prepare the ground for the development of an open and trusted European Data Space for Skills that supports sharing and accessing skills data. It is funded by the European Commission under the Digital Europe Programme and involves 14 ambitious partners from the industry, education and data ecosystem sectors. Coordinated by DIGITALEUROPE, the DS4Skills consortium brings together 10 full Partners and 4 Associated Partners with solid experience in data ecosystem and community building, a wide network of stakeholders from diverse backgrounds, including researchers, training providers, companies as well as associations representing industry and data ecosystems. Initiatives such as EO4GEO, Space4GEO and Space4GEO Alliance are relevant for DS4Skills[121].

Tourism Data Space Blueprint (Data Spaces for Tourism and DATES)[122]

The initiatives are EU projects that aim to explore approaches and options for the deployment of a secure and trusted tourism Data Space, ensuring transparent control of data access, use and re-use. The project focuses on the development of governance and business models, while providing a shared roadmap that will ensure the coordination of the tourism ecosystem stakeholders and the connection between data ecosystems at EU level and interconnected Data Spaces in other sectors. The projects promote the vision of

[119] https://mobilitydataspace-csa.eu/

[120] https://www.skillsdataspace.eu/

[121] http://www.eo4geo.eu/space4geo-alliance/
https://www.space4geo.eu/

[122] https://www.tourismdataspace-csa.eu/wp-content/uploads/2024/01/DRAFT-BLUEPRINT-Tourism-Data-Space-v3.3_final.pdf

a prosperous tourism Data Space and recommend clear strategies on how to inspire and motivate all key tourism stakeholders to collaboratively build a powerful interconnected tourism Data Space. Besides providing leadership and practical advice about how every stakeholder in the tourism value chain can contribute and utilise data streams, the added benefits of a European Tourism Data Space will be highlighted from each stakeholder's perspective. In more general terms, they support the digital transformation of the sector, fostering competitiveness, resilience, and sustainability as key success factors to maintain Europe's leading role.

Agriculture Data Space Blueprint (AgriDataSpace)[123]

AgriDataSpace project aims to pave the way for a European Data Space for agriculture that facilitates data-sharing, processing, and analysis in a secured, trusted, transparent and responsible manner to create new opportunities for monitoring and optimising natural resource use, stimulating data-driven innovations. The AgriDataSpace consortium brings together an excellent team of experts from leading research institutes, agriculture data intermediaries and industry associations representing 10 countries that are rooted in the EU Data Space ecosystem.

Common European Energy Data Space (CEEDS)[124]

The Common European Energy Data Space (CEEDS) blueprint emphasises the need for data space solutions to transform the energy sector by fostering collaboration among stakeholders and improving service quality and financial benefits across the energy value chain. CEEDS aims to create an open market with clear rules and fair data exchange, encouraging participation from data providers, service providers, and consumers. It tackles energy sector challenges by defining diverse use cases (such as mobility, residential energy optimisation, and renewables maintenance) and proposing a federated data space architecture aligned with existing standards. This blueprint also addresses interoperability issues and provides practical recommendations for seamless data exchange. It invites stakeholders to actively engage in CEEDS development to bring innovative, efficient, and sustainable changes to the energy industry, ensuring solutions are scalable and applicable to real-world scenarios.

Reco 13: The Space sector should become one of the key sectors of the Common European Data Spaces, and of the European data strategy.

[123] https://agridataspace-csa.eu/

[124] https://enershare.eu/wp-content/uploads/Blueprint_CEEDS_v2.pdf

6.3. Existing Data Space initiatives

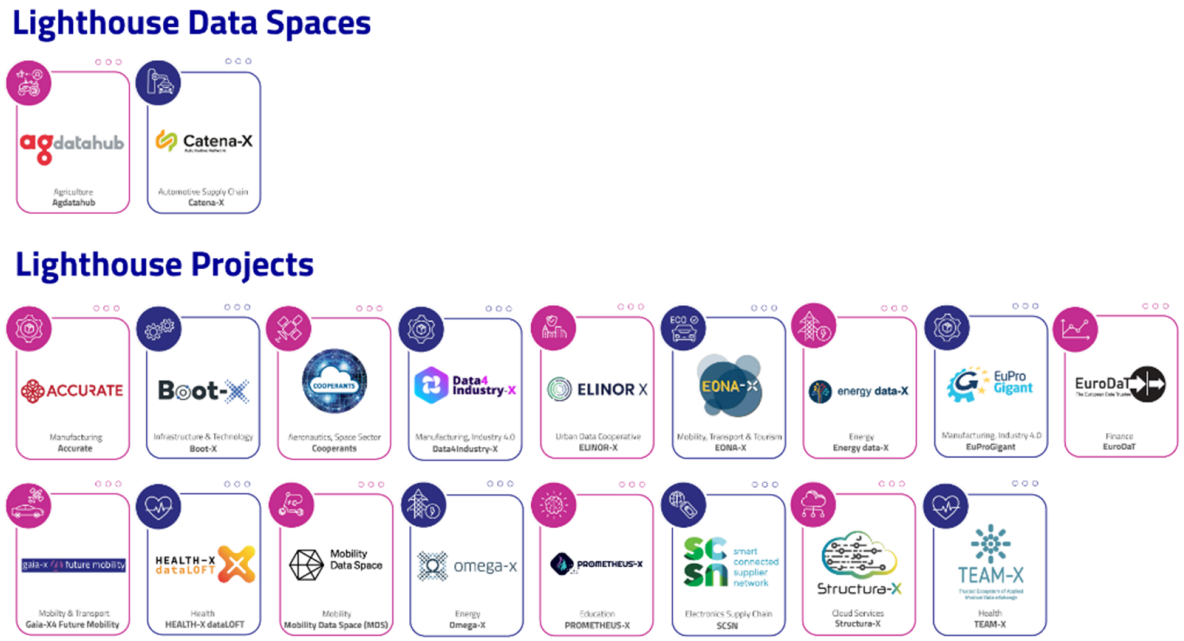

Figure 39 - Key Data Space initiative
Source: Gaia-X

Numerous Data Space initiatives are currently being developed or are in the early operational stages across Europe in various sectors. These initiatives are actively working on establishing their governance frameworks, building technological infrastructure for data-sharing, and implementing specific use cases for their participants. They align with the guidelines put forth by European institutions and receive support from Data Space organisations.

Table 6 - Key Data Space initiatives

Catena-X (automotive)[125]
It is one of the first industrial lighthouse projects of Gaia-X. It aims to create a secure and standardised data-based ecosystem for businesses ranging from OEMs (original equipment manufacturer), 1st Tier and to small & medium enterprises (SMEs) in the entire automotive value-chain. A joint task force with Gaia-X ended in November 2021, resulting in full technical compliance of the proposed Catena-X architecture with Gaia-X principles.
EONA-X (tourism and mobility)[126]
EONA-X is a European Data Space for Mobility, Transport, and Tourism, inspired by the Gaia-X initiative. It was established by prominent entities such as Air France/KLM Group, Aéroport de Marseille Provence, Amadeus, Groupe ADP, Groupe SNCF, and Apidae

[125] https://catena-x.net/en/

[126] https://eona-x.eu/

Tourisme Scic SA. These founding members operate globally, and additional members like Accor Hotels, Compagnie des Alpes, and Alentour are joining. The initiative aligns with the Common European Mobility Data Space strategy, aiming to enhance economic development and improve service quality by leveraging better information for passengers and visitors in Europe. EONA-X seeks to explore opportunities for efficiency, sustainability, and customer-friendly improvements in public transport systems through enhanced data utilisation, in line with the vision of smart cities.

EuProGigant (manufacturing)[127]

It is an Austrian-German lighthouse research project 'for calamity avoiding self-orchestration of value chain and learning ecosystems' working on central questions related to the smart and sovereign use of data in manufacturing. The project aims to deliver on machine connection and machine-oriented data processing using Gaia-X compliant edge architecture, thus creating resilience in the value creation ecosystem.

Mobility Data Space (mobility)[128]

The specific lighthouse project focuses on the future of the mobility sector that involves vehicle manufacturers to ride-share services, public transport operators as well as navigation software companies, research institutes, bike-sharing companies, and many more. One of the project´s key goals is to facilitate Gaia-X compliant data exchange to enable competition around innovative, environmentally sustainable, and user-friendly mobility – on equal and fair terms based on shared European values. The project is scheduled for implementation in the latter half of 2022.

Omega-X (energy)[129]

Four actions are currently preparing for a European energy Data Space, including OMEGA-X and Int-Net. As an example, relying on European common standards, OMEGA-X provisions a federated infrastructure, data marketplace and service marketplace, involving data-sharing between different stakeholders and demonstrating its value for concrete energy use cases while guaranteeing scalability and interoperability with other Data Space initiatives.

TEMS (media)[130]

TEMS project is powered by the European Commission and developed by a consortium of 43 organisations representing hundreds of stakeholders from 14 countries in the cultural and creative sectors. It is a core element in the implementation of the European data strategy.

Fish-X (fisheries)[131]

Co-funded by the Horizon Europe Programme, this 3-year project aims at developing a Fisheries Dataspace (Fish-X), an Insight Platform and a Traceability Application – based on smart orchestrated architecture and open interoperable technology via Gaia-X - to

[127] https://euprogigant.com/en/

[128] https://mobility-dataspace.eu/

[129] https://omega-x.eu/

[130] https://tems-dataspace.eu/

[131] https://fish-x.eu/

support the objectives of Common Fisheries Policy (CFP), EU Green Deal and Farm to Fork Strategy. It aims at overcoming key sets of challenges including the following points: 1) collection and sharing of data, in particular from small-scale and recreational fisheries; and 2) accessing, managing and utilising data to strengthen the monitoring and control as well as the sustainability of EU fisheries.
Fintraffic (maritime)[132]
The goal of the Maritime Data Space project is to create practical solutions for sharing data generated by ships. These solutions aim not only to enhance traffic flow but also to reduce emissions and address various logistical challenges in ports. Sharing data also contributes to increased safety by providing real-time information to stakeholders involved in port visits about the vessel's movements, weather, and other critical factors.
Elinor-X[133]
This project presents the first Gaia-X implementation in Switzerland. A new model of data collaboration is being developed along Elinor Ostrom's Principles of Commons that will enable the public and private sectors to share data easily and targeted. Data is routed based on individually specified and legally binding data-sharing agreements, directly from data provider to data consumer, without ever being stored centrally. Elinor-X provides the foundation for data sources of future digital twins that will enable government and other public service providers to solve important and pressing challenges through data-driven decision-making.

[132] https://www.fintraffic.fi/fi/vts/hankkeet-ja-kehittaminen/mds

[133] https://elinor-x.ch/en/

7. Governance Model for the Space Data Space

Who will join the Space Data Space? How will decisions be made? How will the Data Space be organised and operated?

For the Data Space to function effectively and foster the trust required for data-sharing, these questions must be thoroughly addressed. This chapter explores the key governance aspects that the forthcoming Space Data Space will need to define. It begins with the establishment of a governance authority, a critical component given the importance of liability in building a reliable trust framework.

7.1. Governance challenges

In a Data Space, the diversity of participants, their varying numbers, interests, and levels of maturity, **requires significant coordination** to standardise best practices for data-sharing. Beyond coordination, **participants must agree on common rules and make decisive choices** when consensus cannot be achieved. Key governance challenges for Data Spaces can include:

- Defining the scope of the Data Space
- Establishing the legal status of the governance authority and its potential subsidiaries
- Liaising with external bodies (EU, member state, local, sectoral level)
- Setting conditions for participation
- Creating a governance framework
- Defining roles and responsibilities within the Data Space
- Building trust among participants (e.g., ownership rights, compliance, transparency, security, and value-sharing)
- Encouraging collaboration and cooperation
- Addressing power imbalances among participants
- Meeting sector-specific coordination needs and regulatory requirements
- Balancing membership benefits with autonomy and free trade
- Aligning innovation with regulation and leveraging regulation to promote innovation
- Harmonising public and private interests
- Reconciling societal values with financial sustainability

7.2. Building the Space Data Space governance

7.2.1. Coordination at a sectoral level with a Coordinating Authority

As detailed in the various sectoral Data Space preliminary studies and their respective Blueprints (including Mobility, Smart Cities, Tourism, Skills, Agriculture, Energy and the Green Deal), the autonomy of each Data Space initiative, that can be very local, is essential for fostering bottom-up innovation and allowing a Community of Practice (CoP) to adapt quickly to its market. **There can be multiple Data Space initiatives in the same sector**.

However, it is clear that **many Data Space initiatives within the same sector can share common governance and technical requirements**. For instance, decisions on semantics, certification of data intermediary tools, and codes of conduct could be made at a sectoral level to enhance interoperability within the sector.

The CSA preliminary studies and Blueprints introduce a new role in the Data Space ecosystem known as **sectoral 'Coordinating Authorities' or 'Common European Data Spaces'**. For example, **the Mobility Blueprint introduces the European Mobility Data Space (EMDS)**, the tourism Blueprint introduces the European Tourism Data Space (ETDS), and so forth.

Attention point about employed vocabulary: There can be some **confusion when** members of the Data Space community **refer to 'a Data Space'.** Depending on the context and each person's understanding, a Data Space can mean:

- **The sectoral Coordinating Authority (Common European Data Space)**: one for each sector, e.g., EMDS would become the Coordinating Authority for the Mobility Common European Data Space, being developed at the European level.
- **Specific, narrower Data Space initiatives:** e.g., EONA-X, a mobility Data Space involving key industry players in France and Spain such as Air France, Aéroport de Paris, and Amadeus.

To prevent confusion in this document, we talk about:

- **Data Space Coordinating Authority** when referring to the sector level, and
- **Data Space initiative** when referring to local and narrower projects.

The general idea is that **all Data Space initiatives within a sector will be overseen by their respective Coordinating authority**. For instance, the European Mobility Data Space (EMDS) will coordinate various mobility Data Space initiatives such as EONA-X, the German Mobility Data Space, and others.

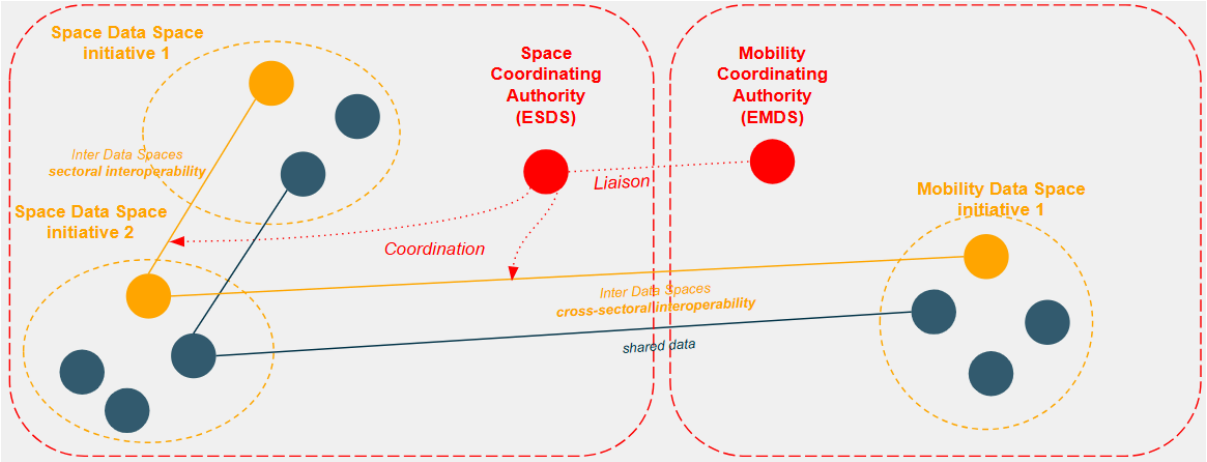

Figure 40 - ESDS Coordinating Authority and Space Data Space initiatives

Example of the European Mobility Data Space (EMDS) Coordinating Authority

Here below is a **proposed organisational structure for the European Mobility Data Space (EMDS)** that would coordinate the multiple Mobility sector Data Space initiatives:

- **Governance Body:** Responsible for strategic oversight and management of the governance framework and operations. Ensures application of the governance framework, including vision, purpose, and long-term goals. Manages data sovereignty principles, guidelines, and policies. Oversees technical infrastructure provision or procurement for data sovereignty and trust.
- **Council of Federated Ecosystems:** Makes strategic decisions regarding the governance framework and technological building blocks. Ensures real use cases co-govern Mobility Data Space specifications and their development. Appoints individuals to advisory committees and working groups for interoperability.
- **Advisory Committees and Working Groups:** Organises into committees and use case-specific groups promoting standardisation. Facilitates reciprocal exchange with external experts, organisations, and other Data Spaces. Enhances Data Space specifications, inherits new requirements, and ensures interoperability.
- **Data Space members for the sector:** Comprises various public and private entities, active Data Spaces initiatives, federated ecosystems, organisations, and EU member States. Participates in decision-making, voting, and appointing/electing members of the governance authority. Maintains a defined voting structure for inclusive decision-making.

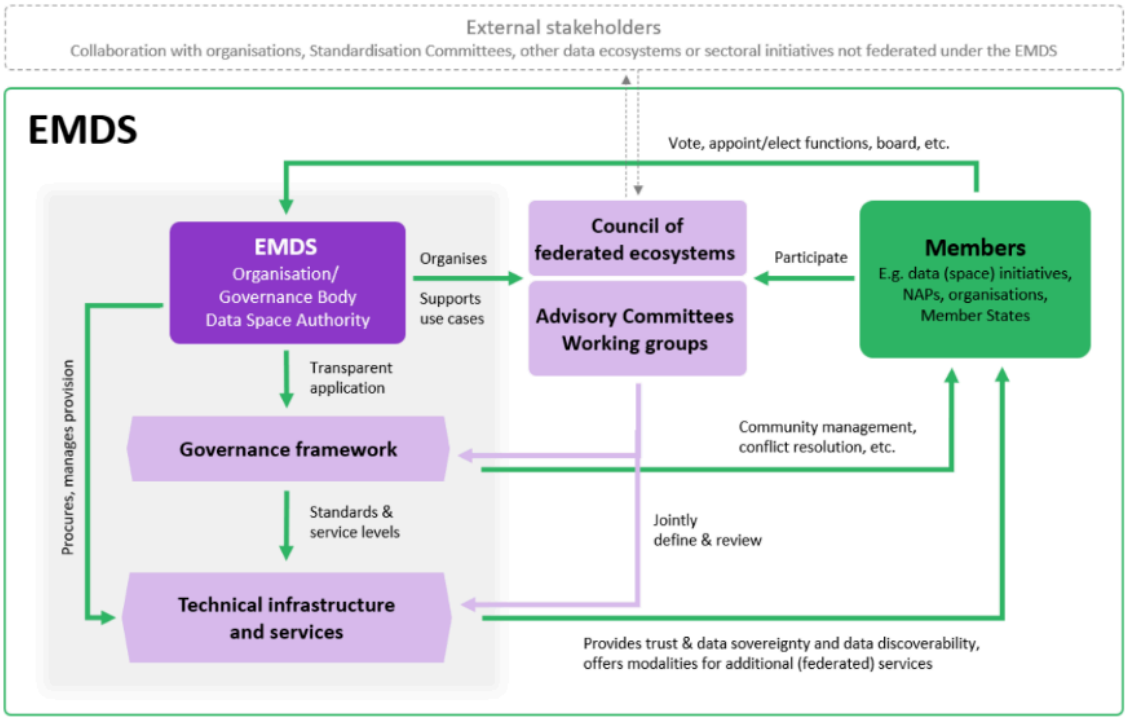

Figure 41 - Proposed organisational structure of the Coordinating Authority European Mobility Data Space
Source: Mobility Data Space Blueprint

Key priorities for the proposed EMDS are:

- **Stakeholder engagement and communication:** Establish communication channels for regular engagement with stakeholders. Address concerns, provide updates, and gather feedback.
- **Partnerships and alliances:** Identify and engage potential strategic partners to enhance collaboration. Foster partnerships among stakeholders within the Space Data Space and across multiple Data Spaces.
- **Educational and outreach activities:** Promote Data Space literacy through workshops, webinars, and resources. Advocate for data-sharing by highlighting its benefits to encourage participation.
- **Regulatory compliance and dispute resolution:** Ensure legal compliance within European and Member State regulations. Monitor legal landscapes and establish a dispute resolution mechanism.
- **Continuous improvement (Metrics, KPIs, and Monitoring):** Define performance metrics and SLAs for infrastructural components. Monitor and report Key Performance Indicators for reliability and efficiency.
- **IT infrastructure management:** Provide or procure operational IT infrastructure for federated Data Spaces. Govern IT operations with strict procedures for security, utilising established frameworks.
- **Audit and compliance:** Implement monitoring tools for continuous activity tracking within the Data Space. Maintain audit trails for transparency and public access to compliance-related information.
- **Data lifecycle management:** Define data retention policies and implement versioning control. Support Data Spaces in managing changes, updates, or removals of data under data sovereignty.
- **Resource management:** Manage the Data Space budget and ensure sustainable financing. Allocate human resources required for the effective operation of the Data Space.

The primary concern regarding sectoral Coordinating Authorities is the extent of integration and interaction with the various Data Space initiatives within the same sector:

- If the Coordinating Authority's prerogatives are too extensive (top-down approach), there is a risk that Data Space initiatives may struggle to adapt to their specific needs (such as addressing particular national concerns) and may lack agility.
- Conversely, if the Coordinating Authority is not sufficiently strong (bottom-up approach), Data Space initiatives within the same sector risk duplicating efforts, becoming misaligned, and losing interoperability.

Using the Mobility Blueprint as an example, the Mobility sector presents five options for establishing the European Mobility Data Space (EMDS), spanning from a highly top-down approach to a distinctly bottom-up one:

1. **EC-Driven Initiative with Operational Data Space Authority:** EC leads with an operational Data Space authority. Resembles a public authority or autonomous organisation. Mixed funding model with supervisory or advisory functions for Data Spaces and stakeholders.
2. **Member state-Driven EDIC as Data Space Backbone:** Member state-driven European Digital Infrastructure Consortium (EDIC) serves as the foundational backbone. Member states retain decision-making power with strong KPIs for digital infrastructure. Joint investments at the European level for cross-border use cases.
3. **European association or decentralised interlinkage of Data Spaces:** European association or decentralised interlinkage governed by technical architects. Existing Data Spaces play a prominent role in connecting ecosystems. Adherence to common European technical frameworks with temporary funding for harmonisation.
4. **European-Level governance, regulatory, or certification framework:** Governance, regulatory, or certification framework at the European level. No creation of a legal entity for the Data Space but emphasises stronger enforcement.
5. **Expert working group for interoperability guidelines:** Expert working group defines guidelines for interoperability. No creation of a legal entity for the Data Space; relies on voluntary compliance.

The Data Space Coordinating Authority of a sector can be embodied in a specific legal entity (see §8.4.2).

Reco 14: The Space Data Space should establish a sectoral Coordinating Authority, proposed to be named the European Space Data Space (ESDS). Stakeholders such as ESA, ESA/EU member states, and industry players should assess options for its structure.

7.2.2. Defining the scope of a Data Space initiative

A single sector can develop multiple Data Space initiatives. **Some specific initiatives might focus on a particular country, a specific group of stakeholders, or an identified set of use cases**. While it can evolve over time, defining the appropriate scope for a single Data Space initiative is crucial to its success and is a complex task. Various factors, such as economic conditions, regulatory requirements, and cultural differences, influence the ease with which certain organisations can collaborate.

Organisations are more likely to join or initiate a Data Space when they share common interests in specific data-sharing use cases. For instance, entities within the Mobility sector in a given country might collaborate to establish a Mobility Data Space. Although not universally applicable, participants in the same Data Space initiative typically belong to an existing Community of Practice (CoP), sharing common language, market understanding, or strategic goals.

The nature of the market significantly influences the determination of the appropriate scope for a Data Space initiative. For example, a Tourism Data Space initiative operates in a predominantly national or local market, primarily comprising SMEs. In contrast, the Space

market is mainly influenced by the public sector and large companies at both ESA/EU member states and continental levels. Regarding the scope:

- If the scope of a Data Space initiative is too broad, coordinating participants and finding common ground may become challenging.
- Conversely, if the scope is too narrow, the Data Space might face difficulties in onboarding new participants, raising funds, developing use cases, and more.

7.2.3. Designing the Governance Authority of a Data Space initiative

Each Data Space initiative must establish a Governance Authority. According to the DSSC, the Data Space Governance Authority is *"responsible for creating, developing, operating, maintaining, and enforcing the governance framework for a particular Data Space, without replacing the role of public enforcement authorities"*. **The Data Space Governance Authority undertakes functions such as:**

- Defining governance scope.
- Rule-setting.
- Ensuring compliance.
- Resolving conflicts, thereby fostering trust and data quality within the Data Space.

Each Data Space Governance Authority should adhere to the recommendations provided by the DSSC and consider sector-specific requirements from a sectoral Coordination Authority (e.g., the European Mobility Data Space in the context of a Mobility Data Space initiative). The Data Space Governance Authority must commit to key principles and responsibilities, including neutrality towards all Data Space participants, the selection of open standards, and compliance with legislation. It ensures transparency, trust, and collaboration among participants and relevant bodies such as the DSSC, the European Data Innovation Board (EDIB), various regulators, and other Data Space initiatives. The Governance Authority of a Data Space can be embodied in a specific legal entity (see §8.4.1).

The actual composition may vary, and the above suggestions can be adjusted based on the specific context and goals of the Data Space initiative. The key is to have a balanced representation that considers all relevant perspectives and ensures effective governance. Here are **a few options for the composition of the board** of a Data Space Governance Authority:

- **Chairperson/President:** Leads the board meetings. Provides overall guidance and direction.
- **Technical experts:** Professionals with expertise in data standards, interoperability, and technical aspects of the Data Space. Ensure that the technical infrastructure aligns with industry best practices.
- **Legal experts:** Legal professionals knowledgeable about data protection, privacy laws, and regulations. Ensure that the Data Space operates within legal boundaries.
- **Industry representatives:** Individuals from participating industries relevant to the Data Space. Provide insights into sector-specific needs and challenges.

- **Data privacy and ethics advocate:** Represents the interests of end-users and ensures privacy and ethical considerations are prioritised.
- **Governance liaison:** Represents governance interests and ensures alignment with regulatory requirements. Facilitates communication with relevant public authorities.
- **Academic/Research representative:** Offers insights from the academic and research community. Promotes innovation and aligns the Data Space with cutting-edge developments.
- **Consumer advocates:** Represents the interests of consumers and ensures fair practices. Advocates for human-centric policies.
- **Data providers and recipients:** Representatives from organisations that provide data to the Data Space and those that consume it. Ensures that the needs of both sides are considered.
- **Community/NGO representative:** Represents non-profit organisations or community interests. Ensures inclusivity and consideration of broader societal impacts.
- **Cybersecurity expert:** Ensures that the Data Space has robust cybersecurity measures in place to protect against threats.
- **Financial expert:** Manages financial aspects, ensuring sustainable funding and resource allocation.
- **Standards and certification specialist:** Ensures adherence to data standards and certifications.
- **Communication and PR specialist:** Manages external communications, building awareness and trust.
- **International representative:** Represents international interests and ensures compatibility with global standards.

The Data Space Governance Authority board may establish particular committees based on the participants' preferences and the market requirements within the Data Space's operational landscape.

