Implementation Plan

Activity 6 – Deliverable 6.2

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1. Introduction

The Geospatially Enabled Ecosystem for Europe, the GeoE3 project has been launched in 2020 to tackle the interoperability challenge. In addition to all other objectives, the project aims to create a data integration platform that enables data integration from various data providers. The platform could work as a one kind of data space.

For all use cases and objectives, the common theme is data integration, which requires interoperability. Therefore, we in this project, have created multiple tools and methods to improve interoperability.

In activity 3, we created interoperability map. As its name implies, it helps users to map, or evaluate the current interoperability levels of their data sets. The evaluation criteria are based on European Interoperability Framework (EIF), European Location Interoperability (EULF), Framework for Enterprise Interoperability (FEI) and the FAIR (Findable, Accessible, Interoperable and Reusable) principles. The interoperability map will provide good guidance for data providers as they can easily understand how mature their data is, and what they can do to improve it.

But the interoperability map doesn't solve the whole challenge of interoperability as it considers mainly data sets, not data services. Therefore, in activity 6 of this project, we created interoperability checks to facilitate the interoperability problem of the service-side perspective. They describe the basic principles of how public services should be designed, implemented and managed during their life cycle. As in the interoperability map, this helps users to find out their current maturity levels and improve them using our recommendations. The interoperability checks were based mainly on the same sources than interoperability map.

This document is a continuation for those earlier deliverables (interoperability map and interoperability checks). As we asked our partner countries to fulfill their answers related to both interoperability map and interoperability checks, we now know their maturity levels of geospatial data and services. That is a good starting point but usually understanding alone doesn't lead to any consequences. Therefore, in this document, we consider timetables and plans for countries to update and develop their geospatial data services, which improves interoperability directly.

The base idea is that most geospatial services are currently based on Open Geospatial Consortium (OGC) Web Services, such as Web Feature Service (WFS), Web Map Service (WMS) and Web Map Tile Service (WMTS), which are already 15 years old standards. They are still workable, but not capable to address the all modern day implementation principles of Web APIs. For example, APIs for geospatial data should be designed according to common design principles of the IT field to ensure consistency, enhanced interoperability and easier adoption.

The world is changing and so does the OGC. It is developing the generation of standards for geospatial data services, called OGC APIs. The idea is to move from former OGC Web Services towards newer OGC APIs, so this document is mainly focused on implementation plans of OGC APIs. Also some supporting services, such as eTranslate and ContextBroker, which are tools created by Connecting Europe Facility (CEF), are considered.

2. Service Architecture

2.1. Overview

The goal of our service architecture is usability and easiness from the perspective of end-users. Everything is available from a single point of access, despite the numerous cross-border distributed services.

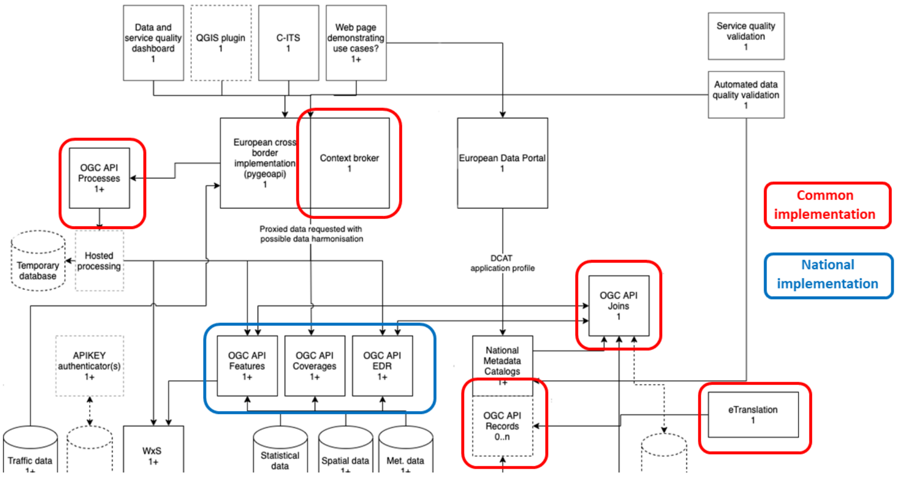

Figure 1. This figure describes the envisaged service architecture for the ecosystem of services being built in the GeoE3 project. The architecture aims at a modular structure, relying on the OGC API family of services.