7.2.4. Creating a separate operating company

A Data Space can decide to create, or appoint, an 'Operating Company' (or many) as a separate entity. The Operating Company of the Data Space is in charge of the development and maintenance of the technical infrastructure of the Data Space. In principle, it should strictly follow the rules established in the Governance Framework by the Data Space Governance Authority. **As an example, the automotive Data Space initiative Catena-X[134] has created a dedicated Operating Company called Cofinity-X[135].**

[134] https://catena-x.net/en/

[135] https://www.cofinity-x.com/

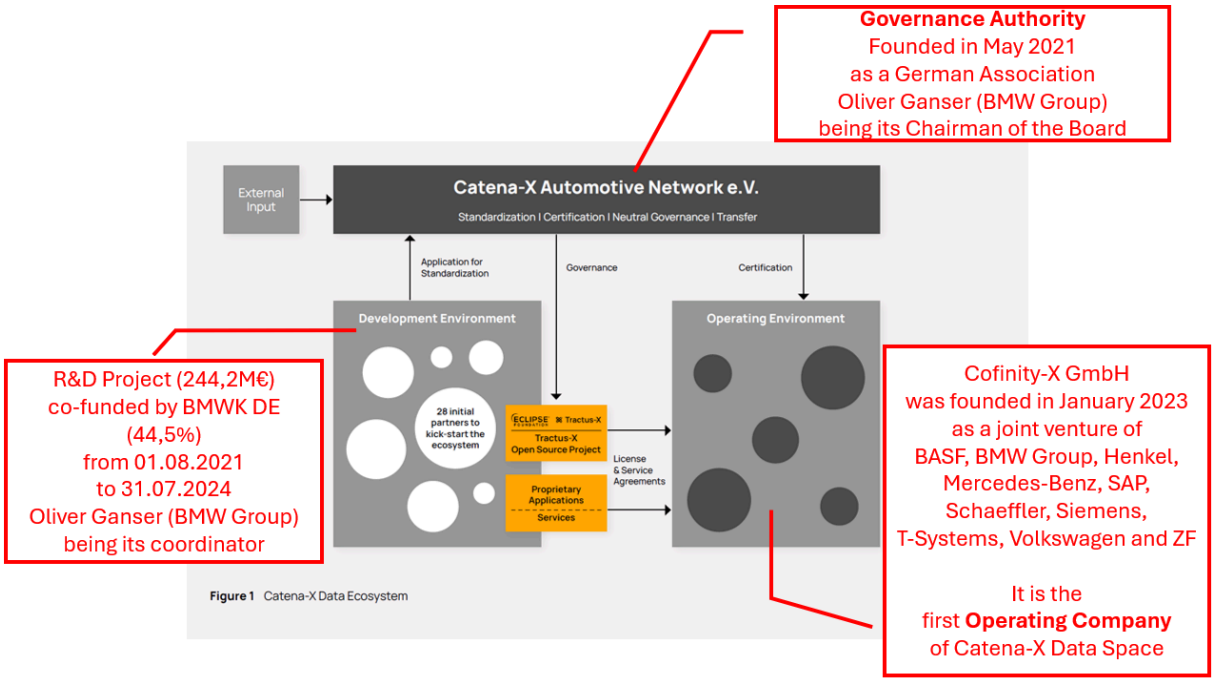

Figure 42 - The Catena-X Data Space and its Operating Company Cofinity-X
Source: Catena-X Operating Model (Released October 16, 2023)

In some instances, **establishing, or appointing, an Operating Company provides added flexibility to the Data Space**, especially when the Governance Authority operates on a non-profit basis. A for-profit Operating Company can raise funds, scale operations, and manage multiple Data Spaces simultaneously (even in different sectors), enabling economies of scale.

Reco 15: Each Space Data Space initiative should designate at least one Operating Company. Establishing a single Operating Company to support multiple Space Data Space initiatives would facilitate resource sharing and efficiency.

7.2.5. Onboarding/offboarding Data Space participants

Efficient onboarding and offboarding processes are crucial to the success of a Data Space.

- **Onboarding:** The Governance Authority sets the minimum participation requirements and creates an Accession Agreement that defines roles, responsibilities, and compliance terms for joining the Data Space. They must balance flexible rules to lower entry barriers with strict rules to ensure interoperability and data quality, encompassing prohibitions, obligations, and permissions. Verification requirements for participants include identity checks, product/service standards, and verifiable attributes such as nationality, industry certification, or valid contracts.
- **Offboarding:** The governance framework provides guidance to ensure obligations and responsibilities are met during the exit process, safeguarding interests and maintaining Data Space integrity. Transition management addresses data rights, transfer, and termination of access to ensure a smooth exit and continuity.

- **Procedural Criteria:** Clear criteria for admission and participation are defined, with efficient onboarding and offboarding processes, including general terms and conditions, participant compliance reviews, and automated procedures to ensure trust and mitigate risks. The criteria should be inclusive to welcome various entities while preventing those misaligned with the Data Space's scope, objectives, or laws.

Example of the onboarding process of Catena-X

The automotive supply chain Data Space project Catena-X has published a set of specifications about three aspects of an onboarding process. First, the initial onboarding of a new participant; second, the registration of a data set, and a guideline to the standards which must be met by a provider of a services or business app. The specifications are quite detailed and are supposed to be implemented in an IDS/EDC based infrastructure. However, the specifications are sufficiently generic to allow for the implementation in other, somehow customisable systems, or in systems set up from scratch.

ONB-001 Registration and initial onboarding: *"To become a participant of Catena-X, each applicant must go through a registration process. Registration is a mandatory requirement for all further activities within the Catena-X network. The registration process, along with other services, provide the foundation of trust for the Catena-X network. This document describes the structure of this process and defines the results of the individual process steps."*

ONB-002 Minimal data provider services offering: *"The purpose of this document is to describe the necessary functional building blocks of a minimal data provider service, as well as to give an overview over the interplay of necessary standards that need to be considered. The document also gives an overview over the mandatory standards that need to be integrated. Service offerings for data providers that do not fulfil the necessary standards and concepts in this document, will not work in the Catena-X network and thus cannot be provided to any customer. In the following chapters, the minimal data provider service will also be referred to as 'upload tool' for better understandability."*

ONB-003 Relevant standards for conformity assessments: *"It lists the internal (e.g. CX Guidelines) and external (e.g. ISO) standards that a partner needs to fulfil before he/she can offer solutions (services or business apps) in the context of Catena-X. Those standards have been derived from common terms in the automotive industry and present the minimal basis so that software can be used within an automotive industry enterprise. Requesting certain standards from partners secures that all customers that use solutions (services or business apps) are guaranteed a certain level of professionality, security, and trust."* For a reference implementation see[136].

Source: Mobility Data Space Blueprint

[136] https://gitlab.eclipse.org/eclipse/xfsc/oaw

7.2.6. Defining Data Space rules

Each Data Space operates under **a complex set of rules that form part of its Governance Framework**. **These rules are both external**, originating from governmental, standard, or sectoral authorities, **and internal**, created by the Data Space participants within the bounds of applicable laws and regulations.

Within this framework, Data Spaces develop internal regulations and policies for day-to-day operations, forming the Governance Framework. The Data Space governance authority prepares these documents, but they must be approved by the decision-making body (Data Space Coordinating Authority) representing all voting members/participants . This process ensures compliance with legal requirements and upholds principles of good governance. **Once approved, these rules are documented in a Data Space Rulebook**, tailored to the specific needs of each Data Space and **made available in both human-readable and, if possible, machine-readable formats**.

Clear and well-defined rules for data-sharing are essential for fostering interoperability and trust among participants from diverse backgrounds. Trust is crucial for the effective functioning of Data Spaces, as participants need control over who accesses their data, the purposes of access, and the terms of use. The Governance Authority plays a key role in setting rules and standards that enhance the security, performance, interoperability, and observability of data transactions. Balancing the enforcement of these rules is strategic: fewer rules can ease integration but may compromise interoperability, data quality, and security, while stricter rules ensure these aspects but increase initial integration costs.

- **About decision-making:**

Here are **a few options for the decision-making process** of a Data Space Governance Authority on the Governance Framework:

- One voting right per member.
- More voting rights for early members
- More voting rights for specific kinds of members (e.g., public players)
- Voting rights relative to capital ownership
- Voting rights relative to the members' activity in the Data Space (e.g., how many data assets are shared, etc.)
- Voting rights relative to the contribution to the Data Space (e.g., contribution to the technological infrastructure, etc.)

- **About the Rulebook of a Data Space:**

According to the DSSC, the Rulebook of a Data Space is: *"The documentation of the Data Space governance framework for operational use. The rulebook can be expressed in human-readable and machine-readable formats."*

The Rulebook of a Data Space should incorporate various types of agreements to ensure effective governance and operations:

- **Organisational agreements:** Define the governance bodies and roles within the Data Space, outlining decision-making authorities and engagement processes. Specific considerations, such as data quality assurance.
- **Functional agreements:** Detail the operations of shared services, including Service Level Agreements (SLAs) and procedures for monitoring, reporting, and maintenance.
- **Operational agreements:** Regulate policies and processes during Data Space operations, covering aspects like risk management, requirements management, and quality management.
- **Technical agreements:** Address the adoption, implementation, and maintenance of common technology, focusing on trust, reliability, security, and interoperability with other Data Spaces. Includes semantic considerations.
- **Liaison agreements:** Establish guiding principles, roles, and processes for collaboration and alignment with other Data Space initiatives to achieve interoperability (within the sector or across sectors).
- **Business agreements:** Specify terms and conditions governing data-sharing between participants, establish sector-specific semantics and metadata definitions and standards, and collaborate with external stakeholders to achieve interoperability. These agreements also cover pricing and payment, audit and compliance, data quality, availability and origin verification, authorised secondary use, and intellectual property issues.
- **Regulatory compliance rules:** Establish the legal framework ensuring compliance with laws such as GDPR, AI act, sectoral rules, national laws, and more. This includes contracts formed within the Data Space or with external entities, and regulatory compliance assessments and follow-ups to enable the enforcement of these agreements.

- **Inheritance of rules in a Rulebook:**

A Data Space initiative has the possibility to ‘inherit’ rules from EU authorities, national arthritis, or of its sectoral European Data Space Coordination Authority (e.g., the European Space Data Space for a Space Data Space initiative). Subsequently, the initiative can choose to incorporate additional provisions tailored to the preferences of its own participants.

Reco 16: The Space Data Space Coordinating Authority should design a sectoral Rulebook that could be inherited by all specific Space Data Space initiatives.

- **Roles and responsibilities within or across Data Spaces:**

Following the DSSC glossary, a Data Space role is *“A distinct and logically consistent set of responsibilities within a Data Space, that encompass associated rights and duties required to perform specific tasks, and that are designed to be fulfilled by one or more participants.”*

Here are some of the roles and responsibilities within a Data Space initiative:

- **Data Space Governance Authority (DSGA):** The participant responsible for establishing, developing, and enforcing a governance framework within a specific Data Space, without replacing the role of public enforcement authorities.
- **Service provider:** A participant in the Data Space offering technical or non-technical services (Data Space application services) utilising available Data Space data and delivering results to other participants. Examples include analytics and data quality services.
- **Data provider:** A participant providing data in a specific data transaction to participants with the right or duty to access and/or receive the data.
- **End-users:** Organisation or natural person, not necessarily Data Space participants, but using Data Space services in a Data Space use case.
- **Data Intermediary:** A participant providing one or more Data Space enabling services (identity, catalogue, consent, contract, interoperability, etc.) without directly engaging in data transactions.
- **Use Case orchestrator:** A participant overseeing a Data Space use case, managing business, organisational, and governance operations.

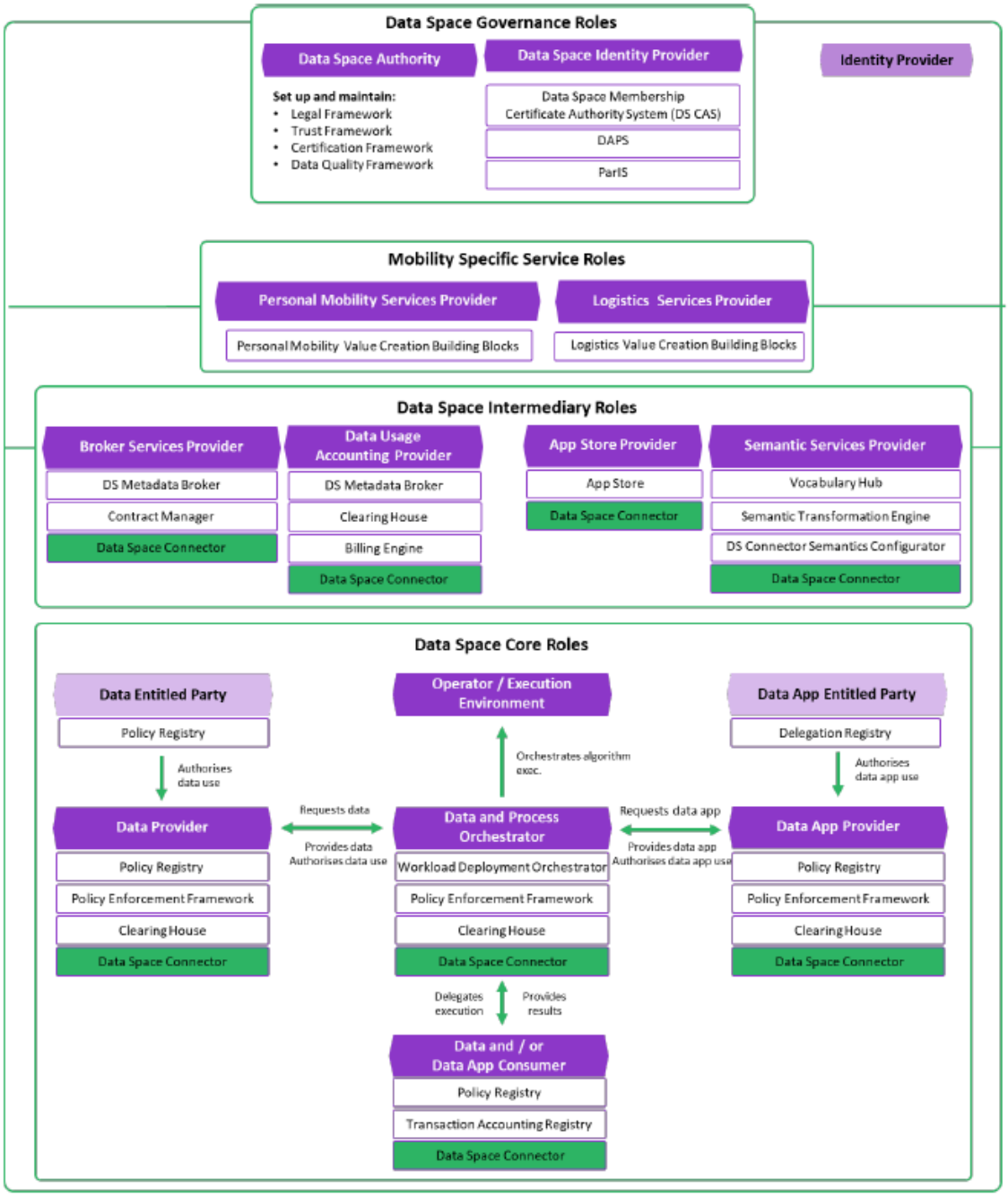

Figure 44 - Example of roles and responsibilities in a Mobility Data Space
Source: Mobility Data Space Blueprint

- **Roles and responsibilities outside Data Space initiatives:**

As outlined in the preceding sections, crucial external organisations, not affiliated with a specific Data Space initiative and not counted as participants or end-users, significantly influence the governance of individual Data Space initiatives:

- **European institutions** (e.g., EDIB, EPDB, etc.) can contribute regulations, guidelines, code of conduct, funding, and sectoral and cross-sectoral coordination.

- **Data Space support organisations** (e.g., DSSC, Simpl, Gaia-X, IDSA, FIWARE, etc.) are instrumental in offering support, education, models, frameworks, cross-sectoral and sectoral standards, glossaries, open-source building, and coordination.
- **Sectoral Coordination Authorities** (e.g, European Mobility Data Space, European Tourism Data Space) provide sectoral support, guidance, code of conduct, standards, open-source building blocks, and coordination.
- **Member states institutions** (e.g., regulators, innovation hubs, ministries, regional or local entities) offer national or local support, funding, education, and sectoral & national coordination.

All the rules established by organisations outside Data Space initiatives, can also created rules and be formulated in Rulebooks. When formulating their own Rulebook, Data Space initiatives have the possibility to inherit entire Rulebooks, or parts of it, from those organisations and institutions.

- **About the Rolebook of Data Spaces:**

The multiplicity of actors involved in the creation of data-sharing rules makes it currently very complex for each Data Space, and even any ecosystem stakeholder in general, to understand **"who does what"** and **"who decides on what"**.

To address this challenge, Sitra proposed in its paper *Towards a Holistic EU Data Governance*[137], to create a 'Rolebook'. The Rolebook is an open, transparent, and dynamic registry of decision-making entities and functions for data-sharing. The key elements that should appear in the Rolebook are:

- **Roles:** The generic functions undertaken by particular stakeholders of the ecosystem involved in data-sharing. Roles may encompass diverse areas, including formulating EU laws, formulating national laws, regulation (e.g., privacy, competition) at EU or national level, developing guidelines or standards for cross-sectoral topics (e.g., identity, consent), developing guidelines or standards for sector-specific topics (e.g., sectoral semantics, sectoral code of conduct), governing or operating a Data Space, operating a data intermediary, etc. Roles describe the rights and obligations attached to a particular function.
- **Authorities and bodies:** The formal or informal structures or organisations that participate in the data-sharing governance process (create, implement, or control the application of rules). Bodies can concern any level. They should each provide self-description elements including a point of contact in the Rolebook. Here are a few examples of bodies: EU or member states parliament, a specific support organisation, a sectoral or cross-sectoral standard organisation, a city or a regional council, a national Data Protection Authority, a Data Space governance body, a company, any organisation, etc.).

[137] https://www.sitra.fi/en/publications/towards-a-holistic-eu-data-governance

In order to streamline the management of their Rulebook, Data Spaces can reuse rules, in a standard machine-readable format, **expressed by relevant entities from the Rolebook and accessible in a Data Space Open Rulebooks Library** (under construction).

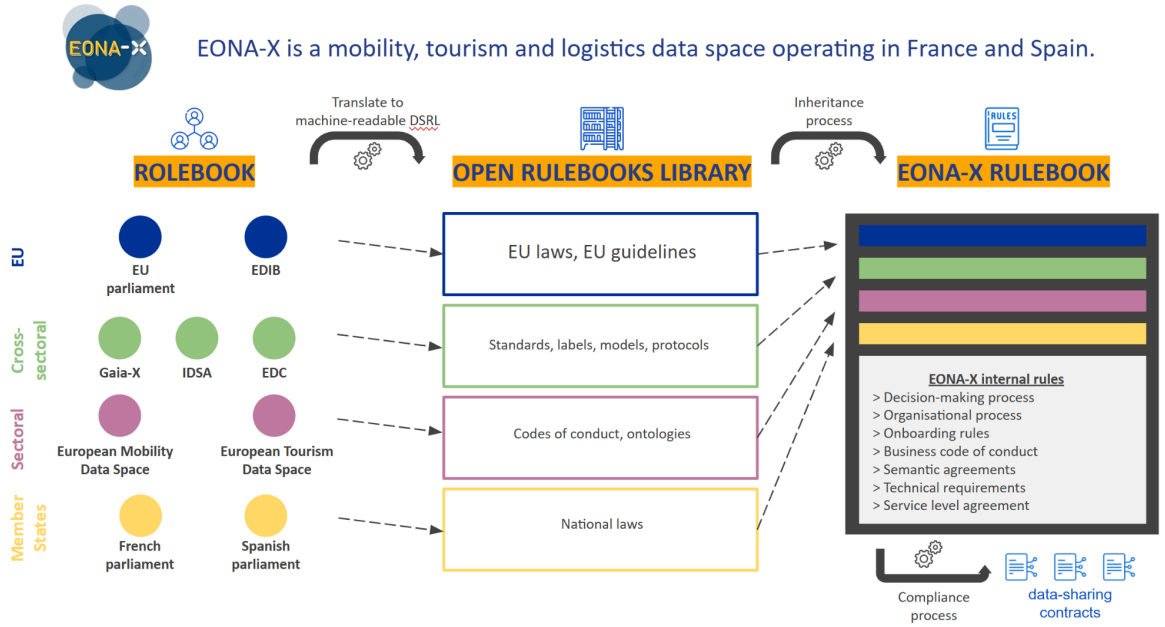

Figure 43 - Inheritance of rules in a Rulebook

7.3. What are available Data Space governance components?

Table 7 - Existing Data Space governance components

IDSA Rulebook[138]
The IDSA rulebook aims to delineate mandatory rules and optional guidelines, encompassing functional, technical, operational, and legal dimensions within its governance framework. This framework supports Data Space governance by addressing key aspects such as common services, role definitions, implementation guidelines for technical artefacts, rules for collaboration within data services, and the legal basis of a Data Space to ensure compliance with regulatory requirements, thereby fostering trust and security. The IDSA governance framework, outlined in the IDSA Rulebook, aligns with the guiding principles of Data Space governance, drawing inspiration from the Open DEI[139] Design Principles for Data Spaces and previous Position Papers on Data Space Governance. It delineates four layers of governance: Data Space instance governance, Data Space ecosystem governance, Data Space domain governance, and soft infrastructure governance. This framework provides recommendations for defining governance elements. Additionally, the IDSA Reference Architecture Model serves as a foundational resource for comprehending Data Spaces, including roles and building blocks. The IDSA Rulebook acts as a guide for translating the IDS Reference Architecture Model into practical implementation, addressing services rollout and central procedures

[138] https://internationaldataspaces.org/wp-content/uploads/dlm_uploads/IDSA-White-Paper-IDSA-Rule-Book.pdf

[139] https://design-principles-for-data-spaces.org/

like admission and withdrawal of members. It emphasises interoperability at the connector level and is managed by active IDSA members through specialised working groups.

Sitra rulebook[140]

SITRA has released Generic Rulebooks for Data Spaces, including 'Rulebook for a fair data economy' and 'IDSA Rulebook Version 2'. The SITRA document positions itself as a guide for those establishing fair data economy networks, offering templates for legal, business, technical, and administrative rules. It facilitates the creation and joining of new data networks, emphasising transparency in data-sharing. The content includes templates for rule implementation, control questions for validation, and templates for an internal code of conduct document.

iSHARE governance framework[141]

The iSHARE framework establishes a trust framework for autonomous business data exchange, facilitating the creation and management of Data Spaces. This framework outlines legal, operational, and technical agreements, promoting governance and interoperability concerning data sovereignty and trust among participating organisations within and across Data Spaces. It supports both intra-Data Space interoperability (within individual Data Spaces) and inter-Data Space interoperability (across multiple Data Spaces). The framework addresses participant trust registration, administration, discovery, and status information within Data Spaces. For interoperability between Data Spaces, it covers Data Space profile registration, participant discovery, and status information. The iSHARE Satellite, serving for the Data Space authority, ensures correct and trustworthy implementation through a certification procedure. The framework emphasises standardised Service Level Agreements (SLAs) to ensure efficient data exchange, incorporating metrics like uptimes, response times, and error rates. Ongoing maintenance and governance of the iSHARE framework are led by Data Spaces utilising it as their trust foundation.

Gaia-X framework[142]

Gaia-X, while not presenting an all-encompassing governance framework, articulates both the Gaia-X Framework and the Gaia-X Trust Framework. The Gaia-X Framework delineates policies related to data and infrastructure, encompassing aspects such as cloud services. It incorporates the Gaia-X Technical Compliance to facilitate decentralised services with a focus on trust, policies, and regulations for data infrastructure and storage. Presently, Gaia-X allows data ecosystems to declare their compliance with this framework through self-declarations. The Gaia-X initiative stands on three pillars: the Gaia-X Association for Cloud and Infrastructure (Association Internationale Sans But Lucratif [AISBL]), the National Gaia-X Hubs, and the Gaia-X Community. Governance of the framework lies in the hands of Gaia-X members, responsible for operating data and infrastructures.

[140] https://www.sitra.fi/en/publications/rulebook-for-a-fair-data-economy/

[141] https://framework.ishare.eu/introduction/governance

[142] https://docs.gaia-x.eu/framework/

8. Legal Model for the Space Data Space

In this section you will find a precise description of the legal framework (space and non-space) that will have to be taken into account while designing the different legal tools used within Space Data Space and between it and other data spaces.

Section §8.4 puts the focus on the potential vehicles of both a sectoral data space for space and specific data space initiatives.

8.1. Legal challenges

Adhering to regulatory and legal mandates is essential for establishing a sustainable and secure Space Data Space. The European data strategy provides overarching guidelines, while specific legal frameworks for Data Spaces are evolving. EU policies cover data privacy, security, intellectual property, liability, and sector-specific regulations to ensure compliance with existing laws, creating a fair and transparent environment. **Key legal considerations include Space law, GDPR, cybersecurity, competition law, intellectual property, data ownership, usage restrictions, and ethical issues, all of which support data protection and collaborative governance.**

Legal considerations are vital for the organisation and governance of Data Spaces, with a focus on regulatory compliance and contractual frameworks. **Data Spaces intersect with various legal frameworks**, requiring careful consideration of personal data protection and intellectual property rights. For example, in the Mobility sector, compliance with privacy and intellectual property laws is essential due to the diverse data categories involved. In the Healthcare sector, there are additional considerations for data sensitivity.

In the Space sector, particularly on the ESA side, the ownership, access, use, and disclosure of data, whether pre-existing or generated under ESA contracts, are governed by the Rules concerning Information, Data, and Intellectual Property (ESA/REG/008) and Part II of the General Clauses and Conditions for ESA Contracts (ESA/REG/002, rev.3). According to these regulations, ownership of information, data, and intellectual property remains with the economic operator that developed them.

8.2. Building the Data Space regulatory framework

8.2.1. Navigating the regulatory landscape

Navigating the regulatory landscape can be challenging for Data Space initiatives, requiring them to map various legal areas at both EU and national levels. These areas are organised into clusters such as data-related legislation, platform regulation, intellectual property, competition, trust and security, and contract law. Clarifying legal requirements and identifying framework relationships is essential to ensure compliance.

The DSSC, along with other Data Space support organisations, provides tools for mapping relevant legal frameworks. These tools help understand applicable legal regulations by analysing laws, regulations, and guidelines, such as data protection, privacy, intellectual property rights, cybersecurity, and sector-specific regulations. They also offer guidance on processing conditions for various data types and purposes.

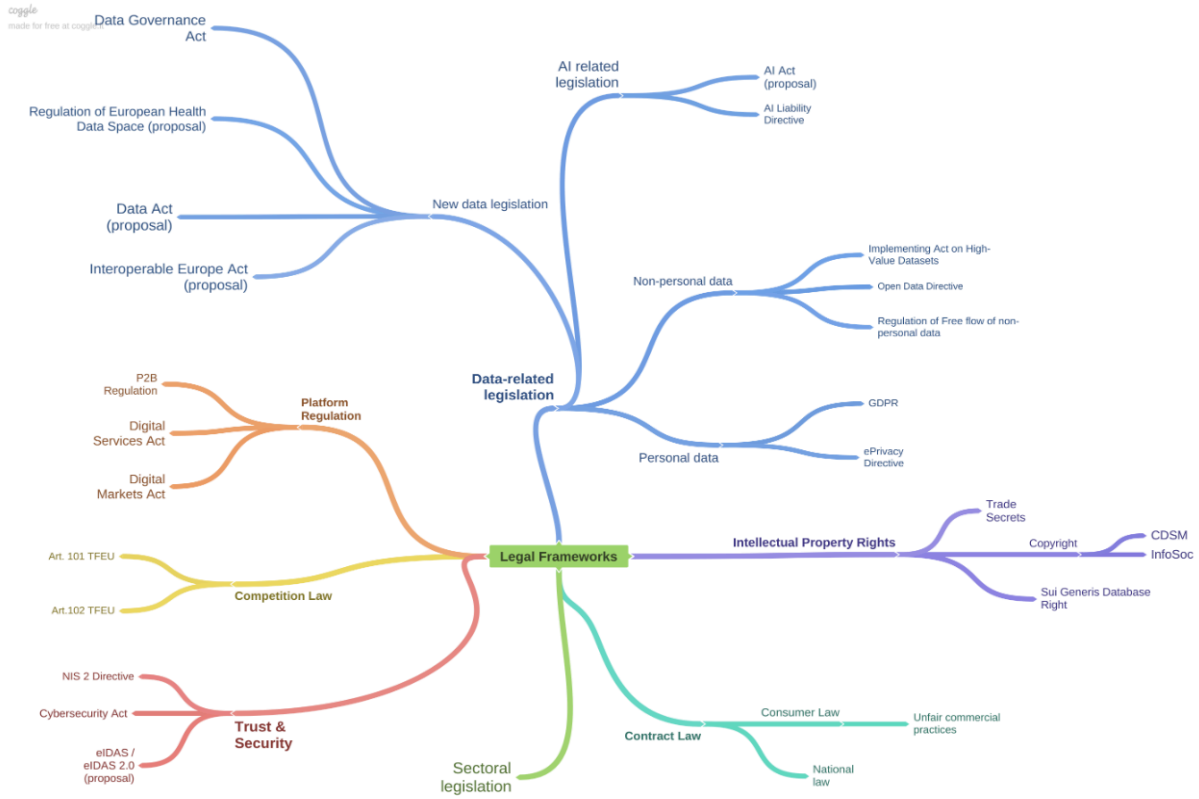

Figure 45 - Legal initial mapping of the primary European cross-cutting legislation for Data Spaces
Source: data spaces support centre

Here are a few types of regulations to take into account according to the DSSC:

- **Data-Related Legislation**
- **Platform Regulations**
- **Intellectual Property Law**
- **Competition Law**
- **Trust and Security**
- **Contract Law**

You will find in:

- Appendix §14.1: Tables presenting the key texts in the context of the Space Data Space.