As you can see from Figure 1 above, open data comes from national data producers (e.g. cadasters and statistical agencies of partner countries) and will be harmonized and integrated through OGC APIs. The main OGC APIs, such as Features, Coverages and EDR, will be implemented nationally, which will allow connection to our data integration platform. Other OGC APIs, such as Joins, Records and Processes will be implemented in a centralized way directly to the GeoE3 data integration platform. For that reason, we don't consider those standards in this national implementation plan document.

In the case of non-open data, the authentication is done with a separate APIKEY authenticator. The requests are authenticated both in European cross-border implementation and in data services. After that, the process is similar than for open data. However, authentication should be avoided, if possible.

Metadata is provided from the European Data Portal catalog service, retrieved via CS-W from national sources. Optionally, an OGC API Records service can be used as an early adaptor for demonstrational purposes.

Where applicable, the services should support a change-only data provision based on, for example, INSPIRE lifespan tags. However, such functionality is not reasonable for example with constantly updating meteorological data.

2.2. National Elements

2.2.1. OGC API Features

OGC API - Features is a multi-part standard that offers the capability to create, modify, and query spatial data on the Web and specifies requirements and recommendations for APIs that want to follow a standard way of sharing feature data.

The OGC API Features is comprised of multiple parts, each of them being a separate standard. The first part, or the Core part defines discovery and query operations that every implementing service has to support. The second part extends the core capabilities with the ability to use additional coordinate reference system identifiers. The third part focus on filtering features and the fourth part allows resource instances to be added, replaced, modified and/or removed for a collection. The third and fourth parts are not approved yet as standards.

The OGC API Features standard is supposed to replace the former OGC Web Feature Service (WFS) standard.

2.2.2. OGC API Coverages

OGC API Coverages is a draft standard that gives access coverages. Usually, the term coverages refers to homogeneous collections of values located in space and time, such as spatio-temporal sensors, satellite images, simulations, and statistics data. The specification does not require any specific data formats but recommends some, such as CoverageJSON, netCDF, GeoTIFF, PNG, and HTML.

This standard will replace the former OGC Web Coverage Service (WCS) standard when it is completed.

2.2.3. OGC API EDR

OGC API Environmental Data Retrieval (EDR) is a standard that provides interfaces to access environmental data resources, which usually refers to continuous data about the natural or built environment that needs to be sampled using spatio-temporal query patterns. For example, with the help of OGC API EDR you can access climate model data or data from hydrological sensors.

This specification provides two fundamental operations: discovery and query. Discovery operation allows users to ask capabilities of the API and retrieve metadata from its resources. Query operations allow users to sample data more specifically based on criteria, such as space/time window or ID.

2.3. Common Elements

2.3.1. OGC API Joins

OGC API Joins is a draft standard that allows joining (geospatial) data with other types of data that are available on the server or directly with other input files. The specification gives access to discovery service metadata and joining operations for data and files.

The data joining operations contain functionalities to retrieve metadata and key values on the feature collections that are available on the server. Also, joining data with the feature collections is supported, as well as accessing and deleting the created joins. File joining operations on the other hand allow joining input data files with other inputted data files.

In this project, we implement this standard in a centralised way and created the GeoE3 Data Joining Service. It provides an example implementation of data integration solution that uses the OGC API – Joins service to combine geospatial and tabular data. The service contains the Finnish regions and municipalities geospatial datasets from the years 2017-2022, and retrieve tabular data from a PxWeb API, which an example of an actual statistical data production environment used by the Statistics Finland.

2.3.2. OGC API Processes

OGC API Processes is a standard that allows users to execute their computational tasks through a server. The processing interface communicates over a RESTful protocol using JSON encodings. So, the user client gives a request into a cloud, which fetches and processes the data, and finally returns output data sets back to the users via an URL.

The OGC API Processes standard addresses the same use cases as the former OGC Web Processing Service (WPS) standard, while supporting the OpenAPI specification and resource-oriented approach. Therefore, the OGC API Processes will replace the former WPS.

In this project, we implemented this directly to the GeoE3 Data Integration Platform. In the platform, users can extrude 2D buildings to 3D buildings of Level of Details (LoD) 1. The extrusion process uses the OGC API Processes standard.

2.3.3. OGC API Records

OGC API Records is a multi-part draft standard that provides standardised ways to discover and access the metadata about geospatial resources (like coverages, tiles, maps, assets, services etc.). The draft standard also supports operations to create, modify and query metadata on the Web.

The first part allows users to access and query records in read-only mode. Other capabilities, such as richer queries or operations to create, update or delete records will be specified in additional parts of the standard.

This standard will be the natural replacement for the OGC Catalogue Service for the Web (CSW) specification.

In this project, we implemented this directly to the GeoE3 Data Integration Platform, where users can query building metadata using OGC API Records standard.

2.4. Connecting Europe Facility (CEF) Tools

2.4.1. eTranslate

The CEF eTranslation is an automatic machine translation tool that allows organisations and public administrations to use documents and information in all official EU languages, Icelandic and Norwegian. It breaks the language barriers of digital systems since it can be freely and securely integrated into the workflow of cross-border services.

2.4.2. Context Broker

Context Broker by CEF is a system that allows organisations to gather (big) data from multiple sources and display them through a user-friendly interface. In other words, it is an API that integrates data from different systems and creates a holistic view of information. The Context Broker updates data automatically, which enables to share, analyse, manage and use the data in real-time implementations.

ContextBroker is used on the GeoE3 Integration Platform to publish temperature forecasts (three hours from now) provided by the Finnish Meteorological Institute. These values are currently available for all LOD2 -modelled buildings of Finland, accessible from the Integration Platform.

As you can see from Error! Reference source not found., both eTranslate and Context Broker can be used as building blocks of digital systems.

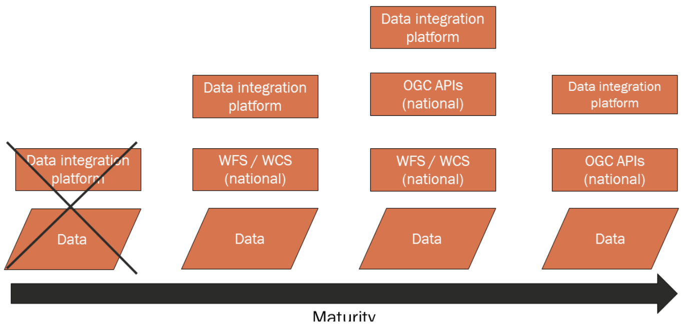

Figure 2. Maturity levels are depending on the national services.

3. National implementation options

As you can see from the Figure 2 above, the maturity level increases when OGC APIs are adopted.

- Level 0: Upload data directly to the integration platform. This is a very static solution without any clear benefits.
- Level 1: Connection to the integration platform via OGC Web Services. This allows data to flow freely, but OGC Web Services are not as interoperable as OGC APIs.
- Level 2: Connection to the integration platform via proxy (OGC API top of current national OGC Web Services). This is the slowest way to connect. End-users can choose which service they want to use, but the interoperability is not the best possible.
- Level 3: Native connection directly using OGC APIs. Provides complete service interoperability.

As mentioned earlier, other services (OGC API Processes, Joins and Records, and CEF Tools) were implemented commonly.

4. National Services

4.1. Starting Point

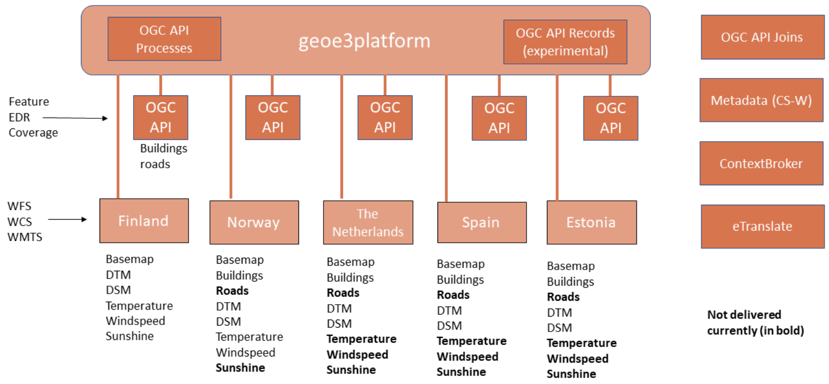

Figure 3. Services of our partner countries before applying this plan.

From the Figure 3 above, you can see our situation before the project. The geospatial services of most countries were based on OGC Web Services (WFS, WCS, WMTS), while only Finland had some OGC APIs implemented for building and road data sets. This means most countries were on the level 1 as they were connected to the GeoE3 platform using only WFS, WCS or WMTS standards.