- Appendix §14.2: Tables presenting the relevant programmes and resources in the context of the Space Data Space.

8.2.2. Contractual Framework

The contractual framework of a Data Space initiative involves defining the legal agreements among participants, including data and service providers and the Data Space Governance Authority. Its goal is to establish clear and enforceable contractual rights and responsibilities, thereby supporting various types of transactions within the Data Space.

Key aspects of the Contractual Framework include:

- **Purpose:** Outlining the rights and obligations of participants, enabling service providers, and the governance authority, translating these into clear contractual terms.
- **Contractual resources:** Contract templates and model clauses. Model clauses for data-sharing contracts. Joint controller and processor agreements (complying with GDPR). Tools for contract automation, potentially using smart contracts.
- **Enforceability:** Establishing enforceability means and measures.
- **Concerned data:** Specifies considerations related to the type and format of data to be shared. Addresses provisions on data availability, reliability, quality, accuracy, consistency, adaptability and data sets interoperability.
- **Essential aspects of agreements:** Defines how data will be used and for what purpose. Specifies the duration and remuneration terms of the agreement. Addresses resharing, consent, and interoperability of shared data.
- **Legal framework and obligations:** Ensures compliance with applicable legislation on (Space) data collection, processing and sharing. Considers notification requirements to EU and/or national competition authorities. Considers notification requirements to EU and/or national space authorities. Addresses data protection, privacy rules, intellectual property terms and other data related clauses.
- **Security and confidentiality:** Clarifies liability in case of misuse, disruption, or loss of data. Addresses data security terms and confidentiality agreements. Specifies data deletion terms upon termination of the agreement.

Overall, according to the DSSC, the Contractual Framework aims to provide the necessary legal structure, clarity, and consistency for data transactions within a Data Space initiative, emphasising compliance with legal requirements and ensuring secure and confidential data handling.

8.3. Legal framework and the Space sector

As a preliminary reminder, under applicable international Space treaties, including mainly the following:

- **Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies**, adopted on

19 December 1966, opened for signature on 27 January 1967, entered into force on 10 October 1967, ratified on 19 June1970 et published by Decree n° 70-960 of 16 October 1970.

- **Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space**, adopted on 19 December 1967, opened for signature on 22 April 1968, entered into force on 3 December 1968.
- **Convention on International Liability for Damage Caused by Space Objects**, adopted on 29 November 1971, opened for signature on 29 March 1972, entered into force on 1 September 1972, ratified on 29 March 1972 and published by Decree n° 76-1 of 2 January 1976.
- **Convention on Registration of Objects Launched into Outer Space**, adopted 12 November 1974, opened for signature 14 January 1975, entered into force 15 September 1976, published by Decree n° 77-1462 of 19 December 1977.

Applicable law shall be the one of the State launching the space object. As a consequence, EU and EU member states' national legislations have a vocation to apply to a substantial extent when considering the future European Space Data Space, while also having to cohabit with other legal regimes.

8.3.1. Horizontal Framework

As detailed above, the Space Data Space, and its multiple initiatives, shall build upon the legislations such as the EU GDPR, ESA GDPR, Data Governance Act, Data Act, AI Act, etc., while ensuring compliance with horizontal regulatory frameworks in the areas of cybersecurity and data privacy domains.

- **General Data Protection Regulation:**

Considering that a substantial amount of data accessed through the Space Data Space will be personal data, including sensitive personal data related to individuals in the EU, **the Space Data Space must be fully compliant with the GDPR**.

GDPR and the Space Data Space

The use and re-use of personal data within the Space Data Space framework shall rely on the processing possibilities outlined in Article 6 and Article 9 of the GDPR, whereby processing may be as follows:

Article 6: Lawfulness of Processing

- Consent (Article 6(1)(a)): Explicit consent from data subjects is required for the processing of their personal data, such as identifiable satellite imagery.
- Contractual Necessity (Article 6(1)(b)): Processing data necessary for fulfilling contracts, such as agreements between space agencies and data providers.

- Legal Obligation (Article 6(1)(c)): Compliance with legal obligations, such as reporting to regulatory bodies.
- Vital Interests (Article 6(1)(d)): Processing necessary to protect vital interests, for example, in environmental monitoring.
- Public Task (Article 6(1)(e)): Processing carried out in the public interest, such as scientific research.
- Legitimate Interests (Article 6(1)(f)): Processing for the legitimate interests of space data stakeholders, ensuring it does not override the rights of data subjects.

Article 9: Processing of Special Categories of Personal Data

- Explicit Consent (Article 9(2)(a)): Necessary for processing special categories of personal data, such as health information gathered for research.
- Employment, Social Security, and Social Protection Law (Article 9(2)(b)): Relevant for collecting data for employment, social security, or social protection purposes.
- Vital Interests (Article 9(2)(c)): Processing to protect vital interests in life-threatening situations monitored from space.
- Non-Profit Bodies (Article 9(2)(d)): Legitimate activities by space-related non-profit organisations.
- Public Interest (Article 9(2)(g)): Necessary processing for substantial public interest, including disaster response.
- Medical Purposes (Article 9(2)(h)): Processing health data for medical research or healthcare provision.
- Public Health (Article 9(2)(i)): Processing for public health monitoring.
- Archiving, Research, and Statistics (Article 9(2)(j)): Data processing for scientific research, historical archiving, or statistical purposes.

The Space Data Space should aim to strengthen data subjects' control over personal data, particularly focusing on rights outlined in Chapter III of the GDPR, such as **access, portability, rectification, and erasure**. They will establish a framework for implementing these rights, potentially including national space data portals and interoperability standards to facilitate secure and seamless data sharing among stakeholders.

Building on GDPR principles, the Space Data Space will define data usage purposes, ensure legal and ethical processing, and establish a dedicated data access body to evaluate requests. This body will collaborate with national authorities, promote interoperability, and safeguard sensitive information. Data access requests must address processing purposes, ethical considerations, and data protection, with a preference for anonymised or pseudonymised formats. Processing may occur in secure environments, ensuring high standards of data security and compliance with GDPR.

The framework will support innovation in the Space sector by providing structured access to data such as satellite imagery while adhering to robust security measures. **It will also account for ESA's distinct data protection rules, which align with GDPR principles but reflect ESA's unique governance structure.** These rules emphasise data protection,

legitimacy, limited retention, individual consent, and independent oversight, ensuring compatibility with broader EU data protection efforts.

- **Data Governance Act and Data Act:**

The Space Data Space shall build upon the horizontal framework on data access and reuse, including the Data Governance Act (DGA), which became effective on September 24, 2023, and the Data Act which came into force on January 11, 2024; to complement it and provide more specific rules for the Space sector. **These specific rules would cover standards and specifications for providers of data intermediation services in the Space sector,** minimum technical requirements for the portability of space data, and criteria for the security of data for bodies dealing with data altruism.

When providing a framework for data reuse in the Space sector, the Space Data Space shall build upon the DGA. However, as a horizontal framework, **the DGA does not address the specificities of sensitive data, which may form part of space data, nor does it address the specificities of space data in itself**. **The DGA alone does not provide an adequate solution to the current uncoordinated patchwork of national laws arising from the fragmented implementation of the GDPR in the space domain.** The DGA does not provide a legal basis for the re-use of sensitive categories of data, whose processing is in principle prohibited, save for exceptions listed in Article 9(2) of GDPR (including an EU law providing the adequate safeguards). Furthermore, the DGA does not impose any obligation to create 'data access bodies' which could be empowered to grant access to space data. However, the technical framework set up under DGA (e.g., secure environments) could be used by the data access bodies under Space Data Space. As concerns data-sharing intermediaries and data altruism organisations, the DGA provides for rules which apply regardless of the concerned sectors.

However, specific targeted rules are needed, for example, on security, in order to take into account the specificities of space personal data. In addition, the DGA regulates data-sharing intermediaries mainly from a competition point of view (neutrality of marketplaces for data) and does not lay down rules mitigating specific risks of primary and secondary use of space data, including on technical formats for interoperability. For these reasons, with the Space Data Space, it must be possible to consolidate the requirements and technical framework needed to achieve a functioning system in the field of primary and secondary use of space data, complementing the DGA rules with more detailed or more practical rules considering the specific nature of space data.

With regards to the Data Act, **the Space Data Space shall build on provisions related to portability and access of data linked to space devices** (satellites, space probes, and other space-related equipment). The Data Act may set a general portability rule for data from such devices, irrespective of whether space-related or not. For space data, the Space Data Space would extend to satellite data and devices feeding data to space data repositories. It would build upon the Data Act and establish the standards and specifications for portability and interoperability, thus making the portability and access technically and practically possible. With regards to the use of data from enterprises (especially commercial data) by

public sector bodies, the Space Data Space shall build upon the Data Act by providing a secure framework for processing space data through data access bodies.

- **Artificial Intelligence Act:**

The aim of establishing the Space Data Space is also to aid all the parties involved in Artificial Intelligence (AI) in the Space sector to carry out their tasks and fulfil their legal obligations under the Artificial Intelligence Act (AI Act). The AI Act provides the framework and rules that providers of some types of AI algorithms need to comply with. **The Space Data Space can support the providers with the provision of quality space data necessary for these algorithms to perform as intended and be compliant with the AI Act**.

Space data plays a key role in the training, validation, testing, and post-market monitoring of AI in space applications. The training and use of AI algorithms in space must take place in a manner that is ethical; discrimination and other adverse effects must be avoided. The aim of establishing the Space Data Space is to also aid providers and users of AI as well as notified bodies and market surveillance authorities to carry out their tasks and effectively and efficiently fulfil their legal obligations under the AI Act. The possibility to access diverse and a large amount of organised data within the Space Data Space infrastructure that provide transparency and information concerning the characteristics of these data would lead to the speedy development, upscale, and uptake of trustworthy AI in space. Additionally, information might be provided on the characteristics of data within the Space Data Space infrastructure that would enable the developer of AI systems to use appropriate data to train, test, and validate algorithms that reflect the geographical, operational, or functional setting within which the AI system is intended to be used. In this regard,

Space Data access bodies and/or national bodies might be tasked with developing and overseeing common rules. By providing a robust framework for data access and ensuring high-quality data standards, the Space Data Space shall facilitate the development and deployment of reliable AI technologies in the Space sector, thereby supporting innovation and ensuring compliance with regulatory requirements.

- **Network and Information 2.0 Directive and Cyber Resilience Act:**

The European Network and Information 2.0 Directive (‘NIS2 Directive’) sets EU-wide rules on cybersecurity, aiming to achieve a high common level of security of network and information systems within the EU, including operators in the Space sector (space being added as a new sector under NIS2 Directive). **The Space Data Space initiative shall implement and strengthen complementary measures to uphold the principles and security provisions established by the NIS2 Directive.** Further the EU Cyber Resilience Act (‘CRA’) which is expected to be implemented in 2025 aims to set out horizontal cybersecurity requirements for digital products and ancillary services. The envisaged set of essential cybersecurity requirements will be applied to all sectors and categories of digital products, ensuring compliance throughout the product life cycle. These requirements will be of a general nature and technology neutral. By aligning with these cybersecurity frameworks

and initiatives, the Space Data Space shall aim to ensure the security, integrity, and resilience of space data infrastructure, fostering trust and enabling innovation in the Space sector.

8.3.2. Space sector legislation

- **INSPIRE Directive:**

Directive 2007/2/EC, also known as **the Infrastructure for Spatial Information in the European Community (INSPIRE) Directive, lays the foundation for a European Union spatial data infrastructure**, facilitating the sharing of environmental spatial information across Member States. Its emphasis on interoperability, standardisation, and access to spatial data is highly relevant to Space Data Space. By adopting principles from the INSPIRE Directive, the Space Data Space can ensure that space data is seamlessly integrated, easily accessible, and compatible with other datasets, thereby enhancing its usability and effectiveness across various sectors.

The INSPIRE Directive's focus on data interoperability and harmonisation aligns with the Space Data Space's objective of promoting the free flow and exchange of space data. By adhering to INSPIRE standards, the Space Data Space can establish common guidelines for data formatting, metadata provision, and quality assurance, facilitating the integration of diverse space datasets from different sources. This interoperability fosters collaboration among stakeholders, promotes innovation, and supports the development of applications ranging from environmental monitoring to disaster management, benefiting both public and private sector entities.

Moreover, the INSPIRE Directive's legal framework and principles of transparency and public access provide valuable guidance for the Space Data Space in managing space data. By implementing similar legal guidelines and policies, the Space Data Space can ensure that space data is managed ethically, securely, and in compliance with EU regulations. This not only enhances data governance and accountability but also builds trust among stakeholders and fosters greater engagement and collaboration in the space sector. In essence, by embracing the principles of the INSPIRE Directive, the Space Data Space can create a robust and transparent framework for the effective management, sharing, and utilisation of space data, advancing Europe's capabilities in space exploration and innovation.

- **Upcoming EU Space Law:**

The European Commission intends to publish a proposal for the European Space Law (EUSL), anticipated in 2024, although its release date has been postponed twice. According to the European Commission, **the upcoming EUSL will focus on three pillars: safety, sustainability, and resilience**. The safety pillar aims to mitigate collision risks from space debris, sustainability will involve calculating and reducing the impact of space activities, and resilience will address protection against cyber threats.

In terms of cybersecurity, the EUSL is expected to emphasise **cybersecurity by design**, enhancing the security levels of the space industry supply chain, and applying cybersecurity measures proportionally to the criticality of certain products. Companies will be required to mitigate their risks by conducting assessments and evaluating potential threats to their infrastructure. Additionally, stakeholders will be mandated to prevent, detect, and protect themselves against cyber incidents, with the EUSL providing a framework for handling such incidents.

It remains to be seen how this new EUSL will impact the Space Data Space. The EUSL's emphasis on cybersecurity, safety, and sustainability could complement and enhance the Space Data Space's framework, potentially leading to more robust data security and improved data management practices. **It may be possible this new EUSL would consider the upcoming 'Space Data Economy Strategy' under preparation by EC DG DEFIS.**

Reco 17: Legal aspects should be managed at the sectoral level within the Coordinating Authority to streamline efforts and ensure process harmonisation.

8.4. Considerations for the legal entity of a Data Space

8.4.1. For a specific Data Space initiative

When a group of organisations decides to form a Data Space initiative, the question of liability arises. In this context, determining the legal structure for the Data Space Governance Authority becomes a critical consideration.

There are two primary alternatives for a Data Space initiative:

- **Option 1:** Establishing **a formal legal structure or entity** for the Data Space Governance Authority.
- **Option 2:** Handling the Data Space governance function through **contractual arrangements.**

A contractual arrangement without a formal entity (Option 2) is quicker to implement but becomes complex when handling liabilities, making it less advisable. If creating a new legal entity is too complicated, appointing an existing legal entity as the Governance Authority (Option 1) might be a viable alternative. An alternative solution to consider is combining multiple legal structures/entities and their associated contractual flows, depending on the purpose and level of intervention in the data value chain.

If a legal structure is chosen (Option 1), there are various possibilities for establishing the formal representation of Data Space governance. These options may include, among others:

- **Government agency (public)**
- **Association / not for profit**
- **Private company (with or without limited liability)**
- **Cooperative**

- **Group of Interest**
- other

While there is no one size fits all solution, the decision regarding the legal status of the Data Space Governance Authority depends on:

- the mission statement of the Space Data Space (general/public interest, economic interest, etc.);
- the scope (national, regional, local, sector segment, etc.);
- the country where the entity is located due to national law specificities;
- the vision and preferences of the diverse Data Space participants;
- The culture and habits of the community of practice.

Each option has drawbacks and advantages:

- **Association:** Well-suited for public/private projects, facilitates new member onboarding, but may face challenges in fundraising and might require additional structures (e.g., private Operating Companies) for handling operational/financial aspects. Based on input from tourism experts and a validation survey, an association is the preferred choice among stakeholders. Besides, the civil protection domain might be prone to organise in this way several public bodies for promoting its Data Space and exercising use case pilots through pre-commercial procurement instruments.
- **Private company:** private actors may encounter difficulties reaching an initial agreement, along with complex onboarding processes and challenges in engaging public sector stakeholders.
- **Cooperative:** governance constraints might be overly stringent, posing challenges in capital-raising efforts.

As outlined in the Governance section of the Blueprint (§7.2.4), **one solution to address these challenges is to set up the Data Space Governance Authority as a non-profit organisation while establishing an Operating Company as a for-profit** entity responsible for maintaining the Data Space's technological infrastructure.

As mentioned by Prof. Dr. Boris Otto (Fraunhofer ISST) in the session *Thinking ahead: Creating Data Spaces* at the GAIA-X Summit on 18th of Nov. 2020, *“any Data Space should have an Operating Company.”*

According to the DSSC, here are the following questions to consider when choosing a formal legal entity for a Data Space:

- Should the future Data Space be a permanent or temporary (even if multiyear) establishment?
- Does the future Data Space aim to generate profits for its members (i.e. the legal entities that create it)?
- What country will be the primary place of establishment (i.e. headquarters) of the future Data Space?

- What level of involvement do the members of the Data Space initiative want to have in managing and operating the future Data Space?

Reco 18: Each Space Data Space initiative should set up a Data Space Governance Authority (DSGA) and explore possible structural frameworks.

8.4.2. For the Coordinating Authority (European Space Data Space - ESDS)

As outlined in §7, the Space Data Space could benefit from establishing a sectoral Governance Authority, potentially involving a dedicated legal entity. **The choice of entity type will depend on stakeholders' preferences and whether a top-down or bottom-up approach is adopted.**

Key criteria include governance neutrality to enable broad participation. A limited liability company (e.g., German GmbH or French SARL) is one option, though cooperatives offer an alternative focused on democratic, member-driven governance and sustainability. A cooperative structure, such as a Societas Cooperativa Europaea (SCE), could ensure equal voting rights and flexibility for member needs.

Another option, preferred in other sectors such as Mobility, is the European Digital Infrastructure Consortium (EDIC)[143], a legal entity established by EU Commission decision involving at least three EU member states. **EDICs are designed for multi-country projects, with strong involvement of member states, and provide clear governance structures, liability protection, and streamlined management, making them a strong fit for the Space Data Space.** An important aspect to consider for ESDS is the fact that certain ESA member states are not EU member states.

[143] https://digital-strategy.ec.europa.eu/en/policies/edic

9. Business model for the Space Data Space

For the Space Data Space to be effective and widely adopted, stakeholders must see clear benefits in sharing data. These benefits could be financial or extend to social and societal advantages, such as improved health outcomes, increased customer interaction time, or faster insurance claim payments during natural disasters. However, defining a viable business model remains a complex challenge.

This chapter explores potential business models and the foundational elements needed to implement them effectively.

9.1. Business model challenges

The prosperity and durability of Data Spaces depend on formulating compelling incentives for cooperation among a varied array of participants and devising robust business models. These models should emphasise self-sufficiency rather than depending solely on public subsidies. In instances of Data Space utilisation, the involvement of stakeholders like data providers, service providers, orchestrators, infrastructure services, and end-users introduces complexity due to differing objectives, requirements, and revenue models. Effective coordination of these varied business models is imperative for ensuring a flourishing and sustainable Data Space. While it is intricate within the confines of a single Data Space initiative (Intra Data Space), the challenges intensify when extending across multiple Data Space initiatives (Inter Data Spaces). Navigating complexities involves:

- **Establishing the value of data before sharing:** considering the exchange value against keeping it in-house. Assessing contextual value, as data may have different worth in various applications.
- **Balancing stakeholder objectives:** Stakeholders may have different goals and strategies, such as offering data for free or seeking compensation. Business models must align diverse interests, including those of data providers, service providers, and infrastructure providers.
- **Ensuring fair retribution and motivational incentives:** Stakeholders should receive fair compensation, balancing short-term gains with long-term benefits. Incentives may include revenue-sharing models, data exchange agreements, and access to exclusive datasets.
- **Addressing IP, privacy, and ethical concerns:** Models should be designed with considerations for data privacy, intellectual property, and ethical concerns. This includes preventing data hoarding and monopolistic practices while encouraging active participation.
- **Adapting to an evolving landscape:** Flexibility is necessary to adapt to evolving business strategies and emerging technologies like AI and blockchain. It’s crucial to balance openness, competition, and collaboration for innovation.

9.2. Value creation in the Data Space

9.2.1. Business Model considerations

According to the DSSC, **the business model of a Data Space initiative should align with its overarching business strategies.** Key strategic decisions include determining whether the Data Space is for-profit or non-profit, its operational scale and scope, legal and regulatory constraints, and the allocation of revenue towards development and operation.

Developing the business model involves addressing several critical questions, such as how to attract both data providers and users, what services participants need to derive value from data, the costs associated with operations, the role of intermediaries, and the revenue model that will cover these costs.

This also could be helpful to create a knowledge database of the business models that could benefit all stakeholders and initiatives of the Space Data Space (at the Space Coordinating Authority level). Moreover, the modelling activities could be necessary tasks to simplify the compliance activities against regulations, stakeholders' needs, and technological implementation.

The business model consists of several elements that ensure alignment with the Data Space's objectives, adherence to principles, and support for economic sustainability, growth, and scaling. These elements include:

- **Participants:** Data Space participants, who are essentially its 'customers,' are grouped into segments based on similar needs and objectives. Participants include data providers, organisations and individuals as data users, and any sub-groups thereof. The Governance Authority may apply different business and governance rules to various participant segments.
- **Value propositions:** A Data Space can only create value if data rights holders are willing to share attractive data with users. The conditions must be appealing to both data rights holders and users, requiring incentives like temporary pricing discounts, marketing activities, and use case hackathons.
- **Revenue model:** Income may come from public funding, participant fees (e.g., subscription, membership, or transaction fees), and other external sources. The revenue model combines different mechanisms to ensure financial sustainability.
- **Cost model:** Key cost factors include development, operational costs of the data-sharing infrastructure, and governance-related expenses. The revenue model must cover all costs for the Data Space to be self-sustaining.
- **Organisation of operations:** Choices regarding whether enabling services are provided in-house or outsourced affect costs. These decisions are crucial for the overall business model.

- **General insights of Data Spaces business models:**

A review of various data-sharing initiatives and sectoral CSA preliminary studies highlights a variety of funding models, including profit-driven, publicly funded, and hybrid public-private approaches. In many cases, initial public funding proves essential, particularly for Data Spaces that advance common interests or foster social innovation, even when private companies participate. Flexible funding mechanisms, such as tiered membership fees, underscore the importance of adaptability in financial structures.

9.2.2. Business Model levels

The business model of a Data Space is structured on 4 levels:

- **Business model for individual Data Space participants (providers/recipients):**

Data Space initiatives **should facilitate peer-to-peer compensation between participants**, including data providers and recipients, across **data value chains within and between Data Spaces**. This approach can drive innovative business models and support the growth of a dynamic data economy.

One of the main challenges in developing business models for Data Space participants is **aligning diverse entities within the same initiative**. These entities vary in public or private status, company size (from large corporations to SMEs), legal structures, and strategic objectives.

Valuing data products remains complex, as their worth fluctuates depending on reuse scenarios. Many sectors still have a low maturity level in this regard.

For multi-party use cases, appointing a ‘data orchestrator’ can help streamline business negotiations. However, integrating participants from different Data Spaces across sectors and member states adds another layer of complexity, requiring a high degree of standardisation.

- **Business model for Data Intermediaries and infrastructure providers:**

The business models for Data Spaces intermediaries (or data intermediation services as defined in the Data Governance Act) and infrastructure providers (Operating Companies) encompass **various payment structures**, allowing to choose from:

- subscription fees,
- commissions on exchanges,
- pay-as-you-go remuneration,
- project-based fees.

Different approaches include:

- freemium access,
- participation-based reductions,
- partnership-based agreements.

Specific models focus on:

- data aggregation, harmonisation,
- API integration,
- data analytics,
- educational services,
- customisation,
- collaboration facilitation,
- advanced quality assurance.

A challenge for Data Intermediaries and infrastructure providers is that **specific activities within a Data Space initiative often require the involvement of multiple intermediaries and infrastructure providers**. To improve the user experience for Data Space participants, streamlined processes that consolidate billing into a **single invoice should be developed**.

Regarding their business models, **the Data Governance Act requires Data Intermediaries to remain neutral**: they must provide their services without discrimination, ensuring fair access to their data intermediation services for all eligible participants. More detail about Data Intermediaries can be found in §10.2.3.

- **Business model for a specific Data Space Governance Authority:**

The sustainability of a Data Space initiative also relies on the Data Space Governance Authority's ability to finance its various activities. Challenges for the Data Space Governance Authority include:

- Ensuring its financing does not conflict with the business models of Data Space participants, such as data providers and recipients.
- Ensuring its financing does not conflict with the business models of Data Intermediaries and infrastructure providers (Operating Companies).

- **Business model for the sectoral Coordination Authority:**

The initial financing for sectoral Data Spaces' sectoral Coordination Authorities (in our case the European Space Data Space - ESDS) is **primarily envisioned as public-driven**. In the long term, sectors may **transition towards more hybrid and sustainable models**, where Data Space initiatives within a sector contribute to their sectoral coordination through member fees or commissions on data exchanges.

Reco 19: Each Space Data Space initiative should propose its own business model, while the Space Data Space Coordinating Authority should help with a sectoral business framework for better interoperability.

9.2.3. Key services and building blocks supporting business models

- **Catalogue, Publication and discovery services:**

Following the DSSC conceptual model, the 'Publication and Discovery' building block in a Data Space is essential for discovering entities, data, and services, connecting participants, and fostering collaboration. It helps locate products, offerings, participants, infrastructure components, and use cases within a catalogue, thereby accelerating growth, reducing costs, and improving service quality. The standards and interoperability mechanisms within a Data Space initiative, or across multiple Data Spaces, enable broad discoverability. An entity, dataset, or service registered in one Data Space's catalogue can be potentially discovered by participants from any sector across all Data Spaces.

For geospatial information, current catalogues use extensions to DCAT, the technical standard for catalogues and discovery in Data Spaces, and to SPARQL, a query language. These are known as GeoDCAT and GeoSPARQL, providing essential properties for spatial data querying, such as data coverage and applicability. In the Space sector, particularly in Open Data catalogues, the STAC protocol (an OGC Community Standard in v1.0) is widely used for describing satellite data, offering profile-specific extensions and easy data linkages. Ongoing OGC efforts aim to map STAC to OWL and (Geo)DCAT languages for seamless integration with similar catalogues. For catalogues of broader assets like tools and workflows, OGC Records offers a generalised standard aligned with the same foundational standards. The latest ISO/OGC CSW generation, based on ISO TC211 geoinformation models, includes EO-specific extensions and supports popular GIS tools and data discovery services. Future standardisation may cover integration with control plane and contract management services in Data Spaces, while catalogue integration techniques support both generic (contracts, identity) and geospatial functionalities. An alternative to STAC is the Odata protocol[144]. This protocol is more generic than STAC and can be used for any data. STAC is more suitable for geospatial data. The goal of STAC is to enable a global index of all imagery (satellite, aerial, drone, etc), derived data products and alternative geospatial captures (LiDAR, SAR, Full Motion Video, Hyperspectral and beyond).

- **Marketplace:**

A marketplace plays a key role in enabling Data Space participants to buy and sell data and services within a single Data Space initiative or across multiple Data Spaces. While there may be several marketplaces within the Space Data Space, they will all remain interoperable.

- **Data value chain tracker:**

This building block (not mentioned by the DSSC but presented in the Skills Blueprint) empowers users and organisations by enabling the tracking of contributors and their contributions along the data value chain, ensuring fair compensation. Unlike closed digital platforms, it allows users to monitor and control the use of their personal or business data even after sharing it.

[144] https://www.odata.org/

- **Billing and clearinghouses:**

The primary function of automated and standard billing is to generate invoices for Data Space participants who receive data or services within or across Data Spaces. To simplify the user experience, a single invoice mechanism should be preferred. Additionally, complementary clearinghouse mechanisms can help streamline the process.

Clearinghouses can support the circulation of 'tokens' or digital currencies (based on blockchain technologies or not) within a Data Space.

9.3. Business models in the Space sector

For the past 40 years, **the Space sector was primarily funded by public money** and viewed as a strategic asset by governments, mainly for political and defence purposes. **In the last decade, however, private investors have become increasingly interested**, first in launch services, then in satellite constellations (for communication, Earth observation, and IoT), and now in **value-added services**. According to the *EUSPA EO and GNSS Market Report*[145], space data now supports 15 sectors, including agriculture, aviation, climate, consumer solutions, emergency management, energy, finance, maritime, road, and urban development.

European taxpayer-funded space infrastructures, such as Sentinel, Copernicus, EGNOS, and Galileo, **offer open data access**. **The challenge now is to enhance its value for EU citizens and businesses by advancing up the value chain to deliver value-added services.** While many large companies see the advantages of space-derived information, they prefer easy access to relevant data without navigating the complexities of the space industry.

This presents two paths: **individual players could attempt to capture new opportunities on their own, or, through collaboration, they could collectively reach a larger market**. A Space Data Space would support the latter approach, fostering data-sharing models that benefit both data owners and stakeholders by **enabling new, cooperative business models across the value chain**.

[145] https://www.euspa.europa.eu/sites/default/files/euspa_market_report_2024.pdf

10. Technical aspects of the Space Data Space

Once the objectives of the Space Data Space are established, along with its governance structure and business models, the next step is to develop its technological foundation. This chapter explores key aspects such as reference architectures, trust and interoperability, data value creation, and the available technological components. A significant focus is placed on 'Data Intermediaries', a new category of economic actors playing a crucial role in the ecosystem.

10.1. Technical challenges

Technical challenges for Data Spaces include ensuring seamless and trusted connectivity among a vast array of databases, datasets, services, information systems, data hubs/platforms, and data lakes in a federated manner, both within a single Data Space (intra Data Space) and across multiple Data Spaces (inter Data Spaces). The main challenges are the following:

- **Interoperability:**
    - **Achieving seamless data exchange:** Ensuring multiple platforms can exchange data seamlessly and support interconnectivity through common interfaces.
    - **Integrating various technologies:** Incorporating new and evolving technologies from various providers.
- **Trust:**
    - **Building trust:** Adhering to principles like inclusiveness, fairness, and autonomy to build trust among diverse data systems and participants.
    - **Facilitating agreements:** Creating a scalable technical and logical framework for enabling agreements between participants.
- **Common principles and architectural Design:**
    - **Adhering to common architectural principles:** Focusing on lower entry barriers, System of Systems (SoS) design, standardisation, mediation, data-centric focus, loose coupling, and orthogonal interoperability/security.
    - **Building a Soft Infrastructure:** based on agreements (including technical standards) and a minimal set of logical components for interoperability.

To ensure a controlled development of the Space Data Space initiatives, we need to ensure that the models for interoperability, trust and architecture provide the best representative description of the developed system and enable the shared understanding between all

stakeholders involved into the Space Data Space initiatives from the design stage to the operational stage.

10.2. Building the technical infrastructure of a Data Space

10.2.1. Implementing reference architectures and models

To facilitate data-sharing among participants within the same Data Space initiative (intra Data Space) and across different Data Spaces (inter Data Spaces), **Data Space initiatives can leverage the emerging reference architectures and models proposed by various support organisations** and initiatives, such as the Data Spaces Support Centre (DSSC), Gaia-X, IDSA, Simpl, etc., as listed in §6.2.2.

- **Navigating the Data Space support organisations landscape:**

The presence of multiple support organisations and initiatives can create a seemingly complex landscape with potential gaps and overlaps. **However, significant alignment efforts are underway** to bring coherence and clarity to the community. These efforts occur both top-down, through EU-funded projects like the DSSC and Simpl, and bottom-up, through ongoing exchanges among participants of different support organisations, who often engage with more than one. Over time, each support organisation tends to specialise in certain aspects, reducing overlap, and to build complementary proposals with others, minimising gaps. Overall they work together at aligning concepts and vocabularies. While these support organisations are not directly creating formal standards, they have begun collaborating with key standard organisations such as ISO.

One of the major bottom-up alignment initiatives is the Data Space Business Alliance (DSBA)[146] where 4 support organisations published a joint *Technical Convergence Discussion Document*[147] , and developed a joint framework presented below:

[146] https://data-spaces-business-alliance.eu/

[147] https://data-spaces-business-alliance.eu/dsba-releases-technical-convergence-discussion-document

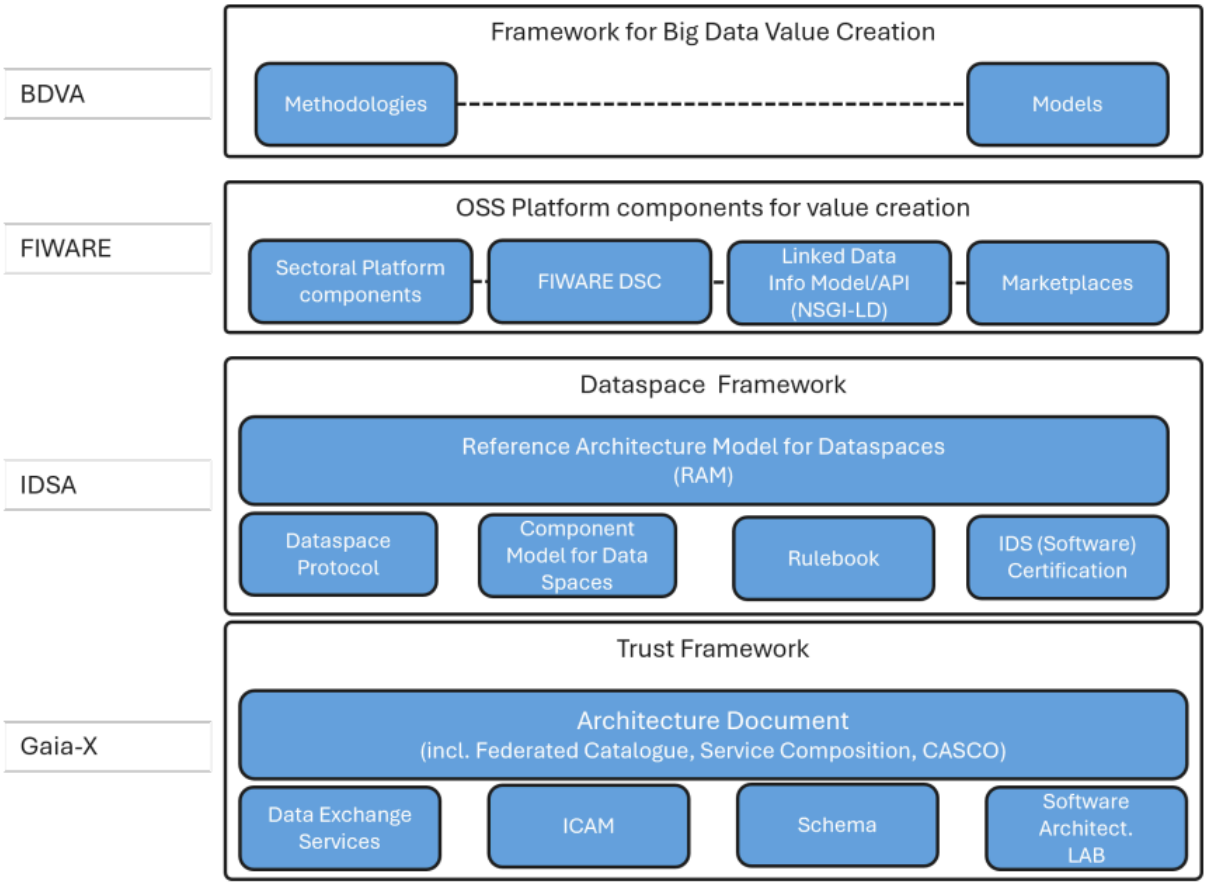

Figure 46 - DSBA joint framework
Source: DSBA

- **Implementing the key conceptual models:**

DSSC conceptual model, glossary and building block[148]

In order to break down Data Spaces into manageable pieces, the DSSC adopted the concept of building blocks: a basic unit or component that can be implemented and combined with other building blocks to achieve the functionality of a Data Space. 12 building blocks have been described, ranging from governance, legal, organisational, to technical building blocks on data interoperability, trust and data value. The DSSC improves its model based on the latest insights on Data Spaces.

148

https://dssc.eu/space/CME/176554182/Conceptual+Model+of+Data+Spaces+%7C+Version+0.5+%7C+September+2023#Conceptual-Model-Level-1

Figure 47 - Overview of the DSSC building blocks
Source: DSSC

IDSA Data Space Protocol (DSP)[149]

The IDSA Data Space Protocol (DSP) is a set of technical and operational standards developed by the International Data Spaces Association (IDSA) to facilitate secure and sovereign data-sharing among participants in a data ecosystem. This protocol ensures that data exchanges are governed by rules that maintain data sovereignty, security, and interoperability. Many Data Space initiatives and technologies already implement the IDSA Data Space protocol. IDSA has already listed 28 technological Data Space connectors referring to its protocol[150].

[149] https://docs.internationaldataspaces.org/ids-knowledgebase/v/dataspace-protocol

[150] https://internationaldataspaces.org/data-connector-report/

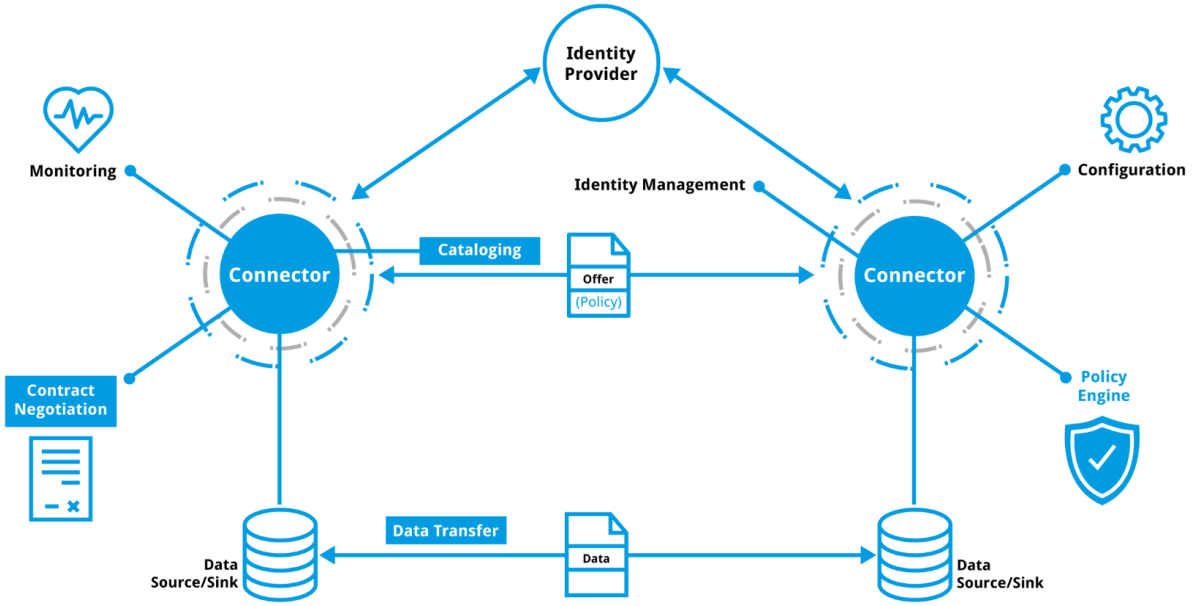

Figure 48 - Overview of IDSA Data Space Protocol
Source: IDSA

Gaia-X framework[151]

Gaia-X provides multiple elements to facilitate data-sharing in federated environments such as: an architecture document, the trust framework, the Gaia-X Clearinghouse (GXDCH), and the Gaia-X labels. Gaia-X puts an important focus on topics such as policy rules and compliance.

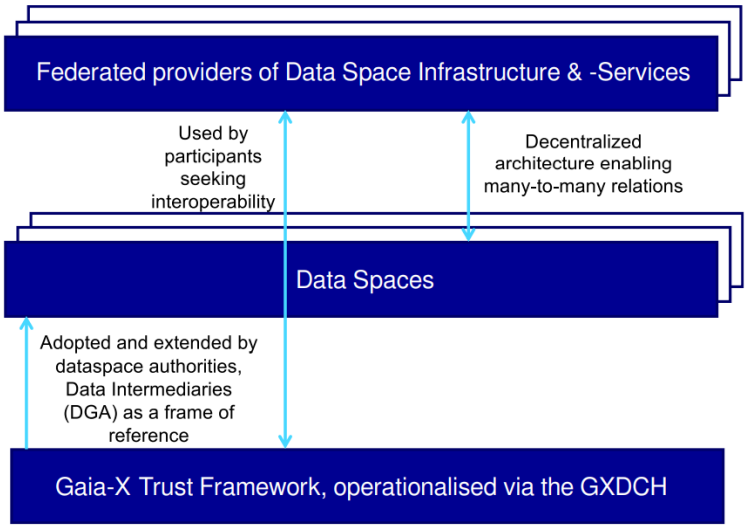

Figure 49 - The Gaia-X Trust Framework as a foundation for interoperable Data Spaces
Source: Gaia-X

[151] https://docs.gaia-x.eu/technical-committee/architecture-document/24.04/pdf/document.pdf

Simpl[152]

Simpl is a 150M€ project funded by the EC (DG CONNECT) , which aims at providing Data Spaces with an Open Source toolbox addressing all the key features of a Data Space. Simpl acts as a 'framework of frameworks', that will provide federation building blocks allowing interoperability across all other existing technological stacks and components of the Data Spaces landscape. Simpl comes with a conceptual model presented below:

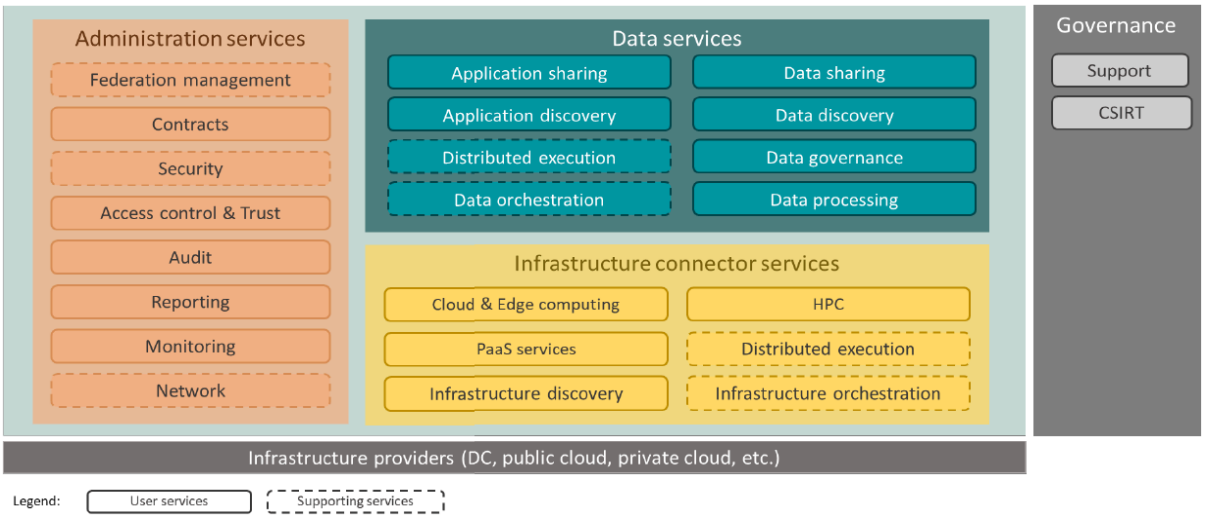

Figure 50 - Simpl high-level conceptual architecture
Source: DG CONNECT

Reco 20: Each Space Data Space initiative should implement existing reference models proposed by key Data Spaces support organisations.

Reco 21: Simpl should be a key component of the Space Data Space, as Destination Earth will be one of the six pilot projects (Simpl Live) for its deployment, starting in 2025.

10.2.2. Separating concerns for combining trust with interoperability

According to the DSSC, **it is important to distinguish between the control plane and the data plane**. The control plane is responsible for deciding how data is managed, routed, and processed, while the data plane is responsible for the actual movement of data. For example, the control plane handles user identification and the management of access and usage policies, whereas the data plane manages the actual exchange of data.

This distinction means that **the control plane can be highly standardised using common protocols for identification, authentication, permissions for sharing and other functions**. In contrast, **the data plane can vary for each Data Space, accommodating different types of data exchanges**. Some Data Spaces focus on sharing large datasets, others on message exchange, and still others on event-based approaches. Although there is no one-size-fits-all solution, certain mechanisms, especially in data interoperability, can help

[152] https://digital-strategy.ec.europa.eu/en/policies/simpl#1712822729753-0

ensure effective collaboration between different data planes. These should be considered both at the European Space Data Space (ESDS) sectoral Coordinating Authority level, and within each specific Space Data Space initiative.

10.2.3. The key role of Data Intermediaries

- **What are Data Intermediaries:**

In the context of Data Spaces, **data intermediaries are digital services that provide essential tools for data-sharing**. They implement core features of a Data Space, such as identity management, monitoring, catalogue management, connector services, and contract services.

A single Data Space initiative can utilise one or more data intermediaries to cover various features for building its technical data-sharing infrastructure. According to the DSSC, data intermediaries can also operate in multiple Data Spaces, offering scale benefits and enabling interoperability. Depending on the design of the Data Space, various data intermediaries might compete or substitute for each other. Therefore, the Data Spaces domain represents a market for these intermediaries to offer their services. If a Data Space appoints one or more Operating Companies, the Operating Company can use one, or more, Data Intermediary for delivering its service.

- **Data Intermediaries in the regulation (DGA):**

The Data Governance Act (DGA) defines Data Intermediaries, or data intermediation services, in Europe, serving as the primary legal framework for operating Data Space intermediaries. The governance rules for these intermediaries should be clearly outlined in the Data Space's Rulebook, as they significantly impact the fairness, transparency, trustworthiness, interoperability, and sustainability of the Data Space.

The DGA outlines the process for Data Intermediaries to participate in a Data Space. To offer their services, Data Intermediaries must gain approval from the Data Space Governance Authority, detailing the services and building blocks they provide in accordance with the DGA. **They must be notified to be recognised with relevant authorities (i.e., ARCEP in France)** and maintain up-to-date records of their certification status as trusted service providers. Data intermediaries must align their services with the decisions of the Data Space Governance Authority (DSGA) and implement the building blocks it specifies.

- **Functions and characteristics of the Data Intermediaries:**

Data intermediaries play a crucial role in the Data Space by **facilitating the integration of diverse data sources**, ensuring **harmonisation**, **standardisation**, and **interoperability** across different participants and stakeholders. A key function is to maintain interoperability between data and services provided by various intermediaries, enabling seamless collaboration and exchange regardless of the chosen provider. Additionally, intermediaries offer a range of services and building blocks aligned with the requirements set by the Data

Space Governance Authority (DSGA), including **data aggregation**, **analytics**, and other value-added solutions.

Data intermediaries are named according to the services they provide. For example, if an intermediary provides connector services or other connection capabilities, it can be referred to as a connector intermediary. If it facilitates personal data sharing, its name will reflect its specific functions: personal data intermediary.

Here are some characteristics Data Intermediaries:

- **Certification and approval:** Data intermediaries need to be approved and certified by the Data Space Governance Authority (DSGA). This certification ensures that they adhere to the standards and regulations set by the DSGA, making them trustworthy service providers.
- **Advertisement and visibility:** Data intermediaries need to be visible and known within the Data Space. They are advertised toward Data Space use cases, and participants can choose from certified intermediaries based on their specific needs.
- **Flexibility and change:** Participants have the flexibility to change data intermediaries if needed. Since all data intermediaries adhere to the same standards within a Data Space, this change can be facilitated with minimal disruption, promoting a dynamic and adaptable ecosystem.
- **Payment and Compensation:** Data and service providers may use data intermediaries to connect to the Data Space, and these intermediaries can be compensated for their services. The process of invoicing and ensuring rightful compensation is often part of the data intermediary's role.

10.2.4. Achieving data interoperability

According to the DSSC, in the context of a Data Space, **agreed-upon data models and data exchange APIs are crucial for actual data services and use cases**. These components serve as the foundation for data sovereignty, trust specifications, discovery, and metadata brokering. Data interoperability, governed through joint repositories, ensures that participating Data Spaces adhere to common data standards and protocols.

Practically, participants can specify **domain-specific and cross-domain semantics**, link them to technical interfaces and mapping tools (that can be augmented by AI), and record exchanged data details. Data interoperability is crucial for organisations, allowing data accessibility across different formats and platforms. This capability facilitates data-driven decisions, leading to cost reduction, operational efficiency, and improved business outcomes. In a Data Space, where organisations must share data in a standardised manner, data interoperability ensures that data can be utilised across various systems and applications.

For the Space Data Space, the downstream Earth Observation (EO) domain has its own semantics for raw and pre-processed data, based on product specifications that are partially covered by ESA and NASA ontologies. Detailed specifications can vary between product types and missions. At the pre-processed level, definitions from the Committee on Earth

Observation Satellites (CEOS)[153] set minimum requirements that can be referenced. At the processed level, indicators and variables, such as Essential Variables derived from EO products, are proposed. Formal harmonisation between data products and quality measures could be beneficial for Data Spaces.

- **Agreeing on common and shared data models:**

Agreeing on data models (semantic interoperability) within and across Data Spaces is essential for achieving interoperability, but it is a complex task. Several questions arise: How can consistency be maintained across organisations and systems over the long term? How can semantic interoperability be ensured across different Data Spaces and sectors? How can common and convenient data models be established for many participants?

Catena-X, the automotive lighthouse Data Space initiative, has proposed a dedicated infrastructure component for managing data models: **the Semantic Hub**. In Catena-X, semantic data models are provided in a suitable publication system called the Semantic Hub[154] . This Hub serves as a foundation for the use and reuse of semantic models by data or service providers. The publication of a semantic data model is versioned, supporting transparency and control over all semantic models and their release status.

The Space sector has unique data characteristics used across downstream domains. Harmonising data has a long history involving various data formats and recent efforts to standardise product specifications (IEEE, OGC, CEOS). Despite these efforts, **high heterogeneity is still evident** between missions, aside from data brokers.

The EARSC EO Industry Certification Scheme guideline document[155] identifies a key barrier to industry growth: *"One of the key barriers to the growth of the industry and the use of Earth Observation products and services is the level of confidence that customer organisations may have in the product or service being offered."* In this respect, efforts to harmonise data include quality assurance initiatives like the ESA-NASA EDAP project[156], which have the potential for global application.

- **Exchanging data:**

According to the DSSC, clear guidelines are essential for data exchange protocols to ensure accurate communication and to overcome technical interoperability barriers. Data spaces need to address three challenges:

- Establishing **efficient and standardised** data exchange among various systems.
- Choosing **suitable exchange protocols** to gain access to shared data. Having the right balance of general-purpose and domain-specific standards is essential.

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[153] https://ceos.org/ard/

[154] https://catena-x.net/fileadmin/user_upload/Standard-Bibliothek/Update_Maerz_2024/CX-0003-SAMMSemanticAspectMetaModel-v1.1.0.pdf

[155] https://earsc.org/wp-content/uploads/2021/04/EARSC-Certification-documents.pdf

[156] https://earth.esa.int/eogateway/activities/edap

- Sharing data in a **federated environment** when direct communication between participants is difficult.

Data exchange protocols and components (i.e., APIs, connectors, etc.) need to be independent of specific data models. For economic and practical reasons, **they should rely as much as possible on elements already in use** within the sector or by the Data Space participants.

In the Space Data Space, **data exchange must accommodate the unique characteristics of Earth Observation (EO) data, such as large files in various formats and endpoints.** It should support scenarios like bulk access, 'streaming' to the web (e.g., OGC Web Services like WM(T)S for visualisation and processed imagery, WCS for numerical data), and data ordering. **The EO community has already established standards for data access and exchange**, developed through investments from public agencies and industry participation under collaborative frameworks like OGC and openEO. Integrating these standards with the control planes could provide a quick win.

For ordering data that is available on request or acquired based on satellite tasking, various implementations exist. Copernicus and commercial data providers have their own interfaces. Meanwhile, efforts like ECMWF Harmonised Data Access[157] aim to define a unified interface for DestinE, and UKEODatahub is developing an EOEPCA-based Open Source data adapter approach to support data streams (currently including Airbus and Planet). Additionally, brokers' APIs already integrate a variety of commercial data ordering interfaces.

- **Monitoring provenance & traceability:**

According to the DSSC, The forward-looking direction of a data value chain is referred to as traceability, i.e., a **data provider can receive evidence of what was done with the data**. The backwards-looking direction of a data value chain is referred to as provenance tracking, i.e., **a data consumer can receive evidence on the origin of the data** and the treatment of the data during its processing in the value chain. Both traceability and provenance are important functional requirements for each participant in such a data value chain, which can consist of multiple data transactions.

Specifically in EO, provenance is important as the processing is computationally demanding and pre-processed data outputs shall be reusable in a variety of scenarios. Initial work has been done on the openEO, within OGC TestBeds and EOEPCA that is based on the Prov-O ontology that can be added as the annotations to the catalogue entries.

10.2.5. Building Data Sovereignty & Trust

According to the DSSC, the Data Sovereignty and Trust components of a Data Space infrastructure provide the **technical enablers to ensure the reliability and authenticity of participants' information**, which is essential for establishing trust among them during interactions and data transactions. These components should be based on common

[157] https://github.com/ecmwf/hda

standards and agreed-upon policies to prevent user lock-in and incorporate verification and authentication mechanisms to ensure interoperability and security.

For most aspects, generic technology mechanisms, specified at the sectoral level through the European Space Data Space (ESDS) Coordinating Authority, should be applied to leverage the potential of the Space Data Space. However, specific requirements must be identified for sensitive data, such as GDPR compliance and trade constraints at the EU and national levels.

- **Managing rules and policies:**

According to the DSSC, the Access and Usage Policies Enforcement components are crucial for data-sharing. They are necessary for all types of transactions and aim to ensure data sovereignty by **enforcing defined policies within Data Spaces**. Since the purpose of a Data Space is to enable controlled, sovereign data-sharing, this goal cannot be achieved without effective policy enforcement. Without this building block, data sovereignty may not be attainable, and regulations, especially those concerning personal data, might not be met.

The Data Space Governance Authority (DSGA) of a Data Space initiative defines rules and policies. As presented in chapter §7 (Governance), these rules and policies enable the actionable implementation of the Data Space Governance Framework and are documented in the Data Space Rulebook.

- **Managing identity:**

A trustworthy data-sharing environment requires that **all participants (e.g., organisations, natural persons) and resources (data, services) are properly identified according to agreed-upon standards** (such as the European standards defined by the eIDAS regulation). According to the DSSC, Data Space components that manage identity and attestations should ensure interoperability, security, and trust through widely recognised technical standards and regulatory frameworks. Identity Management (IM) in Data Spaces involves Identity Providers managing the entire lifecycle of user accounts. These mechanisms empower participants with control over their assets, ensuring data sovereignty. Identity is fundamental for establishing trust, controlling access, and securing data within the Data Space. Authentication and authorisation processes rely on identity to prevent unauthorised access and facilitate secure data-sharing.

In a Data Space ecosystem, participants use Self-Descriptions to communicate, employing metadata to describe themselves, their services, and their resources. Initially defined by the IDS Reference Architecture, GAIA-X has expanded the concept to include all Data Space components, such as Participants, Services, Resources, and even the Data Space itself. Self-descriptions enable data objects or entities to describe themselves in a machine-readable format, facilitating efficient sharing, discovery, and integration across diverse systems. This metadata includes information about data format, structure, content, and relationships, provided either automatically or by the data producer/owner. Self-description is crucial for interoperability and data integration, **allowing systems to**

automatically understand and use data from various sources, simplifying discovery, and empowering consumers to evaluate data quality and relevance before use. **The control of identity can be fully decentralised (Self Sovereign Identity), centralised (i.e., the Data Space Governance Authority validates identities), or a mix of both approaches.**

- **Managing permissions:**

In a Data Space, **data sovereignty relies on the way participants grant permission for the use of their data**. Permission mechanisms are directly linked to identity and authentication (as previously discussed). **They can take the form of contracts between participant organisations and/or consents when natural persons are involved**. Data-sharing contracts can involve two or more parties.

- **Building a compliance chain:**

If all above elements are well implemented in a standard and machine-readable format (Rulebook, identity, contracts, consent, etc.), the Data Space can ensure compliance with the Data Space rules and policies along the data value chain, **building a compliance chain or 'Compliance as Code' mechanisms**.

External components such as the Gaia-X Clearinghouse, can also facilitate compliance across Data Space (inter Data Spaces).

Reco 22: Key standards for technical building blocks regarding interoperability and trust should be harmonised through the European Space Data Space (ESDS) Coordinating Authority.

Reco 23: The Space Data Space should adopt existing industry standards to the greatest extent possible.

10.2.6. User experience (UX/UI) and Data Collaboration

The user experience (UX) within a Data Space, where users engage with diverse services offered by multiple components and organisations, is a crucial aspect requiring meticulous consideration and implementation.