4.2 Objective

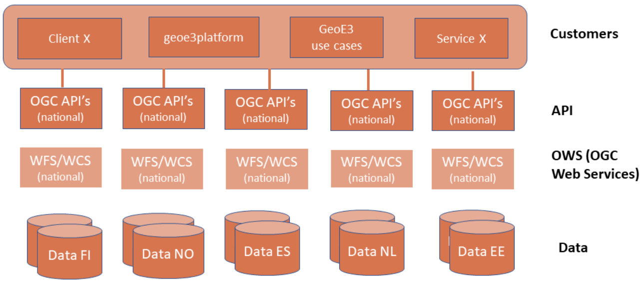

Figure 4. This figure describes the objective of our implementation plan. Idea is to move towards OGC APIs from OGC Web Services.

As you can see from

Figure 4, idea is that users can use GeoE3 data integration platforms, use cases and other services directly using OGC API standards. Eventually, the OGC Web Services will be replaced by OGC APIs, which will improve consistency, interoperability and usability of geospatial data.

5. National Implementation plans

5.1. Implementation Choices

We wanted to find out how and when countries are implementing the services introduced in our service architecture. For that, we created an Excel file that was used as a questionnaire.

The Excel sheet listed the different types of data (Buildings, Roads, Temperature, DTM, DSM, Windspeed, Sunshine, 3D Buildings) and the services, schema, testing, and timeframe associated for each data type. The data and service interoperability levels were also determined, ranging from zero to optimal interoperability.

For each data types, countries were able to choose one of the following answers:

Table 1. Table defining choices and corresponding answer options.

Choices and short explanation	Possible answers:
Data (data set used in the GeoE3 project)	Buildings Roads Temperature DTM (Digital Terrain Model) DSM (Digital Surface Model) Wind speed Sunshine 3D Buildings
Services (The service that is or will be implemented)	not to be implemented OGC API Features OGC API EDR OGC API Coverages
Schema (What is schema of the data?)	National INSPIRE Own
Timeframe (When the service will be ready?)	Implemented already during the project 1-2 years

	2-4 years 4+ years
Service interoperability (see the tables below)	0 - Not interoperable and cannot be integrated 1 - Minimal interoperability and can be integrated with extra effort 2 - Intermediate interoperability and can be integrated mostly automatically 3 - Advanced /Optimal interoperability and can be integrated automatically
Data interoperability (see the tables below)	0 - Not interoperable and cannot be integrated 1 - Minimal interoperability and can be integrated with extra effort 2 - Intermediate interoperability and can be integrated mostly automatically 3 - Advanced /Optimal interoperability and can be integrated automatically
Testing (How the service can be tested?)	OGC CITE test Manual testing No tests

For interoperability levels for geospatial data and services, more information in tables below. The levels are mainly based on the interoperability map of our project.

Table 2. Interoperability levels for geospatial services

Level	Definition
0 (Not interoperable, cannot be integrated)	No service metadata available. Service not accessible/open.
1 (Minimal interoperability and can be integrated with extra effort)	Service metadata available, but not according to standards. Data available through legacy APIs (e.g., REST or SOAP). May be open, but not easily available. Registration may be required.
2 (Intermediate interoperability and can be integrated mostly automatically)	Service metadata is provided through APIs. Data available with OGC APIs (not necessarily the most modern versions).
3 (Advanced /Optimal interoperability and can be integrated automatically)	Metadata provided through DCAT API 2.0 or OGC API Record results. Data available with most modern OGC APIs.

Table 3. Table defining interoperability levels for geospatial data.

Level	Definition
0 (Not interoperable, cannot be integrated)	Metadata not available. No information on data content, vocabulary or quality.
1 (Minimal interoperability and can be integrated with extra effort, no quality assessment)	Data specifications and quality available, but not according to standards. Quality assessment may be done but not available through metadata.
2 (Intermediate interoperability and can be integrated mostly automatically)	Vocabularies and data specifications partly or fully machine-readable (e.g., UML models or textual descriptions). Quality defined in metadata or quality reports in a standardized way. Integration mostly automated, but some steps may be necessary.
3 (Advanced /Optimal interoperability and can be integrated automatically)	Vocabularies and data specifications fully machine-readable in RDF/OWL. Quality information available in national DCAT portal as DQV. Integration possible through instance linking and linked data technologies.