The primary challenge lies in the co-design of a Data Space use cases, which may involve collaboration among participants within a single Data Space or across multiple Data Spaces. Data Collaboration tools, similar to existing products such as Snowflake[158], but allowing cross-organisations collaboration, can prove very useful for a Data Space. Those tools should enable the automation of the co-design process following the Use Case co-design framework (§5.2.5) followed by the Data Space.

The complexity of delineating, devising, and executing UX is heightened when managing numerous components within a Data Space. A smooth and coherent user journey across

[158] https://www.snowflake.com/en/

various services is imperative for fostering a positive UX. Subpar UX can impede user attraction and retention, and, in severe cases, impede the utilisation of a service. **User interfaces (UI) that are transparent and reliable play a pivotal role in enabling users to comprehend how their data is utilised**, accentuating user control.

Reco 24: Each Space Data Space initiative should propose a data collaboration platform.

Reco 25: The UX/UI elements of all Space Data Space initiatives should be harmonised, at least at the sectoral level, using a design system proposed by the Coordinating Authority.

10.3. What technical elements are available for the Data Space?

10.3.1. Existing Data Space technical approaches

Table 8 - Existing Data Space technical approaches

MIMs
'Minimal Interoperability Mechanisms' (MIMs) represent a higher level of abstraction aiming to achieve interoperability of data, systems, and services across various governance levels globally. MIMs are defined as the minimal but sufficient capabilities necessary for interoperability, taking into account diverse city backgrounds and allowing for flexibility in implementation. They are vendor-neutral and technology-agnostic, providing a common ground for interoperability that can be integrated into existing systems and complement other standards and technologies. A MIM describes a common set of tasks or processes required to achieve a specific objective with minimal complexity, often based on existing standards. The primary goal is to offer a useful level of interoperability between different technical solutions while focusing on essential requirements. MIMs acknowledge that achieving complete interoperability can be resource-intensive, and a less-than-perfect level of interoperability can still be a valuable first step. In the European context, MIMs, referred to as MIMs Plus, are governed by the Living-in.eu movement, specifically by the tech subgroup. The development of MIMs Plus adheres to principles such as a citizen-centric approach, a city-led approach at the EU level, the city as a citizen-driven and open innovation ecosystem, technologies as key enablers, ethical and socially responsible data practices, and interoperable digital platforms with open standards, APIs, and shared data models. The Living-in.eu tech subgroup is administered by public bodies, ensuring a focus on public institutions' best interests in driving MIM development.
Personal data management
Protecting personal data requires strong technical and organisational safeguards. Privacy Enhancing Technologies (PET), like personal data intermediaries, are key for enhancing

privacy and ensuring GDPR compliance. Consent-based data management models, controlled by individuals, include systems like Prometheus-X, SOLID, MyData Operators, digital commons, and EU wallets. Anonymisation is highlighted as a simple way to protect personal data, while other PET approaches—such as homomorphic encryption, secure multiparty computation (SMPC), private set intersection (PSI), federated learning (FL), trusted execution environments (TEE), zero-knowledge proofs (ZKP), differential privacy (DP), and synthetic data—address specific aspects like data minimisation, security, and confidentiality.

Security
Data sovereignty and trust in the context of a Data Space are closely linked to information security, defined as the preservation of Confidentiality, Integrity, and Availability (CIA) of information. Confidentiality ensures restricted access, integrity ensures accurate and unmodified data, and availability guarantees authorised access when needed. Information security is crucial for preserving data sovereignty and trust in a Data Space. Access control, encryption, identity management, and certification are key elements to ensure data confidentiality, integrity, and availability. While Data Space participants are primarily responsible for data integrity and availability, generic applications and data quality standards can support these aspects. The use of digital identities, such as digital certificates under the eIDAS regulation, contributes to secure digital communication and exchange. It is essential to consider information security comprehensively across all operations within Data Spaces, addressing potential weak points. The Space Data Space plays a role in providing identification, authentication, and authorisation mechanisms accessible across the Data Space and establishing governance for data integrity and availability to foster trust among participants. Authentication is identified as a crucial aspect, especially in preventing Denial-of-Service (DoS) attacks and ensuring secure data access.

10.3.2. Existing Data Space technical open source tools and stacks

Table 9 - Existing Data Space technical open source tools and stacks

Eclipse Data Space Components (including the connector)[159]
The Eclipse Data Space Components (EDC) is a comprehensive framework, encompassing concept, architecture, code, and samples, providing a foundational set of features for Data Space implementations. Designed to ensure interoperability, EDC leverages defined APIs and aligns with specifications from the Gaia-X AISBL Trust Framework and the IDSA Data Space protocol. Widely adopted, the EDC is utilised in various initiatives, including EONA-X and CATENA-X, and is selected for Gaia-X proof of concepts. The recent announcement reveals plans to integrate Gaia-X features with EDC, simplifying the use of Gaia-X Verifiable Credentials for Participant Compliance in contract negotiations and access control. The Vision Demonstrator, part of the EDC project, showcases a user interface for end-to-end Data Space interaction, covering tasks such as managing Data Spaces, discovering shared data, negotiating contracts, and creating policies and data assets. While the EDC connector is prominent for its implementation of the Data Space connector, it is essential to understand that EDC primarily serves as a

[159] https://projects.eclipse.org/projects/technology.edc

software framework, allowing flexibility in design choices at the protocol and Data Space connector level. Despite this, EDC enjoys substantial support from major organisations and is already deployed in prominent European Data Space initiatives.

Prometheus-X[160]

Prometheus-X is a non-profit established in 2021 to govern and fund Data Space components to easily set up data spaces and data intermediaries. PTX components are based on top of GAIA-X, IDSA and DSSCS specifications such as GAIA-X Trust Framework, Data Space Protocol.
PTX components are used across many data spaces such as the skills data space, the media data space, EONA-X. They include catalogue, contract, consent, connector, trustworthy and decentralised AI functionalities.
Some unique functionalities include:

- Multilateral contracts: data-sharing agreements between *n* participants, enabling to create data and service chains amongst the different resources;
- API consumption: consume APIs via the data space;
- Decentralised AI training: train AI models from multiple sources without centralising the data;
- Trustworthy AI assessment: audit AI models compared to ethical code of conducts, identify potential biases;
- Personal data-sharing: management of personal data-sharing and Personal Data Intermediaries, with components enabling people to control and share their data between the data space participants and ensuring GDPR compliance.

All building blocks are governed by the association and are open sourced.

GAIA-X Clearing House[161]

The GAIA-X Digital Clearing House (GXDCH) serves as a central hub for verifying compliance with GAIA-X rules, providing an automated process for organisations seeking inclusion in the GAIA-X ecosystem. It functions as a node for verifying GAIA-X rules and is crucial for operationalising GAIA-X in the market. The GXDCH operates as a network of execution nodes for compliance components, ensuring a distributed and decentralised approach to GAIA-X compliance. It is not centrally operated by the GAIA-X Association, allowing anyone to benefit from an open, transparent, and secure federated digital ecosystem. The GXDCH is non-exclusive and interchangeable, operated by various market operators, and functions as a GAIA-X Federator. Currently, four clearing houses are operational, with several organisations working to establish new clearing houses within Europe.

FIWARE components[162]

FIWARE has introduced a new Data Space connector aligned with the DSBA convergence document. This connector, an integrated suite, is designed to facilitate participation in a Data Space, adhering to DSBA recommendations. It interfaces with Trust Services, implements authentication based on W3C DID, follows SIOPv2/OIDC 4VP protocols, employs attribute-based access control for authorisation, supports ETSI NGSI-LD for data exchange, and integrates TMForum APIs for contract negotiation. Additionally, Gaia-X and SIMPL offer cloud infrastructure, data products, applications, and services for Data Space

[160] https://prometheus-x.org/building-blocks/
[161] https://gaia-x.eu/services-deliverables/digital-clearing-house/
[162] https://www.fiware.org/catalogue/

as a service. The adoption of such technology by SMEs hinges on perceived added value and the involvement of internal and external data sources. FIWARE's Context Broker and Smart Open Data Models play pivotal roles in this ecosystem, supporting IoT, data management, and open data representation. Furthermore, FIWARE provides a Business Application Ecosystem, CKAN monetisation architecture, and a Smart City architecture for comprehensive data-sharing solutions within and across various sectors and cities.

Digital Europe Programme (DIGITAL) components

As part of the EU Digital Europe Programme (DIGITAL) for the period 2021-2027, the European Commission is actively promoting digitalisation across sectors, particularly focusing on facilitating the establishment of data exchange platforms in compliance with the eIDAS regulation. The Connected Europe Facilities (CEF) within DIGITAL encompasses building blocks like eID and eDelivery, which have been established for over a decade, supporting identity management and secure data delivery. However, the primary emphasis of CEF is on digitising interactions between citizens and administrations, with limited support for B2B use cases. Notably, functionalities aligned with Data Space models, including marketplace features, are currently absent in the centralised metadata handling component of the eDelivery building block. Moreover, in most EU countries, national electronic identification schemes (eIDs) are accessible only for authorities and individuals, not for private legal entities. The eID building block facilitates the mutual recognition of national eIDs across borders, allowing users to authenticate themselves for online services in other European countries. However, these eID tools are intricately linked with national eIDAS structures, requiring coordination with Member State representatives. The eDelivery building block offers technical specifications and standards, along with software and services, to establish a secure network for digital data exchange among public and private organisations. It supports the exchange of structured or unstructured information in messages and can be integrated with Data Space Connectors to connect to federated middleware, aligning with GAIA-X/IDSA/Open DEI concepts. However, limitations exist for use cases involving continuous data flow over extended periods.

Simpl Open[163]

Simpl Open is the technological stack of the Simpl project (funded by the EC). Simpl act as a ‘framework of frameworks’, that will provide federation building blocks allowing interoperability across all other existing technological stacks and components.

Reco 26: All Space Data Space initiatives should leverage existing technological stacks and tools working in other Data Spaces.

10.3.3. Existing Data Space technical standards

The DSSC maintains lists of commonly used standards across Data Space initiatives:

- **Data Interoperability standards and technologies landscape**[164]
- **Data Sovereignty and Trust standards and technologies landscape**[165]

[163] https://simpl-programme.ec.europa.eu/

[164] https://dssc.eu/space/SE1/185794608/Data+Interoperability+standards+and+technologies+landscape

[165] https://dssc.eu/space/SE1/185794711/Data+Sovereignty+and+Trust+standards+and+technologies+landscape

- **Data Value Creation standards and technologies landscape**[166]

Reco 27: All Space Data Space initiatives should adopt existing cross-sector standards already utilised in other Data Spaces.

10.3.4. SDS Sectoral Standards Landscape (SDS-SSL)

Following recommendation of the SDS Brussels Workshop of October 2024, in this Blueprint, **we introduce the first SDS Sectoral Standards Landscape (SDS-SSL).**

This knowledge base will assist the Space Community of Practice in mapping all relevant **space specific data-sharing standards and models**.

All members of the Space Community of Practice—including industry participants, ESA, EUSPA, and ESA/EU member states—are encouraged to contribute ideas and entries to the knowledge base.

The initial version of the Sectoral Standards Landscape (SDS-SSL) can be found in Appendix §15.5. of this document.

[166] https://dssc.eu/space/SE1/185794822/Data+Value+Creation+standards+and+technologies+landscape

11. Roll-out plan

This section does not describe new concepts or tools. It must be seen as a 'How To' for the future consortia willing to create the Space Data Space including the European Space Data Space (ESDS) Coordinating Authority, and the multiple Space Data Space initiatives such as the Civil Security from Space (CSS) Data Space.

Following the elements provided in the Blueprint, the Space Data Space (SDS) should:

- **Develop the governance of the Space Data Space at the sectoral level:**

1. Define the Space Data Space (SDS) **sectoral Mission Statement and scope**.
2. Define the **structure for the SDS Coordinating Authority** (formal legal entity or not). **We propose to name it the European Space Data Space (ESDS)**. (§8.4.2)
3. Define the **relationship between the Coordinating Authority and the multiple Space Data Space initiatives** (from very top-down to bottom-up). (§7.2.1)
4. Define the **Rulebook of the Space Data Space**, that will be inherited by all Space Data Space initiatives. The SDS Rulebook can include technical, legal, business and organisational policies. (§7.2.6)
5. Develop and maintain a **collaborative platform** for the SDS Coordinating Authority.
6. Develop and maintain the **SDS Use Case Radar (SDS-UCS)**. (§14.3)
7. Develop and maintain the **SDS Sectoral Standards Landscape (SDS-SSL)**. (§14.5)
8. Develop and maintain the **SDS Data Ecosystems Catalogue (SDS-DEC)**. (§14.4)
9. Identify **initial sponsors and funding** for the SDS Coordinating Authority (EU, EU/ESA member states, industry players, etc.).

- **Develop Space Data Space initiatives:**

1. **Federate existing Space Data Space initiatives.**
2. **Identify existing data-sharing initiatives/ecosystems from the Space sector that could transition to Space Data Space initiatives** (e.g., CSS Data Space). Run gap analysis and feasibility studies for the creation of Space Data Space initiatives.
3. **Identify new Data Space initiatives opportunities.**
4. For each initiative, **follow the Data Space Cookbook.** (§4.1.7)

Note: The sectoral Coordinating Authority, and multiple Data Space initiatives can be developed simultaneously.

12. Conclusion

The extensive engagement of industry stakeholders over the past year in shaping the *Space Data Space Blueprint* and its use cases should catalyse a collaborative initiative between the European Commission and the European Space Agency (ESA).

- ESA should advance its CSS Programme by developing and implementing a dedicated Data Space for Civil Security from Space.
- The European Commission should support the establishment of a Common European Data Space for Space, integrating various Space Data Space initiatives, starting with the CSS Data Space and expanding to initiatives built around existing programs such as DestinE, Copernicus, and Galileo, as well as new public and private sector initiatives.

The Vision - Unlocking the full potential of European space data: The overarching goal is to create a dynamic, federated network of space data that serves as a strategic competitive advantage for Europe, especially in the context of the race for AI. This initiative will pave the way for a space data Single Market, positioning Europe as a global leader in space data infrastructure. The federated approach outlined in this Blueprint aligns with the EU's robust 2020 data strategy, offering a global alternative to the vendor lock-in, state-centric models prevalent in the US and China.

Why Europe can lead: Several factors support this ambition:

- Progressive legislation on data-sharing, ensuring a regulatory advantage.
- Transformative initiatives like Gaia-X, the DSSC and Simpl, reshaping data governance across industries.
- Europe's proven track record in setting global standards, as seen with GSM.

Expected Outcomes of a Space Data Space:

1. Broaden the customer base for space data.
2. Increase Return on Investment (ROI) for space assets.
3. Enhance coordination of space-related projects.
4. Provide a seamless interface for engaging non-space sectors.

The Role of Key Stakeholders: At the European level, active involvement and financial support from the European Commission (including EUSPA) and ESA are essential. Additionally, EU/ESA member states should play a pivotal role, particularly those already engaged in initiatives like Gaia-X. Finland, Spain, Poland, and Hungary have been strong supporters from the outset, and other countries are expected to join. EU/ESA member states governments should encourage both public and private sector participation to ensure broad adoption.

The Path Forward: To drive success, clear objectives, measurable outcomes, and strong communication will be critical. By uniting efforts across Europe, this initiative will establish a resilient, competitive, and globally influential European Space Data ecosystem.

13. Frequently Asked Questions (FAQ)

This section lists the most commonly asked questions. Some concepts are fairly new and different people may have differing visions of some matters. To build an interoperable federated system, it is paramount all stakeholders have the same answers to the same questions. The answers are State-of-the-Art at the moment of publication.

Q1: What makes Data Spaces unique?
A: Data Spaces stand out due to their governance framework and federation principle. They ensure all participants, including data providers and consumers, have a say in governance, preventing vendor lock-in. Each Data Space remains autonomous while ensuring interoperability with others.

Q2: How do regulations impact Data Spaces?
A: The Data Governance Act and Data Act establish the legal foundation, defining rights and responsibilities for Data Space participants. Other regulations (GDPR, AI Act, etc.) provide additional protections and rules for sharing data.

Q3: How certain is the success of Data Spaces?
A: While the concept is quite new (EU data strategy 2020, Data Governance Act in force since 2023), the European Commission's €10B investment and coordination across 27 countries and 14 sectors provide unprecedented support.

Q4: How many Data Spaces exist today?
A: As of late 2024, +100 Data Space initiatives are in development.

Q5: Don't we already have a wide range of data-sharing standards?
A: Yes, but Data Spaces harmonise standards across sectors, addressing gaps in legal models, governance, and business agreements.

Q6: How do Data Spaces differ from data lakes?
A: Data lakes centralise data for processing, while Data Spaces enable decentralised, governed data-sharing through interoperable frameworks.

Q7: Can a data lake become a Data Space?
A: Yes, a data lake can transition to Data Space. A data lake can participate in a Data Space by providing datasets under agreed conditions.

Q8: Are Data Spaces related to open data?
A: Yes, but they extend beyond open data by enabling controlled and conditional data-sharing of private and commercial data while maintaining data sovereignty. It is to be noted that most Data Space initiatives combine open data and sharing of private data.

Q9: Do all Data Spaces use the same technologies?

A: No, they use a mix of open source digital commons and proprietary solutions, coming from a limited pool of technological players and stacks, facilitating interoperability.

Q10: Are Data Spaces linked to blockchain/Web3?
A: Some explore blockchain for identity, consent, smart contracts, and governance, but it is not mandatory.

Q11: How do Data Spaces enhance interoperability?
A: They enforce standardised data-sharing mechanisms across sectors.

Q12: How do they address governance and compliance?
A: Data owners define access rules collectively, while protocols ensure legal compliance and data provenance guarantees traceability.

Q13: Are Data Spaces marketplaces or data repositories?
A: No, but marketplaces and repositories are common building blocks of Data Spaces.

Q14: Who should initiate a Data Space?
A: Stakeholders with unmet data-sharing needs that current infrastructures do not address.

Q15: Isn't Europe already sharing a lot of space data?
A: Europe leads in Space Open Data, but lags in value-added EO data (14% market share). Space Data Spaces will enable controlled, monetised data-sharing and unlock greater economic value.

Q16: How do Data Spaces relate to existing frameworks like EOP (Earth Observation Programmes)?
A: Data Spaces integrate multi-domain data-sharing to maximise EO data value, complementing rather than competing with EOP.

Q17: Is Destination Earth a Data Space?
A: Not yet. It is currently a data lake, but the European Commission funded a study, as part of Simpl, to evaluate the transition to Data Space with the implementation of the Simpl Open stack.

Q18: Should there be one or multiple Space Data Spaces?
A: Multiple bottom-up initiatives will emerge, but they must remain interoperable and be federated under the Common European Data Space for Space (ESDS).

Q19: What role do Data Spaces play in civil security?
A: They enhance data accessibility, interoperability, and crisis response by enabling seamless, real-time data integration across sectors.

14. Appendix

14.1. Key texts in the context of the Space Data Space

Table 11 - Key texts in the context of the Space Data Space

European strategy for data[167]
The European strategy for data aims at creating a single market for data that will ensure Europe's global competitiveness and data sovereignty. Creating a single market for data will allow it to flow freely within the EU and across sectors for the benefit of businesses, researchers, and public administrations. The strategy contributes to a comprehensive approach to the data economy that aims to increase the use of, and demand for, data and data-enabled products and services throughout the Single Market.
Data Governance Act (DGA)[168]
The Data Governance Act, enacted on May 30, 2022, focuses on enhancing data availability and trust in data intermediaries while strengthening data-sharing mechanisms across the EU. The regulation addresses the re-use of specific protected data held by public sector bodies, encourages neutral data intermediaries to facilitate data-sharing, establishes a harmonised framework for fostering data altruism, and creates the European Data Innovation Board to assist the Commission in regulatory matters. As a key component of the European data strategy, the Data Governance Act aims to boost trust in data-sharing, improve mechanisms for data availability, and overcome technical challenges to data reuse. It also supports the establishment of common European Data Spaces in strategic sectors involving public and private entities. The Act came into force on June 23, 2022, with applicability scheduled from September 2023, following a 15-month grace period.
Data Act (DA)[169]
The Data Act (DA) mandates companies to grant users access to data generated by their IoT devices, extending to individuals or other businesses, and imposes additional data-sharing requirements. Proposed by the Commission on February 23, 2022, the DA aims to establish equitable value distribution in the data economy by introducing new data access and use rights in various sharing contexts. The Act empowers individuals and businesses in their contributions to IoT-generated data, proposing a framework for efficient data interoperability within European Data Spaces. The DA's objectives include fostering fairness, promoting a competitive data market, encouraging data-driven innovation, and enhancing data accessibility. It is anticipated to result in innovative services, competitive pricing for aftermarket services, and improved access to data.

[167] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0066

[168] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0868

[169] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022PC0068&from=EN

General Data Protection Regulation (GDPR)[170]
The GDPR plays a crucial role in regulating personal data-sharing within a Data Space, covering aspects such as consent and influencing the oversight of data-sharing tools by Data Protection Authorities (DPAs) as outlined in the Data Governance Act. It establishes minimum standards for data protection and freedom of circulation across EU Member States and applies to organisations targeting or collecting data related to EU citizens, emphasising privacy and security in the collection, processing, and sharing of personal data. Concerns have been raised during the trilogue phase of the Data Act regarding the clarity of personal data-related issues and alignment between the GDPR and the Data Act, drawing attention from Member States and private organisations.
ESA's GDPR[171]

[170] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679

[171] https://www.esa.int/About_Us/Law_at_ESA/Highlights_of_ESA_rules_and_regulations & https://www.esa.int/Services/Privacy_notice

ESA has its own data protection framework with some Principles of Personal Data Protection, which were adopted by ESA Council on 13 June 2017, while the Rules of Procedure for the Data Protection Supervisory Authority were adopted by ESA Council on 13 June 2017. Additionally, the *Policy on Personal Data Protection* (including its Annex *Governance Scheme of the Agency's Personal Data Protection*) were adopted by ESA's Director General on 1 March 2022 for a duration of four years, unless it is subject to prior revocation or revision as determined by the Director General. This Policy replaces the ancient Policy on Personal Data Protection of 2018.

This Policy protects all personal data, relating to any data subject, whether collected by the Agency or disclosed to the Agency by a third party. The specific provisions set forth in this Policy are without prejudice to the security principles and the security implementation standards, which are laid down in ESA Security Regulations and Directives. The key concept of Data Controller is also large in scope as meaning any natural or legal person who makes the decision, determining the purposes and means, alone or conjointly, to process personal data, or commissions others to process personal data on its behalf. The quality of data controller therefore belongs to ESA itself, not to ESA's Staff Member who is materially involved in the related activities. The quality of Data Controller belongs to the Contractor itself, not to the Contractor Personnel who is materially involved in the related activities.

Considering the foregoing, ESA's Data Protection Policy is therefore wide in its scope covering ESA's internal as well as external personal data processing activities, aimed at achieving ESA's announced goal, which is to "*provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems (as per ESA Convention). We serve the public interest, and we wish to foster the public interest in space activities and programs.*"

E-privacy[172]

The E-privacy Directive was implemented in 2002 and amended in 2009. It is most commonly known as the 'Cookie Law', as it resulted in the requirement of providing consent to the collection of 'cookies. The law supplements the GDPR in dealing with the confidentiality of electronic communication, though the scope of the GDPR is limited to personal data, and the E-privacy directive includes non-personal data. The E-privacy Regulation is set to replace the E-privacy Directive, although approval has been delayed, and it is yet to be put into effect.

AI Act[173]

The Artificial Intelligence Act (AI Act) advocates for a 'risk-proportionate approach',

[172] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-privacy-and-electronic-communications

[173] https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai

requiring organisations involved in AI development to comply with regulations proportional to the risk levels associated with their specific use cases. This risk classification includes high, limited, or minimal risk. As many Data Spaces are incorporating AI technologies, the regulation needs to adapt to their decentralised nature. Notified bodies mentioned in the AI Act will be involved in supervising data intermediaries highlighted in the Data Governance Act. The AI Act establishes an Artificial Intelligence Board (AIB), sharing governance aspects with the European Data Innovation Board (EDIB). The proposal, initiated in April 2021, focuses on the specific use of AI systems and associated risks, providing a risk-based classification. The regulation aims to establish a technology-neutral definition of AI systems, with some presenting 'unacceptable' risks prohibited, while 'high-risk' AI systems must meet requirements for market access. Given the increasing use of AI, including generative models like ChatGPT, in the tourism sector, the AI Act is highly relevant for the tourism Data Space.

Digital Markets Act (DMA)[174]

The Digital Markets Act (DMA) defines objective criteria to identify large online platforms as "gatekeepers," precisely targeting the issues related to such platforms. The Data Markets Act (DMA) extends its focus to big data platforms acting as 'gatekeepers,' potentially affecting certain Data Spaces. It concentrates on their role as intermediaries, introducing obligations to ensure fair competition. These obligations may include enabling third-party interoperability, granting business users access to data generated through gatekeepers' services, and providing tools for companies to verify their advertisements hosted by gatekeepers. In essence, the regulation establishes new rules for data-sharing by gatekeepers, directly influencing the operations of specific Data Spaces.

Digital Services Act (DSA)[175]

The Data Services Act (DSA) aims to regulate all digital services, including social media, online marketplaces, and other platforms in the European Union. It introduces binding and harmonised EU-wide obligations affecting a broad range of digital services connecting consumers to goods, services, and content. The DSA aligns the legality standards online with offline, imposing new obligations on service providers and online platforms. These obligations include measures to prevent illegal content, enhance traceability and accountability for online marketplaces, and increase transparency in content moderation and algorithms. The DSA also addresses misleading practices and dark patterns. The regulations outlined in the DSA may directly impact various use cases within Data Spaces.

Interoperable Europe Act (IEA)[176]

174 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/digital-markets-act-ensuring-fair-and-open-digital-markets_en

175 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/digital-services-act_en

176 https://www.consilium.europa.eu/en/press/press-releases/2024/03/04/interoperable-europe-act-council-adopts-new-law-for-more-efficient-digital-public-services-across-the-eu/

The Interoperable Europe Act (IEA) aims to facilitate the development of a network of interconnected digital public administrations in Europe, expediting the digital transformation of the European public sector. By influencing data-sharing practices and standards through procurement, the public sector's role is integral in shaping broader data governance practices. The IEA, focusing on business-to-government (B2G) data-sharing, outlines specific rules and establishes the Interoperable Europe Board (IEB) as a dedicated governance body. Ensuring synergies and coherence between IEB and the European Data Innovation Board (EDIB) is deemed crucial. The proposal for the Europe Interoperability Act was submitted by the Commission in November 2022, aiming to foster a consistent, human-centric EU approach to interoperability across policymaking and implementation. The Act introduces a cooperative EU framework for public administrations to collaboratively build seamless and secure cross-border data exchange for public services, fostering shared interoperability solutions.

Digital Decade

The Digital Decade policy programme sets up a monitoring and cooperation mechanism to achieve the common goals and targets for Europe's digital transformation by 2030. It also introduces multi-country, large-scale projects to achieve these digital goals and targets. The Digital Decade introduces the framework of European Digital Infrastructure Consortia (EDIC). The EDICs are intended to support the implementation of the common European Data Spaces by sector.

European Digital Infrastructure Consortia (EDIC)

With the *DECISION (EU) 2022/2481 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL* of 14 December 2022 establishing the Digital Decade Policy Programme 2030, the EU has created the legal framework for an EDIC. This framework is designed to facilitate Multi-Country Projects within the EU. An EDIC is an international organisation, and as such, a legal entity subject to European law and to the national law of the Member State where the seat of the EDIC is located. The EU Member States that are members of an EDIC are expected to provide at least parts of the financial and in-kind contributions. Its lifetime can be unlimited or limited. The internal organisation can be designed according to the members' joint decisions, and it can apply for EU funding, hire staff, purchase goods or engage contractors (e.g. for hosting an IT platform). An EDIC can ensure debt and the liability of the EDIC's members is by default limited to their respective contributions. In addition, it may pursue non- commercial or commercial activities. An EDIC can accept private members, but their ultimate impact on the evolution of the consortium is limited, since the statutes confer the majority of voting rights to the Member States represented in the EDIC. Concerns have been raised about the potential delays in decision-making and operational inertia resulting from the primacy of Member States' voting rights.

High Value Datasets

The Open Data Directive, in effect since July 16, 2019, replaces the Public Sector Information (PSI) Directive and regulates the reuse of publicly available information held by the public sector. While acknowledging the existence of protected data such as

personal and commercially confidential data, the Directive aims to facilitate the extraction of valuable knowledge from such data without compromising its protected nature. The Directive is complemented by the Data Governance Act (DGA), which provides rules and safeguards for the reuse of protected data when permitted by other legislation. On January 20, 2023, the European Commission published a list of high-value datasets that public sector bodies must make available for reuse, free of charge, within 16 months. The Open Data Directive strengthens rules on formats, enabling diverse reuse scenarios, including real-time dynamic data, and the EC has recently released specific high-value datasets (HVDs) along with guidelines for their publication and reuse.

NIS2 Directive[177]

The Network and Information Systems Directive (NIS2 Directive) or Directive (EU) 2022/2555 is an EU legislation aimed at improving the security and resilience of network and information systems in the EU. It establishes requirements for the management of cybersecurity risks, including the identification of critical infrastructure, risk management measures, and incident reporting. The NIS2 is an update to the NIS Directive that expands its scope to include new sectors and services, introduces harmonised security requirements for operators of essential services and digital service providers, enhances cooperation and information sharing, and introduces stronger enforcement measures and sanctions for non-compliance.

Regulation on the free flow of non-personal data[178]

Regulation (EU) 2018/1807 on the free flow of non-personal data aims to remove barriers to the free flow of non-personal data within the EU. It applies to all non-personal data stored or processed electronically, regardless of the sector. It prohibits data localisation requirements, unless they are justified on grounds of public security in compliance with the principle of proportionality. The Commission has published informative guidance to offer businesses greater clarity on how to manage data across borders.

eIDAS

Regulation 910/2014 on electronic identification and trust services for electronic transactions in the internal market (eIDAS)

E-Commerce Directive

Directive 2000/31/EC on certain legal aspects of information society services, in particular electronic commerce, in the internal Market.

Platform-to-Business Regulation

Platform-to-Business Regulation (EU) 2019/1150 of the
European Parliament and of the Council of 20 June 2019 on promoting fairness and

[177] https://www.enisa.europa.eu/topics/cybersecurity-policy/nis-directive-new

[178] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R1807

transparency for business users of online intermediation services.
Specific national regulations
Specific national regulations play an important role in the definition of data-sharing rules of Data Space initiatives. Rules emanating at the national level can be sectoral or cross-sectoral.

14.2. Relevant programmes and resources in the context of the Space Data Space

Table 12 - Relevant programmes and resources in the context of the Space Data Space

Towards a Common European Data Space[179]
With this Communication, the Commission proposes a package of measures as a key step towards a common Data Space in the EU - a seamless digital area with a scale that will enable the development of new products and services based on data.
Digital Europe Programme[180]
The Digital Europe Programme aims to bring digital technology to businesses, citizens and public administrations. The Digital Europe Programme will provide strategic funding to answer these challenges, supporting projects in five key capacity areas: supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring a wide use of digital technologies across the economy and society, including through Digital Innovation Hubs.
European Digital Identity Framework[181]
The Framework for a European Digital Identity is an initiative by the European Commission aimed at creating a secure and interoperable digital identity for EU citizens, residents, and businesses. The framework was introduced in June 2021 and is part of the European Commission's broader vision of a European Digital Single Market. The European Digital Identity Framework is established in Regulation (EU) 2021/694. The regulation aims to enable individuals and businesses to easily and securely access online services, regardless of their country of origin.
Guidance on sharing private sector data in the European Data Economy[182]

[179] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0232&from=EN

[180] https://digital-strategy.ec.europa.eu/en/activities/digital-programme

[181] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-digital-identity_en

[182] https://digital-strategy.ec.europa.eu/en/news/staff-working-document-guidance-sharing-private-sector-data-european-data-economy

Drawing from the principles identified in the communication *Towards a Common European Data Space*, this Staff Working Document aims to provide a toolbox for companies that are data holders, data users, or both. For this purpose, it contains a How To guide on legal, business, and technical aspects of data-sharing that can be used in practice when considering and preparing data transfers between companies coming from the same or different sectors.

14.3. SDS Use Cases Radar (SDS-UCR)

Table 13 - SDS Use Cases Radar (SDS-UCR)

Usage scenario/use case	Links to Data Spaces from other sectors
Digital Twins Earth, Smart Cities, Smart Building, Ocean, Energy, Forest	Energy, Smart Cities, Smart Building, Sea activities, Forestry, automotive, media
Risk assessment	Finance, Agriculture, Energy, Smart Building, Smart territories
Climate risk management	Green Deal, Finance
Exposure and vulnerability mapping	Digital Territories, Smart building, Agriculture
Natural hazards like floods, drought, harsh weather, forest wildfires	Digital Territories, Agriculture, Forestry
Estimation of emission GHG reductions	Green Deal
Results-based climate financing	Finance
Climate change scenarios	Green Deal
Climate Change Adjustments for detailed engineering design	Green Deal, Smart Building
Interventions in areas with limited access	Digital Territories, Security
Instability factors, crisis, socioeconomic trends	Digital Territories, Security
Early warning decision support for crisis	Digital Territories, Security
Monitoring of illegal resources exploitation	Digital Territories, Security, Customs
Monitoring of the evolution of structures and urban extent	Digital Territories
Urban planning & land administration	Digital Territories, Agriculture

Urban transport	Digital Territories, Mobility
Urban environment & health	Digital Territories, Health
Urban climate resilience	Digital Territories, Green Deal
Marine ecosystem protection	Sea activities
Water quality & pollution	Sea activities
Maritime disasters	Sea activities
Consequences of a warming in sea	Sea activities, Green Deal
Shoreline and riverbank erosion	Sea activities
Impact of port infrastructure	Sea activities, Digital Territories, Smart building
Improving green policy decisions	Green Deal
Support energy communities	Energy
Resilience of critical energy infrastructures	Energy, Finance
Tourism flows	Tourism, Mobility
Preservation of natural resources and historical sites	Tourism, Green Deal, Cultural heritage
Resource and infrastructure management	Smart Territories, Smart Building
Telemedicine	Health
Pollution and health (air quality, water, heat waves)	Health, DS Smart City, DS Sea Activities
Virus and pandemic tracking	Health
Food security (including soil moisture)	Agriculture
Agriculture yield management & monitoring	Agriculture
Illegal landfills	Green Deal
Industrial and natural carbon capture & storage	Green Deal, Agriculture, Sea activities
Biomass monitoring (algaes)	Green Deal, Agriculture, Forestry, activities
Deforestation	Green Deal
Marine litters	Sea activities

14.4. SDS Data Ecosystems Catalogue (SDS-DEC)

Table 14 - SDS Data Ecosystems Catalogue (SDS-DEC)

Name of platform/ ecosystem	URL
Destination Earth	www.destination-earth.eu
Copernicus	www.copernicus.eu
Global Development Assistance (GDA)	https://gda.esa.int/
Civil Security from Space (CSS)	https://connectivity.esa.int/civil-security-space
ESAC Science Data Centre (ESDC)	https://www.cosmos.esa.int/web/esdc
Open science Catalogue	https://opensciencedata.esa.int/
Database and Information System Characterising Objects in Space (DISCOS)	https://discosweb.esoc.esa.int/
PSID	https://connectivity.esa.int/projects/psid
UK Earth Observation Data Hub (EODH)	https://eodatahub.org.uk/
WASDI	https://www.wasdi.cloud/
Space Data Marketplace (CNES)	https://www.space-data-marketplace.eu/
SPACE4GEO Alliance	www.space4geo.eu
Domino-X	https://domino-x.space/
MESEO	https://meseoproject.eu/
OCAI	https://ocai.space-codev.org/
BeOpen	https://beopen-dep.eu/about/
Open Maps for Europe 2 (OME2)	https://eurogeographics.org/news/project-launched-to-prototype-large-scale-high-value-pan-european-datasets/
Cooperants	https://cooperants.de/en/
UK EO Hub	https://eodatahub.org.uk/
New Space Portugal / Digital Planet	https://www.newspaceportugal.org/en/atividades/digital-planet

14.5. SDS Sectoral Standards Landscape (SDS-SSL)

Table 15 - SDS Sectoral Standards Landscape (SDS-SSL)

Name	Publisher	URL
CEOS-ARD Framework	CEOS	https://ceos.org/ard/
EARSC EO Industry Certification Scheme guideline document	EARSC	https://earsc.org/wp-content/uploads/2021/04/EARSC-Certification-documents.pdf
OGC Standards (incl community standards like STAC, openEO)	OGC	https://www.ogc.org/publications/
ECMWF Harmonised Data Access	ECMWF	https://github.com/ecmwf/hda
PROV-O	W3C	https://www.w3.org/TR/prov-o/

14.6. Attendees of the ESA-ESPI 2023 Workshop in Torrejón

22–23 November 2023
Hosted by the EU Satellite Centre – Torrejón de Ardoz, Madrid (Spain)

- **Working Group 1**

Moderator: Olivier Dion, CEO, Onecub

Co-moderator: Bianca Hoersch, Chief Digital Officer, ESA

Participants: Carmen Aguilera Rios, Head of Section Operational Market Development & Safety Critical Applications, EUSPA; **Sergio Albani,** Head of RTDI Unit, EU Satellite Centre; **Pablo Alonso Garcia,** IE Business School; **Emin Allagui,** Senior Specialist Sales and Business Development, SES Techcom; **Joanna Baksalary,** Head of the Space Area, ITTI; **Steve Bochinger,** Executive Advisor Space & High-Tech Sectors, Euroconsult; **Weronika Borejko,** Project Manager, EARSC**; Arnaud Cauchy,** Digital Transformation Officer, Airbus Defence & Space; **Laetitia Cesari,** Lawyer, De Gaulle Fleurance & Associés; **Juan Antonio de la Torre Valentín,** Head of the Systems and Infrastructure Unit, Spanish National Security Department; **Lars Edgardh,** Co-founder, Spacemetric; **Carles Franquesa,** Founder, Aistech Space; **Leandro Fuentes Martín,** EUROSUR National Coordination Centre – Coordination Centre for Maritime Surveillance of Coasts and Frontiers, Guardia Civil; **Quentin Gillet,** Strategic Account Manager – Government Solutions Europe, ICEYE; **Luis Mariano González Casillas,** Payload Data Processing & Applications Business Unit Director, GMV; **Andreas Kaljord,** Director Earth Observation, Kongsberg Satellite Services – KSAT; **Jérémie Majerowicz,** Senior Solution Engineer – European National Government Team, ESRI; **Pierre-Philippe Mathieu,** Implementation Manager of ESA Civil Security from Space Programme, ESA; **Isidoros Monogioudis,** Project Officer Information Technologies,

EDA; **Jakub Ryzenko,** Head of Crisis Information Centre, CIK; **Irene Saiz Briones,** Junior Research Fellow, ESPI; **Graham Turnock,** Special Advisor, ESA.

- **Working Group 2**

Moderator: Emmanuel Mondon, Co-founder and Member of the Management Board, Space Cooperative Europe

Co-moderator: Michela Corvino, Earth Observation Security Applications Engineer, ESA

Participants: Ulrich Ahle, CEO, Gaia-X Association; **Berylia Bancquart,** Strategy Analysis Officer, ESA; **Robert Bielecki,** Co-founder and CTO, FACTiven; **Laure Brooker,** Proposal and Study Manager, Airbus Defence & Space; **Gordon Campbell,** Head of Enterprise Earth Observation Data Applications Division, ESA; **Matteo Carucci,** Head of Data & Analytics, Eutelsat Group; **Enrique Fraga,** Space Systems EST General Manager, GMV; **Ludek Kuhr,** CEO, BizGarden; **Christine Leurquin,** Director of Strategy for European Institutions, Belgium and Luxembourg, RHEA Group; **Aurelio Martí Ferrer,** Business Development Director, Open Cosmos; **Silvia Mediavilla,** Global Account Manager, International Public Sector, EU Agencies, Vodafone Business International; **Andrea Éva Nemes, Diplomat,** Department for Space Policy and Space Activities, Ministry of Foreign Affairs and Trade of Hungary; **Adrien Pain,** Business Developer, CS Group; **Andreas Papp,** Consultant, Andreas Papp Consulting; **Romain Poly,** Director, Innovation Management, Kongsberg Satellite Services – KSAT; **Irene Pujol,** Project Coordinator, IE Business School; **Franck Ranera,** Senior Manager Government Solutions Europe, ICEYE; **Alberto Rueda Carazo,** Research Fellow, ESPI; **Heriberto Saldivar,** Head of Strategy Department, ESA**; Anna Samsel,** Deputy Head of Unit – Space Data Economy and International Cooperation, DG DEFIS; **Juan Carlos Sánchez Delgado,** Deputy Director and Director for Security and Planning, Spanish Space Agency; **Nicolas Saporiti,** CEO, Geo212; **Isabel Vera Trallero,** Space Project Manager, INTA; **Elodie Viau,** Head of Spacecraft and Systems Engineering, Airbus Defence & Space; **Terence Wall,** Security Programme Team, World Customs organisation.

- **Working Group 3**

Moderator: Eric Pol, Chairman, aNewGovernance

Co-moderator: Isabelle Duvaux-Béchon, ESA

Participants: Mathieu Bataille, Research Fellow, Lead on Security & Defence, ESPI; **Liz Brandt,** CEO, Ctrl-Shift; **Anatole Deligant,** PeaceEye Project Manager, Spatial Services; **James Francis,** Research Intern, ESPI; **Krzysztof Getko,** Product Manager, CloudFerro; **Marc Lafitte,** Section Head – Satellite Imagery and Geospatial Information, IAEA; **Philippe Lattes,** President & Co-founder, LEOBLUE; **Pierangelo Lombardo,** Senior Data Scientist, Eutelsat Group; **Nadia Maaref,** Director, TEKEVER; **Uwe Marquard,** Key Account Manager, T-Systems International; **Federico Milani,** Deputy Head – Data Policy and Innovation Unit, DG CONNECT; **Antoni Miś,** Operational Support Officer, OSCE; **Alberto Palomo,** Chief Data Officer, Spanish Government; **Rubén Pérez,** Business Development Manager, RHEA Group; **Juhapekka Ristola,** Senior Advisor, Sitra; **Rosario Ruiloba,** Vice President of Business Development, Unseenlabs; **Almudena Sánchez González,** Business Development Executive, GMV; **Sebastien Tailhades,** Managing Director, OHB; **Cécile Théard-Jallu,** Associate, De Gaulle Fleurance & Associés; **Christopher Topping,** Civil Security from Space Programme Manager, ESA; **Frédéric Tourret,** CEO, FACTiven;

Marie-Françoise Voidrot, Director, Collaborative Solutions and Innovation Program, Open Geospatial Consortium; **Grzegorz Wrochna,** President, Polish Space Agency.

14.7. Summary of the ESA-ESPI 2023 Workshop in Torrejón

Summary of the SDS 2023 kickoff in Madrid

Day 1

Session 1: Space Data Space for which objectives?

Group 1

- Use cases identified:
  - Monitoring of crowds
  - Terrestrial Situational Awareness for crisis management
  - Precision farming linked to food security
  - Borders monitoring
- Identification of space data as the only available source for some of the user cases
- Identification of the need for fusion with other available sources like CCTV
- Users expect information not data

Group 2

- Interoperability as a Core Principle: It is agreed that the Space Data Space should not function as a centralised platform; instead, it should facilitate interoperability among data owners and solution providers, ensuring seamless exchange and utilisation of data.
- The group highlighted three main use-cases: flood pre-warning systems, which utilise data modelling for early alerts; customs and border monitoring; and conflict analysis through satellite imagery to objectively verify on-ground incidents, aiding in the planning and execution of humanitarian interventions.
- Enhanced Data Integration for Comprehensive Spatial Analysis: The potential to transcend traditional open and public data limits by integrating space data with diverse sources such as human intelligence and location-based services (GSM/GPS), fostering collaboration among various stakeholders. This holistic approach, which includes ground infrastructure, can significantly amplify the efficacy and application of space data in areas ranging from rural development to emergency response, creating a robust and versatile data ecosystem.
- Barriers in Commercial Space data-sharing: Significant economic and governance barriers impede the free sharing of commercial space data, stemming from its high value, financial sustainability challenges, and the need for a clear framework that balances proprietary rights with the benefits of broader data accessibility.

Group 3

- Many potential use cases were identified. Two were selected (flood management; health and pollution) because they encompassed the different challenges that can be addressed by the establishment of a Space Data Space: type of operators; type of data; going beyond open and space data.

- The Space Data Space aims to contribute to activities across the whole life cycle of emergency management (from prevention to recovery).
- Debate on what a Space Data Space is: Horizontal? Vertical? Component of a system-of-systems to combine its products with products from other Data Spaces?
- Space Data Spaces should not be thought of as a centralised platform; it requires interoperability between data owners and solution providers.
- There is a need to be efficient in data search, to ensure reliable access to data, and to create trust towards the data exchange processes.
- Providing opportunities to all to develop and/or use services and products. In this context, the establishment of a Space Data Space should contribute to a sustainable and resilient ecosystem, both from a service and business perspective.

Session 2: Which governance for the Space Data Space?

Group 1

- Two types of stakeholders where named: data providers and data consumers
- A need for a governance body was identified The need for a legal entity was discussed, although no agreement was reached for this matter.
- A need for accreditation/credentials for the data was recognised.
- The ecosystem of Space Data Space for security was identified to be highly shaped by public actors. In the security domain there is a key role played by public players and specifically national Governments. They are deemed to be a key stakeholder although it was observed that the coordination should be performed at a European level.

Group 2

- Institutional vs. Commercial Data: Institutional data is publicly funded and not free, while commercial data, aimed at generating revenue, brings into question the balance of data-sharing and selling within the Space Data Space.
- Data Storage and Cloud Providers: Cloud providers are crucial to the Space Data Space for data storage, with their willingness and cost structures greatly affecting data governance.
- Banking Analogy for Trust: Utilising the SWIFT model from banking as an analogy, where it serves as a trusted intermediary for secure financial communications, could inform the development of trust-building mechanisms within the Space Data Space.
- Top-Down vs. Bottom-Up Approaches: While recognising the predominance of top-down approaches, there is value in considering bottom-up contributions from users to shape the Space Data Space's development.

Group 3

- A dedicated governance scheme is compulsory given the variety and multiplicity of actors involved. The processes should be clear for all stakeholders from the start.
- Private actors will not provide their data if they do not have incentives (e.g. monetary, fair credit, access to data or information). The design of the economic model of the Space Data Space will have to take into account the specific concerns of both providers and users.

- The objective of the Space Data Space is to help facilitate access to space data. To this end, existing governance schemes for other Data Spaces can prove useful sources of best practices.
- Data Space is not a new infrastructure, but rather a framework to standardise data-sharing.
- Optimise and analyse the requests of users in order to adapt the offer.
- Access to all data must be assured, but in terms of certification practices, users should be able to identify which sources are certified and which ones are not.

Session 3: Connecting the Space Data Space with third parties, existing Space projects and other Data Spaces

Group 1

- There is a series of relevant space activities like Copernicus Contributing Missions (CCM), Copernicus Data Space Ecosystem (CDSE), and also defence capabilities.
- The key role of service providers - Copernicus Emergency Management Services (CEMS), SatCen and EMSA- are currently acting as data integrators and providers for civil security users.
- The commercial world is already taking onboard the Copernicus system, meanwhile there is a lack of integration of non-space private data to complement the EO data.
- From a technical perspective, the satcom may offer rapid access to data for civil protection.
- There is a need for further education of the end-users based on specific use cases.
- Currently data within individual sectors is being gathered and shared. There was a need spotted for the introduction of space data as an added value to the needs of other sectors (for example agriculture).

Group 2

- Space projects to support Space Data Space: Copernicus Data Space ecosystem, Atlantic Constellation project as a tri-nation initiative, NATO APSS, Destination Earth, and Govsatcom hub for enhanced data services.
- Identification of existing or emerging Data Spaces include Tourism, Circular Economy, Green Deal, Finance, Agriculture, Energy, Health (Telemedicine), and Mobility.
- KPI to include web analytics, frequency of Space Data Space mentions in publications, trend analysis pre- and post-Space Data Space implementation.
- Three Success Factors for Space Data Space: 1) Quantifying new services utilising space data; 2) Evaluating stakeholder engagement by their numbers and derived value, alongside the impact on end-users; 3) Assessing data-sharing effectiveness through the availability and willingness of sources to share.
- Adoption of Objective Key Results (OKRs) over traditional KPIs is recommended for a holistic assessment of efforts in establishing the Space Data Space community, focusing not just on metrics but also on strategic execution.

Group 3

- Providers of the Space Data Space will be ESA, EU and Member States organisations and services. Access to the Data Space will be open beyond the EU and European boundaries, if governance allows and if they respect the established criteria.
- Interoperability: definition of a set of standards to interact within and between (Space) Data Spaces
- Participation in the Data Space is voluntary, but not adopting the standards and best practices can have consequences in terms of competitiveness vis-à-vis other actors
- Data Space is not a data lake, rather it should be conceptualised as a federated data catalogue and a 'signposting' tool.
- Increased need to establish awareness and understanding that "open" data is not necessarily 'free' data.
- Raw data will be referenced/catalogued in, and accessible through, the Space Data Space. This remains open to discussion for added-value data. Notifications can be created to inform about the availability of new data.
- The Space Data Space should be able to interact with other Data Spaces. For instance, in the case of floods, other Data Spaces of interests could be: In situ, Drones, Infrastructures, Social data, Mobility

Open questions

- Should we have Data Space integrating only space data? A space Data Space per provider? In short, should we have one or a network/federation of Space Data Space(s)?
- What are the specificities of a Space Data Space (if any) compared to other Data Spaces?
- What are other incentives to engage with other providers and expand the network?
- Is a Data Space a marketplace? Or a repository of data?

14.8. Community work SDS-Next - Use Case #1 Natural Disasters

How space data helps

BEFORE: Satellite images facilitate the detection and monitoring of areas at risk of floods. For example, satellites can detect high waters, as well as weather (precipitation) forecast. Satellite imagery can also help mitigate the damage caused by floods by identifying people and assets at risk. They can give early warning.

DURING: Satellites can inform targeted responses by enabling the determination of the spread direction, updated forecast or cloud analysis.

AFTER: Satellite imagery can help to determine priorities in reconstruction, damage assessment, potential works to mitigate future risks.

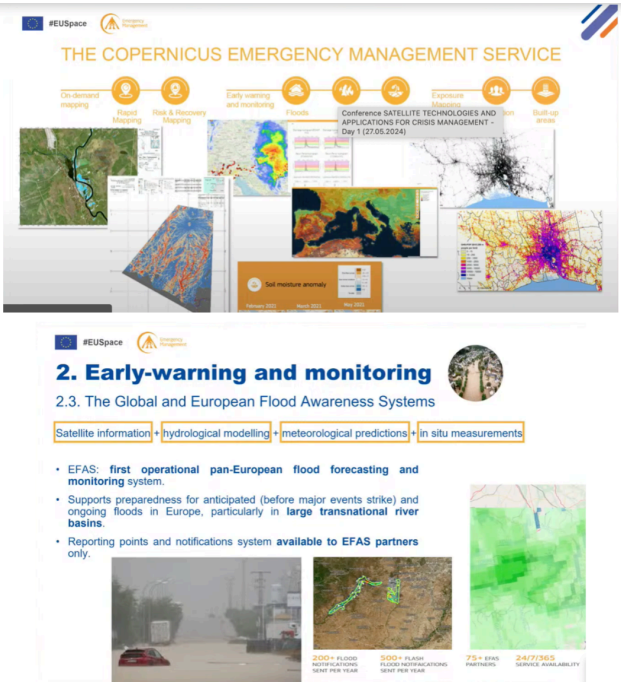


Figure 51 - How Data Spaces help for Natural Disasters use case

Context description template

How to use this template

1. Start by describing the current situation and how this results in a opportunity or challenge for your organisation
2. Describe how data sharing can address the opportunity or challenge. Keep the use case description short and focus on the impact of the use case
3. Look in the appendix for examples of completed templates for DSC use cases

Use case name:	UC1 Natural Disasters
Describe the current situation:	Crisis decision making needs actionable information from many different sources. Space data is not always interoperable (position, image, weather forecast, wind force and evolution...) or needs rework. This creates problem as time to information is critical. Another issue is the age of the information: In an on-going forest fire, an image 8 hours old is of no use to deploy assets, ensure the security of responders or decide evacuation of civilians.
Describe the opportunity or challenge:	Ensure accessibility to near real time data through multiplication (and synchronisation) of sources + Gateways which could format sources according to user defined incident criteria and parameters. This would reduce time from data transmission to decision making
Which of these categories matches your opportunity or challenge:	■ Automation of certain (repetitive) tasks ■ Difficulty in assessing certain risks due to a lack of information ❑ Other: ... ■ New insights enabling new value propositions ❑ Inefficiency in a value chain
Describe how data sharing can address the above situation:	Data sharing along interoperable standards and geo-mapping can give natural disasters command centres directly actionable information. No need to rework data to ensure interoperability, or to analyse pictures or GPS positioning of assets: They appear on the site map. Since the mapping is pre-determined, near real time can be enabled by activating different satellites (from public and private sector) to increase coverage frequency. Automation is ensured by automated contracts checking authorisations, and ensuring each data sharing follows the data space governance (eligibility, confidentiality...). This use case can be developed in stages, the ultimate one being a gateway where the crisis responders determine their criteria (including geographic imprint) and the type of information needed, but can also receive available information for the zone they may not be aware of.

Figure 52 - Context description for Natural Disasters use case

Potential template

How to use this template

1. Describe the potential value for the Entitled party first, as without sufficient potential value the Entitled party will not participate in the use case
2. Complete the table for the other roles with a score as shown in the legend
3. Score the potential of this use case on societal impact
4. Conclude on the potential value by adding up the scores per role. As a rule of thumb, every role in the use case should have at least 2 points (excluding societal impact)
5. Complete the template for the actors separately if you have very different actors per role
6. Look in the appendix for examples of this template
7. Interview stakeholders to validate the result of the template if necessary

Note: The goal of this template is to consider potential value from perspective of different roles. The scores only offer an indication, as they are subjective

Use case name:	UC1 Natural Disasters
What is the potential value for the Entitled party?	I am not sure who the entitled party should be. As for data consumer, understood as crisis management center: systematic, NRT and real time data to be able to predict, react and assess different kinds of disasters.
For the Entitled party, does the potential value outweigh the perceived risk associated with sharing data?	Yes / ~~No~~

Legend:
High = 2
Low = 1
None = -

	Questions to answer to assess potential value for Data service provider(s), Data service consumer(s) and Enabling party/ies	Data service provider(s)	Data service consumer(s)	Enabling party/ies
Potential revenue increase	Is there potential for extra revenue from new or improved products or services?	2	-	2
	Is there potential for extra revenue from improved customer relation?	2	-	2
	Is there potential for extra revenue from transaction fees from revealing data?	2	-	2
	Is there potential for extra revenue from other sources?	-	-	-
Potential cost reduction	Is there potential for cost reduction due to improved internal efficiency?	1	2	1
	Is there potential for cost reduction due to improved risk management?	-	2	-
	Is there potential for cost reduction from other sources?	-	-	-
Other	Contribution to strategic objectives, part of obligations or ethical branding	-	-	-
	Total per role	7	4	7
Potential societal impact	What is the potential societal impact? This includes many topics, examples are improving sustainability, improving health, reducing poverty, increasing equality or contributing to a more circular economy	–		

Figure 53 - Potential for Natural Disasters use case

Interaction complexity template

How to use this template

1. Start with the results from the Use case scoping step in mind
2. Mark the level of interaction complexity for all 5 questions in the table
3. Take the average the 5 answers to get the final score of the assessment
4. Use this score to estimate what facilities are needed to establish trust and interoperability. A high score means that more extensive facilities are need to arrange the necessary trust and interoperability in the use case
5. Look in the appendix for examples of completed templates
6. Interview stakeholders to validate the result of the template if necessary

Note: The goal of this template is to consider interaction complexity from different perspectives. The scores only offer an indication, as they are very subjective

Use case name:	UC1 Natural Disasters

The two factors	**Questions per driver**	**Per question select the answer corresponding to the use case situation**		
		Low interaction complexity	Medium interaction complexity	High interaction complexity
Actor complexity	What is the number of actors involved in the use case?	Few actors		Many actors
	What degree of competition is there between the parties involved that is relevant for this use case?	No competition		Major competition
	If different actors fulfil the same role, how different are these actors?	Very similar / Not applicable		Very different
Data complexity	How different are the types of data shared in your use case?	One type		Many types
	How sensitive is the data being shared for your use case?	Not sensitive		Highly sensitive

Figure 54 - Interaction complexity for Natural Disasters use case

14.9. Community work SDS-Next - Use Case #2 Drivers for Migration

- **Block 1 - Mapping of resources (water, food, minerals):**

Migration often stems from significant events, with natural resource conditions being a key driver. Resources, classified as biotic (from living sources like forests) or abiotic (from non-living sources like water and minerals), vary by renewability and location—some are surface-based while others lie underground. Their interdependence, such as plants and animals relying on water and land, adds complexity to resource mapping and influences migration patterns. Monitoring these dispersed and varied resources requires adaptable tools. Remote sensing, especially satellite imagery, enables large-scale observation, supplemented by alternatives like balloons, aircraft, and UAVs for more detailed or flexible monitoring. In-situ data from sensors, such as water quality measurements, along with physical sampling (e.g., drilling, coring), provide additional insights. Integrating these diverse data sources into a centralised Data Space enhances the efficiency and effectiveness of resource mapping.