5.2. Countries' plans (results)

5.2.1. Finland

Table 4. Implementation plan for Finland

Finland								
Data	Buildings	Roads	Temperature	DTM	DSM	Wind speed	Sunshine	3D buildings
Services	OGC API Features	OGC API Features	OGC API EDR	OGC API Coverages	OGC API Coverages	OGC API EDR	not to be implemented	OGC API Features
Schema	INSPIRE	INSPIRE	National	Own	Own	National		National
Timeframe	during the project	during the project	1-2 years	2-4 years	2-4 years	2-4 years		2-4 years
Data interoperability	2	2	1	1	1	1		1
Service interoperability	2	2	2	1	1	1		1
Testing	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test		OGC CITE test

5.2.2. Norway

Table 5. Implementation plan for Norway

Norway								
Data	Buildings	Roads	Temperature	DTM	DSM	Wind speed	Sunshine	3D buildings
Services	OGC API Features	OGC API Features	not to be implemented	OGC API Coverages	OGC API Coverages	not to be implemented	not to be implemented	OGC API Features
Schema	National	National		National	National			National
Timeframe	2-4 years	during the project		during the project	during the project			2-4 years
Data interoperability	2	3		2	2			2
Service interoperability	3	3		3	3			3
Testing	OGC CITE test	OGC CITE test		OGC CITE test	OGC CITE test			OGC CITE test

5.2.3. Estonia

Table 6. Implementation plan for Estonia

Estonia

Data	Buildings	Roads	Temperature	DTM	DSM	Wind speed	Sunshine	3D buildings
Services	OGC API Features	OGC API Features	OGC API Features	OGC API Features	OGC API Features	OGC API Features	OGC API Features	OGC API Features
Schema	INSPIRE	INSPIRE	INSPIRE	National	National	INSPIRE	INSPIRE	National
Timeframe	Implemented already	Implemented already	Implemented already	Implemented already	Implemented already	Implemented already	Implemented already	Implemented already
Data interoperability	1	1	1	1	1	1	1	1
Service interoperability	2	2	2	2	2	2	2	2
Testing	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test	OGC CITE test

5.2.4. Spain

Table 7. Implementation plan for Spain

Spain								
Data	Buildings	Roads	Temperature	DTM	DSM	Wind speed	Sunshine	3D buildings
Services	OGC API Features	OGC API Features		OGC API Coverages	OGC API Coverages			OGC API Features
Schema	INSPIRE	INSPIRE		INSPIRE	INSPIRE			Own
Timeframe	2-4 years	during the project		during the project	during the project			2-4 years
Data interoperability	2	2		2	2			2
Service interoperability	2	2		2	2			2
Testing	OGC CITE test	OGC CITE test		OGC CITE test	OGC CITE test			OGC CITE test

5.2.5. The Netherlands

Table 8. Implementation plan for the Netherlands

Netherlands								
Data	Buildings	Roads	Temperature	DTM	DSM	Wind speed	Sunshine	3D buildings
Services	OGC API Features	OGC API Features	not to be implemented	OGC API Coverages	OGC API Coverages	not to be implemented	not to be implemented	OGC API Features
Schema	National	INSPIRE						
Timeframe	1-2 years	2-4 years		2-4 years	2-4 years			1-2 years
Data interoperability	1	1		1	1			1

Service interoperability	2	2		2				
Testing								

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6. Summary of the Results

Before the GeoE3 project, Finland was the only country which had implemented OGC APIs. It published building and road data sets using OGC API Features.

Based on our discussions with partner countries and tables above, also other countries have been progressed during the project. Some countries have already implemented OGC APIs and other countries have planned to do so within the next a few years.

Estonia has made the fastest progress. It has implemented OGC API Features for all GeoE3 datasets, including buildings, roads, DTM, DSM, and temperature data, but the API is not public yet. Whenever possible, it uses INSPIRE schema. Also, national schema is used. The Estonian data sets have minimum interoperability and geospatial services have intermediate interoperability that enables integration almost automatically.

Also, the Netherlands has been foremost in advancing OGC APIs. They have already created OGC API Tiles and Common, which can be used in this page. In the Netherlands, the OGC API features and Coverages are in the implementation phase, which means, they will be workable in 1-4 years. Currently, the Netherlands is planning to combine OGC APIs together and adding metadata to them, most likely using OGC API Records. Also, adding three more coordinate reference systems are under the consideration.

The situation is similar in Spain. They have created OGC API Maps and Tiles, but OGC API Features and Coverages are still under the construction. Most probably, they will be ready in 1-4 years, just like in the Netherlands.

Norway and Finland are going to implement OGC APIs for geospatial data sets either during the project or in the next 1-4 years. For 2D/3D buildings and roads, they have been or will be implementing OGC API Features and they are planning OGC API Coverages for DTMs and DSMs.