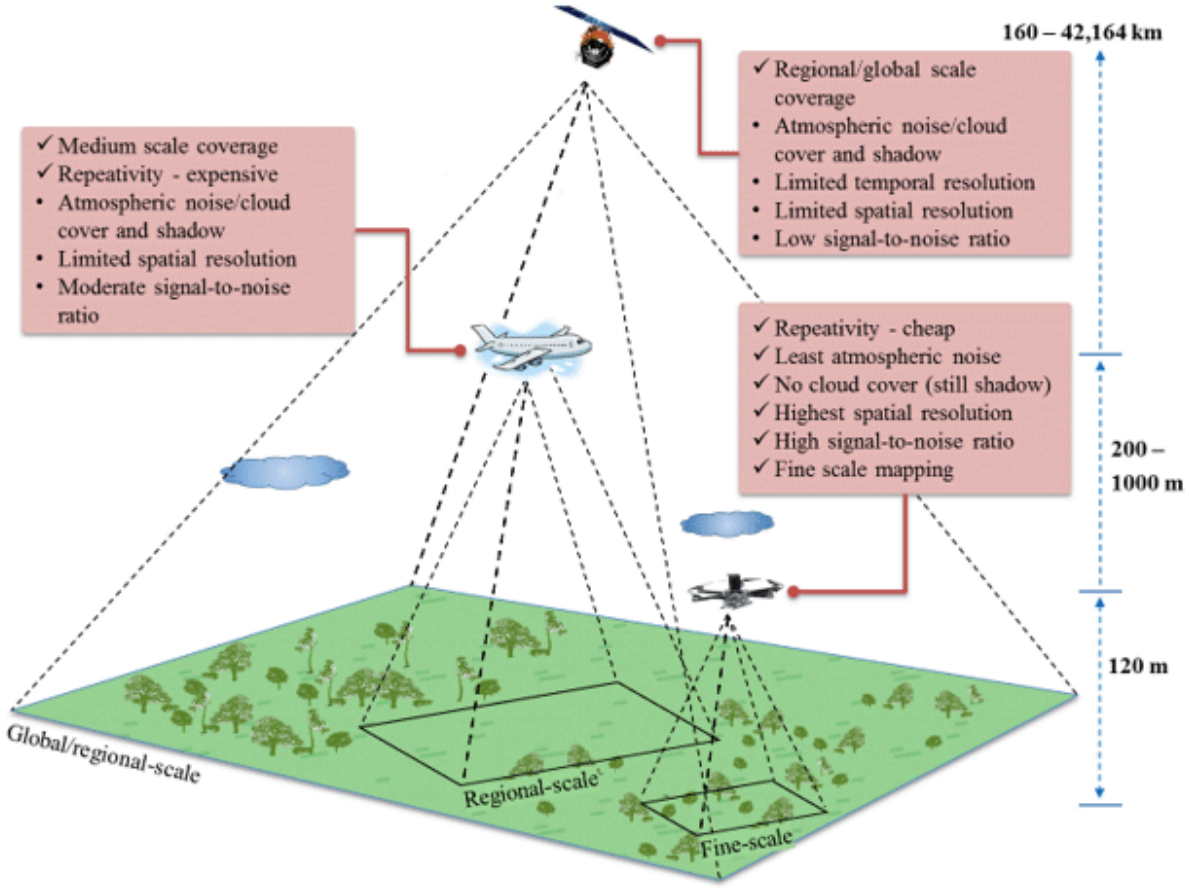


Figure 55 - Comparison of satellite, airborne and unmanned aerial vehicle (UAV) remote sensing systems for environmental monitoring applications

Monitoring resources is increasingly complex due to external pressures like overpopulation, overconsumption, environmental degradation, and climate change, all of which intensify resource demand and scarcity. Economic practices, technological extraction, political issues, and lack of awareness further complicate sustainable management, while industrial and agricultural activities strain resources. Effective mapping relies on diverse data sources (remote sensing, in-situ sensors, etc.) and requires adaptable models, as climate-linked events render historical data less predictive. AI can process real-time data for evolving conditions, though it needs extensive datasets for accuracy. Initiatives like CS Sopra Steria's France 2030 water monitoring program illustrate how Data Spaces can consolidate data sources, offering public authorities insights for better resource management and more precise forecasting by integrating external impact factors.

- **Block 2: Mapping of infrastructures**

Inadequate socio-economic infrastructures and services can be a push-factor for migration, as well as it can dissuade people from returning to their home. The mapping of strategic infrastructures such as roads, border control sites, or health facilities, etc. is a means to better understand the migration context and environment people evolve in.

Infrastructure data integrates diverse sources (OSM, Wikimapia, Geo212 data, UN, field reports, press, and satellite imagery) and can be cross-verified with human and field data from humanitarian and on-the-ground actors. A detailed data model will be developed in collaboration with partners in the Dataspace, including other service developers and end-users, covering layers such as roads, main tracks, towns, hamlets, refugee camps, health facilities, and security posts, including borders, walls, and fences.

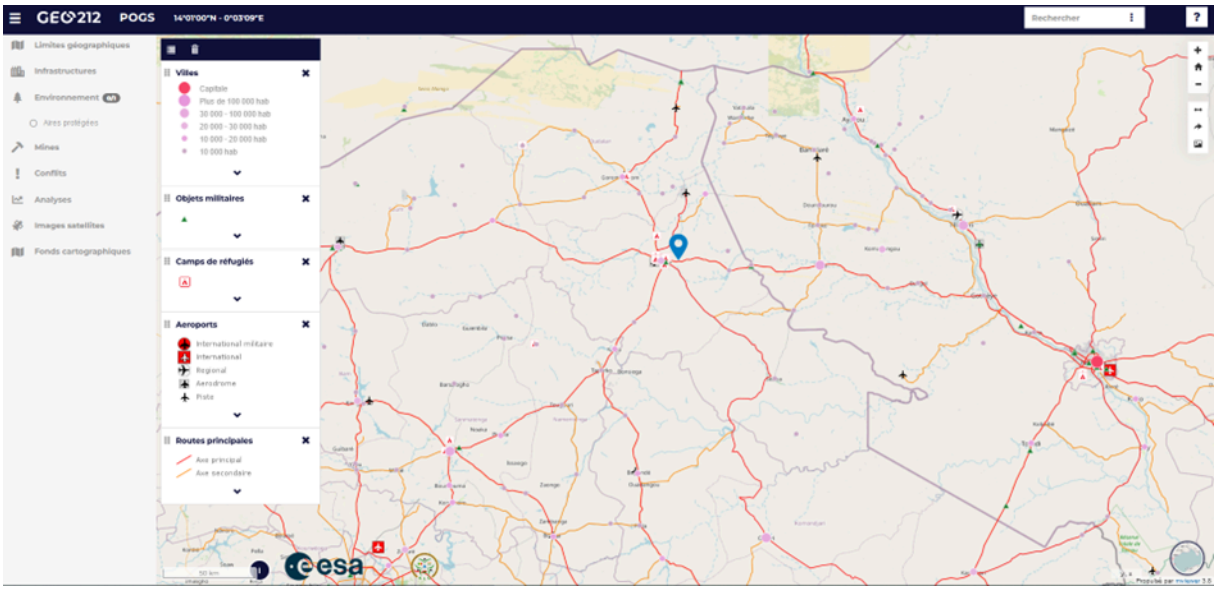


Figure 56 - Geographic picture of the Liptako Gourma region
Source: WebSIG powered by Geo212 (study on violence and mining supported by ESA)

- **Block 3: Dynamic Mapping of actors**

Step 2: Use case scoping - Description template

Initial scale of the use case		
	Proof of Concept	X
Describe the data shared		VHR Imagery Stakeholders Position/Location News (Headlines Hunter from Austria) Fact and information from the ground (Human Intelligence from PeaceEye)
What analysis is done on the data		
Data service consumer(s):		
	Who fulfils this role	Policy/Decision Makers People on the ground International Organisations (UN, OECD, OSCE) Private sector Entities (Mining, Energy, etc…)
	Value for Data service consumer(s)	
Data service provider(s):		
	Who fulfils this role	VHR Imagery (Sinergise/CDSE) Neptun Data Processing GmbH (product name: headlinehunter.ai) Spatial Services https://www.spatial-services.com/ Human Intelligence from PeaceEye
	Value for Data service provider(s)	
Entitled party:		

	Who fulfils this role	EO operators (Airbus, Maxar, Iceye, etc…) Citizens/Civil Society Organisation/People on the ground working for states, int'l organisations, NGO Media/News operators
Enabling party/ies:		
	Who fulfils this role	CloudFerro Telecom operators Trusted European Media Data Space (TEMS) for Media Geocitizens Flexco https://www.wirtschaft.at/u/630116t
Frequency of sharing data:		
	Recurring	X
Relevant data services		
	Data push: Data service consumer pushes data to Data service provider	X
	Data pull: Data service consumer requests data from Data service provider	X

Step 2: Use case scoping - Interaction template

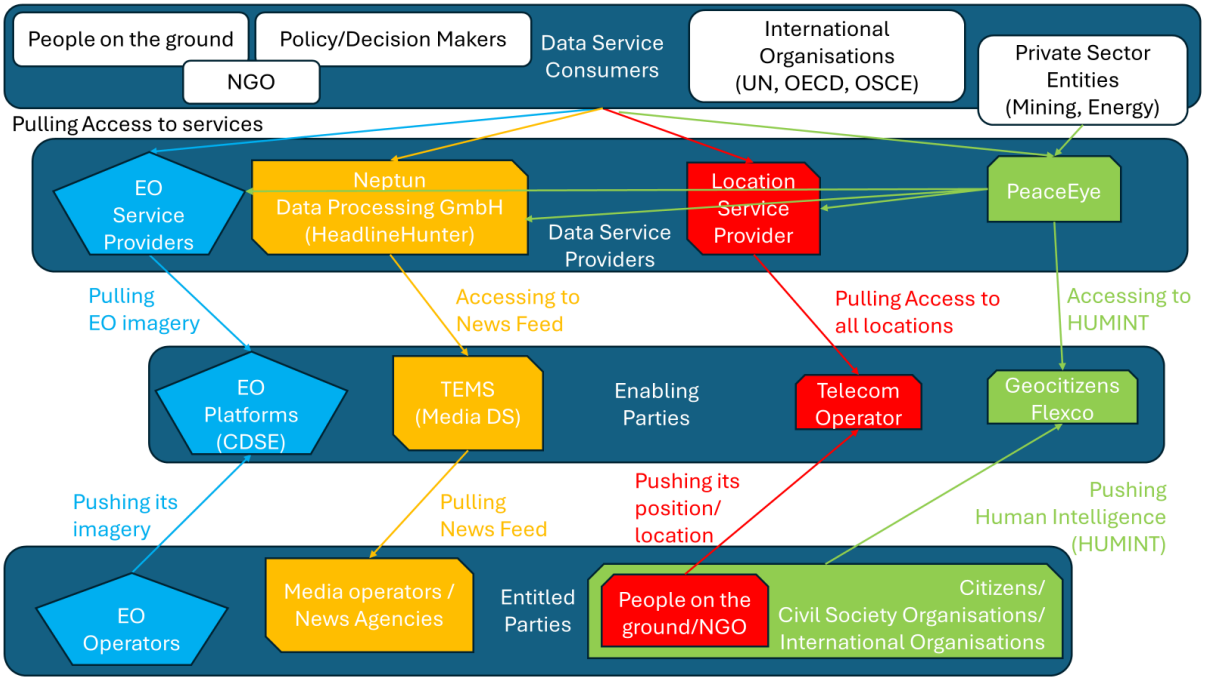
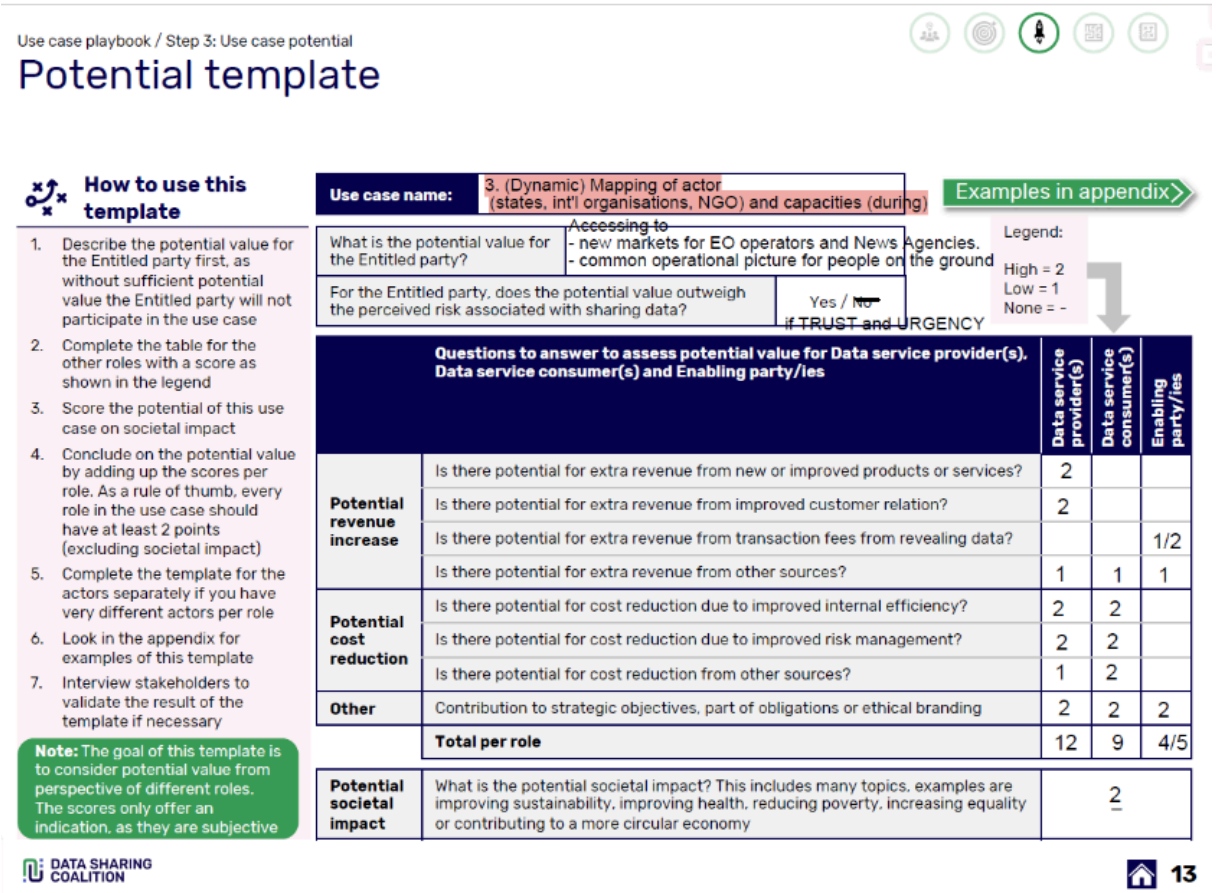


Figure 57 - Interaction for Mapping of actors use case

Step 3: Use case potential



Use case playbook / Step 3: Use case potential

Potential template

How to use this template

1. Describe the potential value for the Entitled party first, as without sufficient potential value the Entitled party will not participate in the use case
2. Complete the table for the other roles with a score as shown in the legend
3. Score the potential of this use case on societal impact
4. Conclude on the potential value by adding up the scores per role. As a rule of thumb, every role in the use case should have at least 2 points (excluding societal impact)
5. Complete the template for the actors separately if you have very different actors per role
6. Look in the appendix for examples of this template
7. Interview stakeholders to validate the result of the template if necessary

Note: The goal of this template is to consider potential value from perspective of different roles. The scores only offer an indication, as they are subjective

Use case name: 3. (Dynamic) Mapping of actor (states, int'l organisations, NGO) and capacities (during)

Examples in appendix

What is the potential value for the Entitled party?	Accessing to - new markets for EO operators and News Agencies. - common operational picture for people on the ground
For the Entitled party, does the potential value outweigh the perceived risk associated with sharing data?	Yes / ~~NO~~ if ~~TRUST and~~ URGENCY

Legend:
High = 2
Low = 1
None = -

	Questions to answer to assess potential value for Data service provider(s), Data service consumer(s) and Enabling party/ies	Data service provider(s)	Data service consumer(s)	Enabling party/ies
Potential revenue increase	Is there potential for extra revenue from new or improved products or services?	2		
	Is there potential for extra revenue from improved customer relation?	2		
	Is there potential for extra revenue from transaction fees from revealing data?			1/2
	Is there potential for extra revenue from other sources?	1	1	1
Potential cost reduction	Is there potential for cost reduction due to improved internal efficiency?	2	2	
	Is there potential for cost reduction due to improved risk management?	2	2	
	Is there potential for cost reduction from other sources?	1	2	
Other	Contribution to strategic objectives, part of obligations or ethical branding	2	2	2
	Total per role	12	9	4/5
Potential societal impact	What is the potential societal impact? This includes many topics, examples are improving sustainability, improving health, reducing poverty, increasing equality or contributing to a more circular economy	2		

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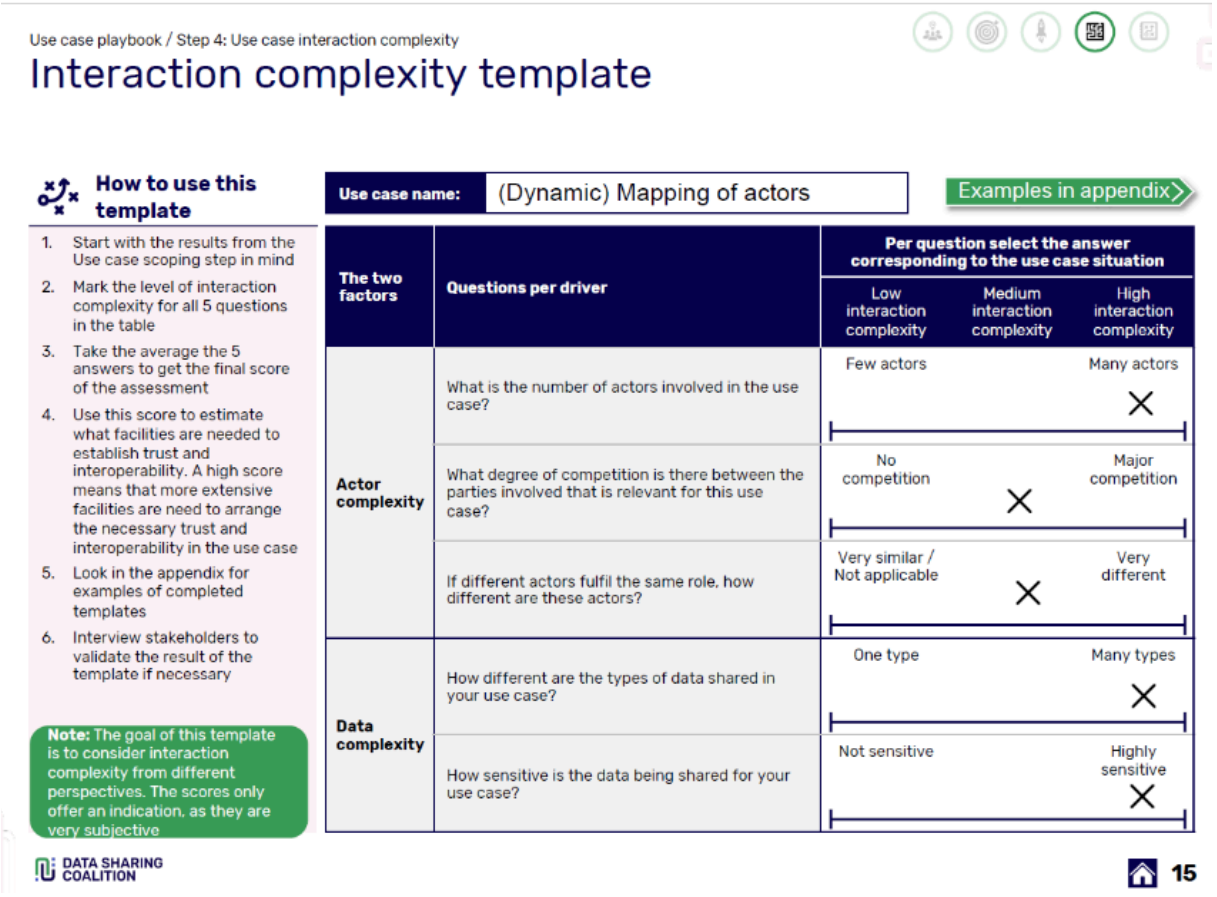
Figure 58 - Potential for Mapping of actors use case

Step 4: Use case interaction complexity



Use case playbook / Step 4: Use case interaction complexity

Interaction complexity template

How to use this template

1. Start with the results from the Use case scoping step in mind
2. Mark the level of interaction complexity for all 5 questions in the table
3. Take the average the 5 answers to get the final score of the assessment
4. Use this score to estimate what facilities are needed to establish trust and interoperability. A high score means that more extensive facilities are need to arrange the necessary trust and interoperability in the use case
5. Look in the appendix for examples of completed templates
6. Interview stakeholders to validate the result of the template if necessary

Note: The goal of this template is to consider interaction complexity from different perspectives. The scores only offer an indication, as they are very subjective

Use case name: (Dynamic) Mapping of actors

Examples in appendix

The two factors	Questions per driver	Per question select the answer corresponding to the use case situation		
		Low interaction complexity	Medium interaction complexity	High interaction complexity
Actor complexity	What is the number of actors involved in the use case?	Few actors		Many actors X
	What degree of competition is there between the parties involved that is relevant for this use case?	No competition	X	Major competition
	If different actors fulfil the same role, how different are these actors?	Very similar / Not applicable	X	Very different
Data complexity	How different are the types of data shared in your use case?	One type		Many types X
	How sensitive is the data being shared for your use case?	Not sensitive		Highly sensitive X

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Figure 59 - Interaction complexity for Mapping of actors use case

- **Block 4: Dynamic tracing of migration**

Step 1: Use case generation

Describe the current situation	Migration movements are significantly influenced by political and natural factors. Countries in the Middle East, Africa, and parts of Asia experience high levels of displacement due to ongoing wars, ethnic violence, and oppressive regimes. Natural factors, such as climate change, natural disasters, and environmental degradation, also play a crucial role. Countries in regions prone to extreme weather events like floods, droughts, and hurricanes, see substantial internal and cross-border migration.
Describe the opportunity or challenge	Migration present several challenges for Earth observation, being the main ones: Disaster Response and Management: Earth observation can provide near real-time data to predict, monitor and respond to natural disasters like floods, hurricanes, and droughts. Identifying the most affected areas and assessing the needs of displaced populations. Environmental Monitoring and Climate Change Research: Monitor environmental changes and degradation, helping to identify areas at risk of desertification, deforestation, and other ecological issues. It can also help to understand how migration patterns are influenced by changing environmental conditions. Agricultural Planning and Food Security: Ensure food security in regions affected by migration. This information can aid in efficient resource distribution and the development of resilient agricultural practices. Border monitoring: To improve security and assist in the management of migration flows.
Which of these categories matches your opportunity or challenge:	
New insights enabling new value propositions	X

Difficulty in assessing certain risks due to a lack of information	X
Describe how data-sharing can address the above situation	Federated Data Spaces can incorporate real-time data from satellite imagery, weather stations, and IoT sensors. This real-time monitoring enables early warning systems for natural disasters, allowing for timely evacuations and preparation to minimise the impact on affected populations. All together, it facilitates the integration and sharing of diverse datasets, enabling better coordination, decision-making, and resource management

Step 2: Use case scoping - Description template

Describe the use case	East Africa is experiencing significant climate-induced migration due to recurrent droughts and changing weather patterns. These environmental changes are leading to crop failures, water scarcity, and increased food insecurity, prompting mass movements of people within and across national borders. Governments and humanitarian organisations need effective tools to monitor these migration patterns and manage the resulting humanitarian crisis. The proposed use case is to use a federated Data Space and Earth observation technologies to monitor and manage climate-induced migration in East Africa, ensuring timely and efficient responses to the needs of affected populations.
Initial scale of the use case	
Pilot	X
Describe the data shared	Copernicus ESA CCI land Cover Global Human Settlement population grid MODIS Vegetation Index Products at 250m SoilGrids, ISRIC 2019 SRTM Digital Elevation Model, NASA. Other data
What analysis is done on the data	Displacement monitoring Environmental impact of the displacements

Data service consumer(s):	
Who fulfils this role	Public international/national and regional /local policy and decision makers. NGOs and Civil Protection agencies.
Entitled party:	
Who fulfils this role	EO operators People on the ground working for states, int'l organisations, NGO Media

- **<u>Block 5: Detection of incidents (man-made disaster, conflicts)</u>**

The Space Data Space stakeholders will apply their expertise to analyse data on natural disasters and human violence, generating maps and analytics of 'incidents' occurring in the departure areas and along migration routes. These analyses will rely on various data sources, particularly the ACLED database. Extensive analyses will be developed and further detailed in collaboration with stakeholders and field actors.

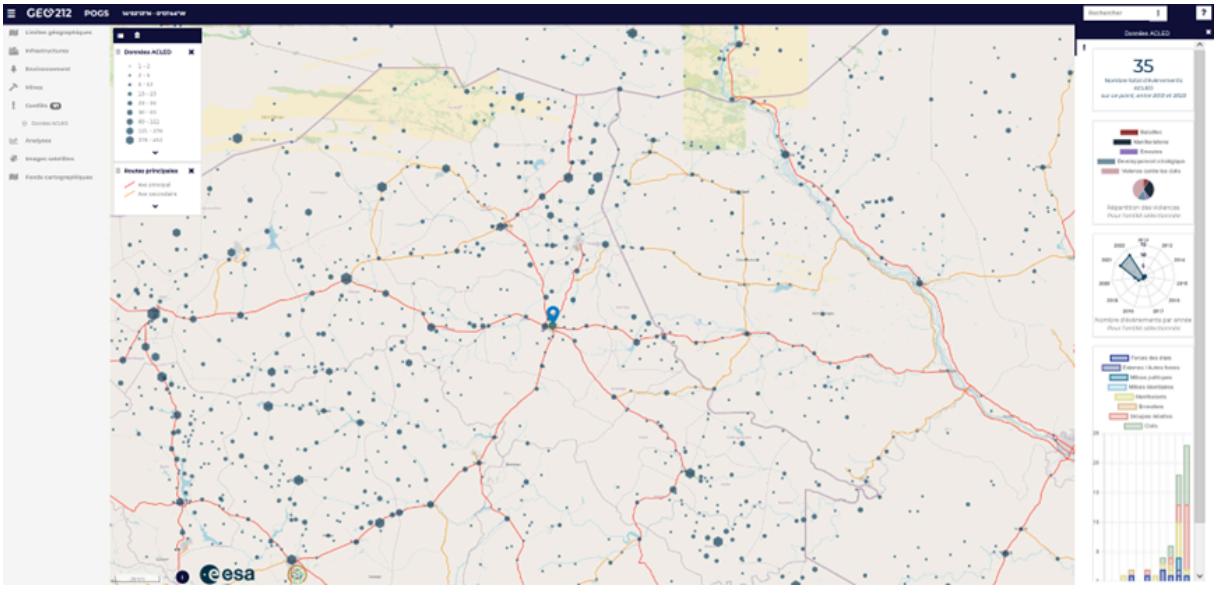


Figure 60 - Raw ACLED data, analysed regarding 4 axes:
actors involved in violent acts, nature of conflicts, evolution of violence in the last 10 years

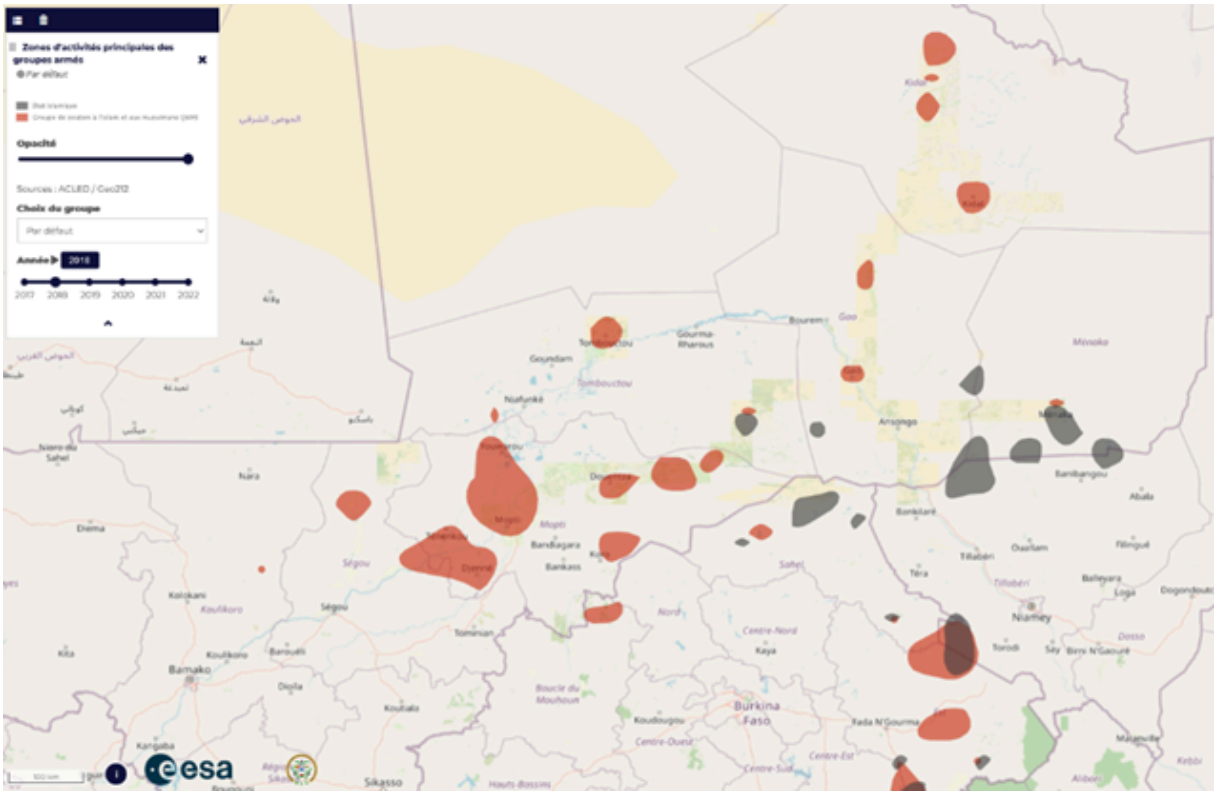


Figure 61 - Operating area of JNIM and Islamic State in 2018
Source: ACLED data analysis powered by Geo212

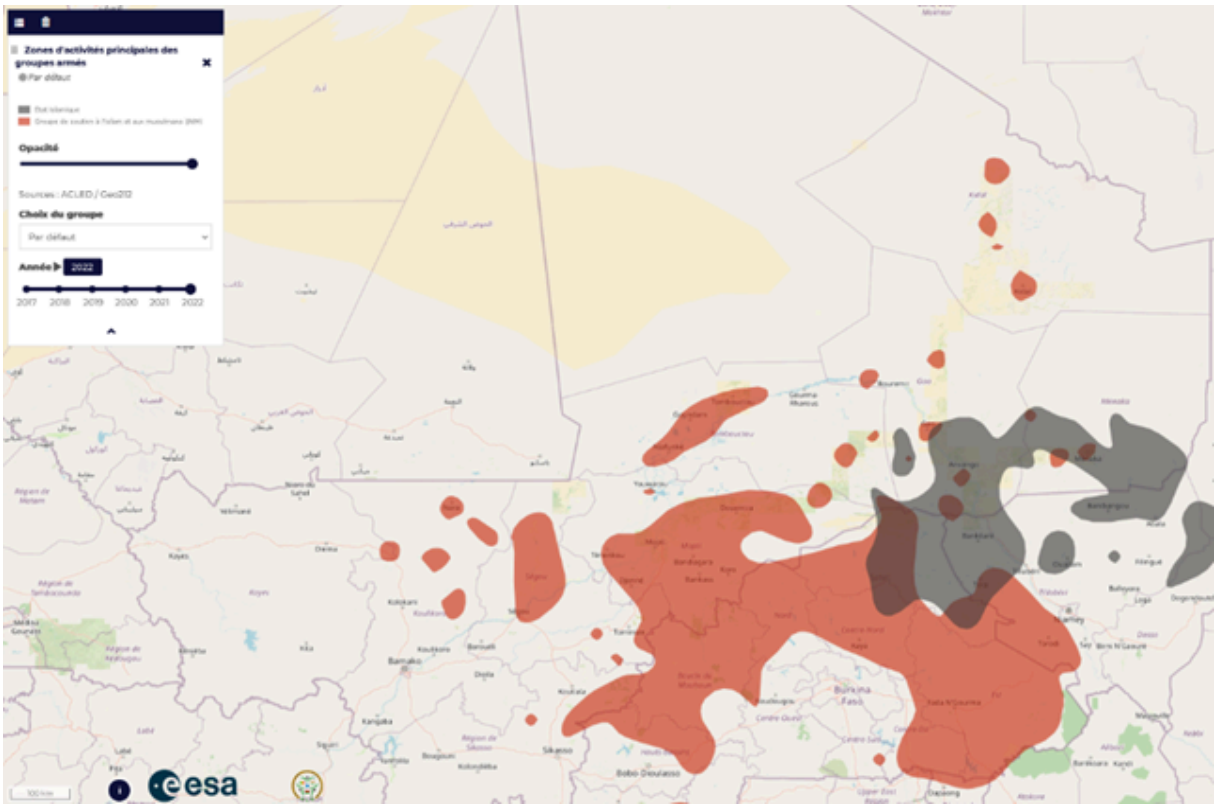


Figure 62 - operating area of JNIM and Islamic State in 2022
Source: ACLED data analysis powered by Geo212

Source: Acled Data – analysis Geo212

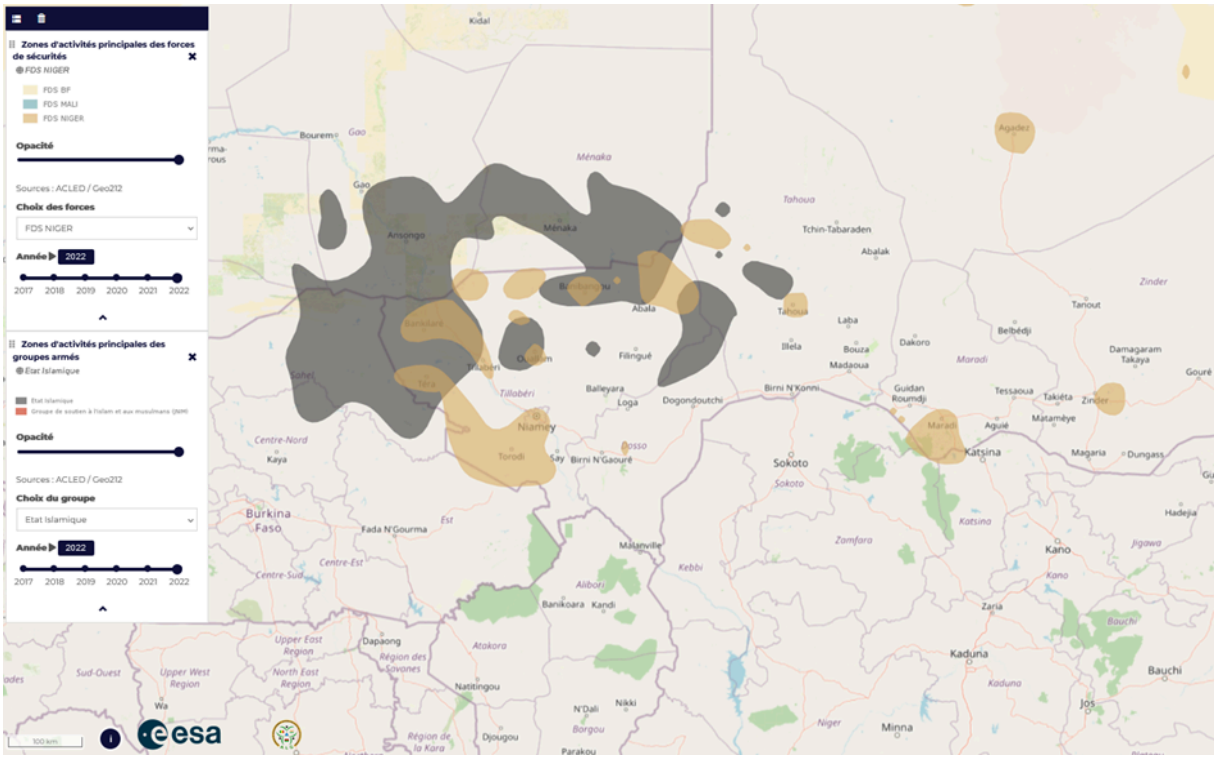


Figure 63 - Analysis of the fighting zone between Niger's security forces and the Islamic state in 2022

This analysis could also be delivered to complete the block 3 (Dynamic) Mapping of actors (states, int'l organisations, NGO) and capacities (during).

- **<u>Block 6: Climate Change Impacts / Extreme weather events</u>**

Step 1: Use case generation

Describe the current situation	Climate makes some countries characteristically prone to extreme weather conditions where lack of water resources leads to food scarcity. In addition, natural threats and climate change further undermine the available natural resources, most notably by increasing the spatial and temporal variability of the rainy and dry seasons. These adverse environmental impacts and the mismanagement of natural resources negatively affect the country's economy that depend on climate-sensitive agriculture and pastoralism. Understanding human migrations face limitations related to data availability, data quality, data reliability and data comparability inter alia.

Describe the opportunity or challenge	The challenge is to extract patterns out of the climate data and socio-economic data that allow foreseen conditions leading to migration processes. Environmental and non-environmental indicators are considered to understand environmental migration better. Monitoring human migrations patters will allow to design effective policies, plan for ad-hoc resources and provides the right solutions on the field to the population needs.
Which of these categories matches your opportunity or challenge:	
New insights enabling new value propositions	X
Difficulty in assessing certain risks due to a lack of information	X
Describe how data-sharing can address the above situation	Environmental indicators can be used to measure the direct impact of environmental events on agricultural and urban features that may impact on the local population, ultimately leading to migration. As a matter of example, Agricultural Drought Indicator (ADI) could be one of the environmental indicator defined, based on the cause-effect relationship for agricultural drought, whereby a shortage of precipitation leads to a soil moisture deficit, resulting in a reduction of vegetation productivity. In order to get patterns out of climate data, a huge amount of temporal and spatial data are needed at local resolution. All available information sources should be used, as no single source/system is able to provide such data. A trusted data-sharing infrastructure will allow a reliable data collection and can promote that new quality and massive data sources become available for adequate analytics useful for policy makers, humanitarian aid agencies and related stakeholders.

Step 2: Use case scoping - Description template

Describe the use case	Human migrations phenomena are in the political focus at global scale due to its social and economical implications. Positive and negative effects require international/national and regional/local authorities cooperation. Climate change, among other factors, exacerbates migrations. Understanding migrations can be improved by data-sharing by involved stakeholders, including affected individuals, NGOs, private and public entities. Analysing the climate information can anticipate extreme weather events through the elaboration of some indicators related with the climate change effects. Anticipation is key to reduce the effects and take mitigation measures by the involved stakeholders.
Initial scale of the use case	
Proof of Concept	X
Pilot	X
Describe the data shared	Public data: demography, climate, economy, health, satellite based positioning. Private data: cells based mobility. NGOs and individuals data: social networks based text in local language, drones and cells based images, and videos. EO Satellite data: VHR Imagery, Multispectral data, Radar Data
What analysis is done on the data	Early warnings about extreme weather events with potential impact on human displacement.
Data service consumer(s):	
Who fulfils this role	Public international/national and regional /local policy and decision makers. NGOs and Civil Protection agencies.
Value for Data service consumer(s)	Timely and accurate observations rather than estimates, quantified value and trends, realistic situation awareness, projections to future and forecasts, resilient connectivity. Better knowledge of migrations drivers and potential effects, better preparedness and management of such events
Data service provider(s):	

Who fulfils this role	Space downstream industry, Local service operators based on In-situ data and non-satellite sensor based data.
Value for Data service provider(s)	Access to valuable massive and heterogeneous data.
Entitled party:	
	EO operators, Local operators for In-situ data and non-satellite sensor based data EU, International organisations, public agencies, national/regional/local governments, (e.g, population, economic data, activities sector distribution,…)
	Data use and improvement through cross validation.
Enabling party/ies:	
	IT and cybersecurity industry, telecom operators
Value for Enabling party/ies	Revenue streams with growth potential.

Step 2: Use case scoping - Interaction template

In the template in the next page, we draw all interactions between roles and label the interactions in chronological order, marking the relevant data service type.

The description related to the various steps are the following:

Humanitarian agency requests a service to Remote Sensing (RS) & analytics industry to provide migrations info related to climate extreme events
Data owners grant their data usage
RS & analytics industry requests information regarding cells positioning
Telecom operator checks that RS & analytics industry is authorised to receive the anonymised cells data and send it
RS & analytics industry provides the human displacements service related to climate extreme events

Next pages are including as well the following steps:
Step 3: Use case potential
Step 4: Use case interaction complexity

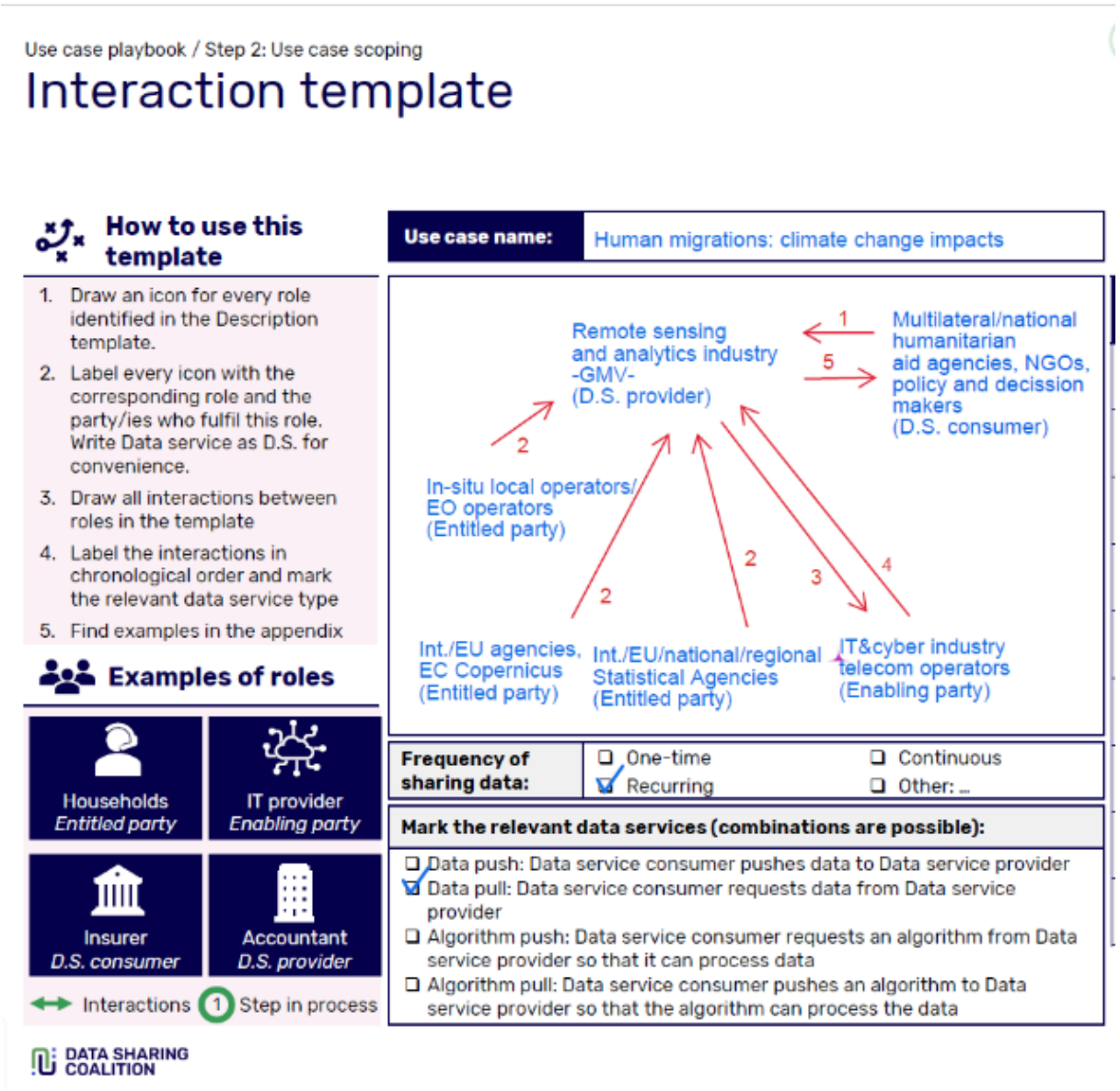
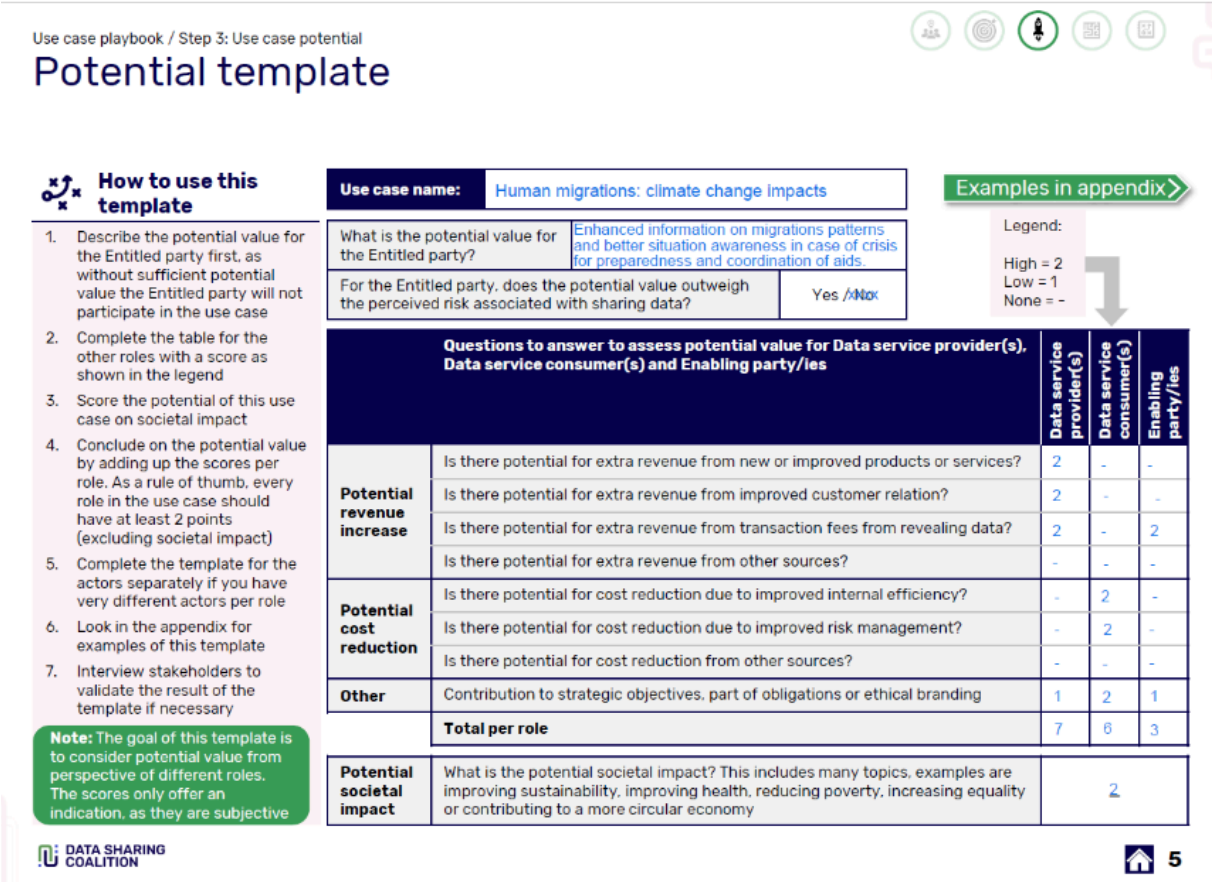


Figure 64 - Interaction for Climate Change use case



Use case playbook / Step 3: Use case potential

Potential template

How to use this template

1. Describe the potential value for the Entitled party first, as without sufficient potential value the Entitled party will not participate in the use case
2. Complete the table for the other roles with a score as shown in the legend
3. Score the potential of this use case on societal impact
4. Conclude on the potential value by adding up the scores per role. As a rule of thumb, every role in the use case should have at least 2 points (excluding societal impact)
5. Complete the template for the actors separately if you have very different actors per role
6. Look in the appendix for examples of this template
7. Interview stakeholders to validate the result of the template if necessary

Note: The goal of this template is to consider potential value from perspective of different roles. The scores only offer an indication, as they are subjective

Use case name:	Human migrations: climate change impacts
What is the potential value for the Entitled party?	Enhanced information on migrations patterns and better situation awareness in case of crisis for preparedness and coordination of aids.
For the Entitled party, does the potential value outweigh the perceived risk associated with sharing data?	Yes /~~No~~

Examples in appendix

Legend:
High = 2
Low = 1
None = -

	Questions to answer to assess potential value for Data service provider(s), Data service consumer(s) and Enabling party/ies	**Data service provider(s)**	**Data service consumer(s)**	**Enabling party/ies**
Potential revenue increase	Is there potential for extra revenue from new or improved products or services?	2	-	-
	Is there potential for extra revenue from improved customer relation?	2	-	-
	Is there potential for extra revenue from transaction fees from revealing data?	2	-	2
	Is there potential for extra revenue from other sources?	-	-	-
Potential cost reduction	Is there potential for cost reduction due to improved internal efficiency?	-	2	-
	Is there potential for cost reduction due to improved risk management?	-	2	-
	Is there potential for cost reduction from other sources?	-	-	-
Other	Contribution to strategic objectives, part of obligations or ethical branding	1	2	1
	Total per role	7	6	3
Potential societal impact	What is the potential societal impact? This includes many topics, examples are improving sustainability, improving health, reducing poverty, increasing equality or contributing to a more circular economy	2		

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Figure 65 - Potential for Climate Change use case

15. List of participants to SDS-Next

Core Team and Public Entities (6):

- **SDS-Next Core Team:** Emmanuel MONDON (Space Cooperative Europe SCE), Olivier Dion (Onecub SAS), Eric Pol (aNewGovernance ASBL)
- **ESA:** Pascal Legai (ESA Coordinator), Elisabeth Sourgens, Christopher Leigh Topping, Isabelle Duvaux-Bechon, Florent Mazurelle
- **EDA:** Isidoros Monogioudis
- **EU SatCen:** Juan Luis Valero

NGO/NPO (3):

- **EARSC (Belgium):** Emmanuel Pajot, Weronika Borejko
- **European Space Policy Institute - ESPI (Austria):** Mathieu Bataille, James Francis, Giulia Pavesi, Julien Potin
- **OGC:** Piotr Zaborowski, Marie-Françoise Voidrot

Industry (22):

- **Airbus Defence and Space (France):** Laure Brooker, Elodie Viau, Arnaud Cauchy
- **Aistech Space (Spain):** Carles Franquesa, Josep Pino, David Paredes
- **CloudFerro (Poland):** Krzysztof Getko, Monika Krzyżanowska, Konstanty Jelenski
- **CS Group, a Sopra Steria company (France):** PAIN Adrien, D'HOINE Sylvain, SOUILLE Gwenael
- **Ctrl-Shift (UK):** Liz Brandt
- **De Gaulle Fleurance (France):** Cécile Théard-Jallu, Laetitia Cesari,
- **Deutsche Telekom (Germany):** Uwe Marquard, Jurry de la Mar, Sven Hillmer
- **DIH Tourism 4.0 (Czech Republic):** Ludek Kuhr, Jan Orava
- **E-geos (Italy):** Donatella Giampaolo
- **Eutelsat (France, Italy):** Matteo Carucci, Pierangelo Lombardo
- **FACTiven (Luxembourg):** Frederic Tourret
- **Geo212 (France):** Nicolas Saporiti, Alexandra Boulay
- **GMV (Spain):** Almudena Sánchez González, Amaya Atencia Yepez, Luis Mariano González Casillas
- **Heuking (Germany):** Thomas Jansen
- **iTTi (Poland):** Joanna Baksalary, Rafał Renk, Grzegorz Taberski, Jakub Rezler
- **OHB (Germany):** Sebastien Tailhades, Dietrich Kuhn, Danijela Ristic-Durrant
- **Open Cosmos (Spain/UK):** Aurelio Martí Ferrer, Ian Broadhurst, Amani Mohamud
- **PeaceEye (Austria):** Andreas Papp, Anatole Deligant, Sapiens Ndatabaye
- **SES (Luxembourg):** Emin Allagui
- **Starion (ex-RHEA Group - Luxembourg, Spain, UK):** Ruben Francisco Perez Moreno, Vahid Joroughi, Jordi Prados Camargo, Alastair Pidgeon
- **Unseenlabs (Spain):** Rosario Ruiloba
- **Vodafone (Spain, Germany, UK):** Silvia Mediavilla, Fabian Best, Ilaria Thibault

16. References

16.1. List of abbreviations

Abbreviation	
AI	Artificial Intelligence
AISBL	Association Internationale Sans But Lucratif
API	Application Programming Interface
CAMS	Copernicus Atmosphere Monitoring Service
CCM	Copernicus Contributing Missions
CDSE	Copernicus Data Space Ecosystem
CEOS	Committee on Earth Observation Satellites
CEF	Connecting Europe Facility
CNES	Centre national d'études spatiales
CoP	Community of Practice
CSA	Coordination and Support Action
CSS	Civil Security from Space
DA	Data Act
DCAT	Data Catalog Vocabulary
DEP	Digital Europe Programme
DestinE	Destination Earth
DIAS	Data and Information Access Services
DID	Decentralised IDentifier
DG CONNECT	European Commission’s Directorate-General for Communications Networks, Content and Technology
DG DEFIS	European Commission’s Directorate-General for Defence Industry and Space
DGA	Data Governance Act
DMA	Digital Markets Act

DS	Data Space
DSA	Digital Services Act
DSBA	Data Spaces Business Alliance
DSC	Data-Sharing Coalition
DSSC	Data Spaces Support Centre
DSGA	Data Space Governance Authority
DTE	Digital Twin Earth
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
EDC	Eclipse Dataspace Components
EDIB	European Data Innovation Board
EDIC	European Digital Infrastructure Consortium
eIDAS	electronic identification Authentication and Trust Services
EHDS	European Health Data Space
EMDS	European Mobility Data Space
EO	Earth Observation
EOEPCA	Earth Observation Exploitation Platform Common Architecture
EOP	Earth Observation Programmes
ESA	European Space Agency
ESAC	European Space Astronomy Centre
ESDC	ESAC Science Data Centre
ESDS	European Space Data Space
ESEC	European Space Security and Education Centre
ESPI	European Space Policy Institute
ETDS	European Tourism Data Space
EU	European Union
EU SatCen	European Union Satellite Centre

EUSL	EU Space Law
EUSPA	EU Agency for the Space Programme
GDPR	General Data Protection Regulation
GNSS	Global Navigation Satellite System
GPDRA	Global Programme for Disaster Risk Analytics
GPS	Global Positioning System
GSM	Global System for Mobile Communications
IAA	Identification and Authentication and Authorisation
IDSA	International Data Spaces Association
ICMPD	International Centre for Migration Policy Development
IoT	Internet-of-Things
JRC	Joint Research Centre
LIST	Luxembourg Institute of Science and Technology
MEPs	Members of the European Parliament
MIM	Minimal Interoperable Mechanism
NBS	Nature-Based Solutions
NGO	Non-governmental organization
OASC	Open & Agile Smart Cities
OECD	Organisation for Economic Co-operation and Development
OGC	Open Geospatial Consortium
PMR	Professional Mobile Radio
PROTECT	Protection of Space Assets
PSI	Public Sector Information
S4GF	Space for a Green Future
SME	Small and medium-sized Enterprise
S2P	Space Safety Programme
SDS	Space Data Space

SSA	Space Situational Awareness
SSI	Self Sovereign Identity
STAC	SpatioTemporal Asset Catalogs
R3	Rapid and Resilient Crisis Response
UK	United Kingdom
USA	United States of America

16.2. List of figures

16.3. List of tables