The climate data (sunshine hours, wind speed, temperature) is not considered as important as other data sets. Most countries don't have plans to implement OGC APIs for them. In addition to Estonia, only Finland will create OGC API EDRs for temperature and sunshine data sets. For windspeed, only Finland plans to share data using OGC API standard (EDR).

The GeoE3 project has used either national schemas or INSPIRE compliant schemas in data transfer. The purpose is to study OGC's new JSON-FG (JSON Features and Geometries) standard during the implementation phase of the project. JSON-FG supports coordinate systems other than WGS84 and at the same time provides support for more complex geometry types.The testing of the services is either manual for the interfaces or, if possible, OGC's CITE tests are used (if available at the end of the project). Workstation applications such as QGIS can also be used for testing.

GEOE3

7. Ideas for the Future

We have identified the following developments for countries to follow further:

7.1. Location Innovation Hub (LIH)

Location Innovation Hub (LIH) is one of the over 200 European Digital Innovation Hubs that support companies in fostering their digital investments and digitalisation. Hubs provide innovation services, training, skills development, and financial advice for both small and medium-sized enterprises (SMEs), as well as public organisations. Every hub has a specific focus, and LIH focuses on spatial data, services, and technologies. This covers multiple sectors like the built environment, bioeconomy (including forests and agriculture/food), transport, health and well-being.

If you are a start-up, SME, or data provider in Europe you might be interested in LIH's services. To learn more, explore their website.

7.2. United Nations Integrated Geospatial Information Framework (UNGGIM)

The United Nations Integrated Geospatial Information Framework (UN IGIF) supports national governments' implementation of geospatial information management and provides detailed guidance for integrating geospatial information with other data. It provides a framework for national implementation.

For further details, please browse their website.

United Nations Initiative on Global Geospatial Information Management (UN-GGIM) Europe is an initiative that aims to enhance the management and availability of geospatial information at the European level. It assures collaboration between European institutions and national mapping and member states' cadastral and statistic institutions. They have several working groups like Core Data, Data Integration, and the European Geodetic Reference Frames.

Learn more by visiting their website.

In connection with the UN work, Geospatial Media and its partners have created a white paper on the Geospatial Knowledge Infrastructure. The aim is to create a connection with the industry and connect geospatial data with digital ecosystems.

To find out more, check out this PDF file.

7.3. European Data Spaces

The European data space is a term that describes a common data market across the European Union. It is a curated pool of data, services, tools, infrastructure, and governance that aims to boost growth and create higher value from data. The idea is to enable secure and standardised access to high-value datasets across different sectors and country borders while respecting European values and rights.

At the time of writing, the EU has plans for nine initial Common European data spaces:

- Industrial data space
- Green Deal data space
- Mobility data space

- Health data space
- Financial data space
- Energy data space
- Agriculture data space
- Data spaces for Public Administrations
- Skills data space

Geospatial data is part of the many European data spaces like Green Deal data space, mobility, health, energy and agriculture data spaces. The European implementation act on High-Value Datasets will have an especially big impact on the availability of geospatial data but also meteorological and statistical data.

For example, The European Data Space Support Center has provided a DSSC Starter Kit that describes the building blocks for data spaces. The components needed are interoperability, trust, data value and governance. For future work countries should consider these as well. Currently, there are many preparation projects that are making plans for the European data spaces.

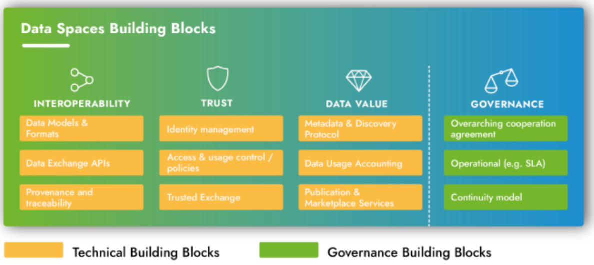

Figure 5. Building blocks for data spaces

Read more from this PDF.

7.4. Gaia-X

Gaia-X is a European project that aims to create an open, transparent, and secure infrastructure for data and services. Basically, its goal is to establish a federated ecosystem by linking many cloud service providers and users in a data space manner.

Gaia-X has also identified number of data spaces

- Industry 4.0
- Health
- Education and skills

- Energy
- Mobility
- Finance & Insurance
- Space

Several national hubs create a local community in Gaia-X. A working group on geospatial data has also been established. Gaia-X is seeking to cooperate with the European Commission.

The Joint Research Centre (JRC) evaluated several projects regarding Gaia-X, including GeoE3. You can read the report from this link.