

Aktuelles aus Europa:

INSPIRE und die Semantische Interoperabilität

Markus Jobst

Agenda

- Rückblick Geo-Ökosystem
- Interoperabilität und seine Dimensionen
- Wirkung auf INSPIRE
- Perspektiven
- Resümee



Ein Geoinformations-Ökosystem

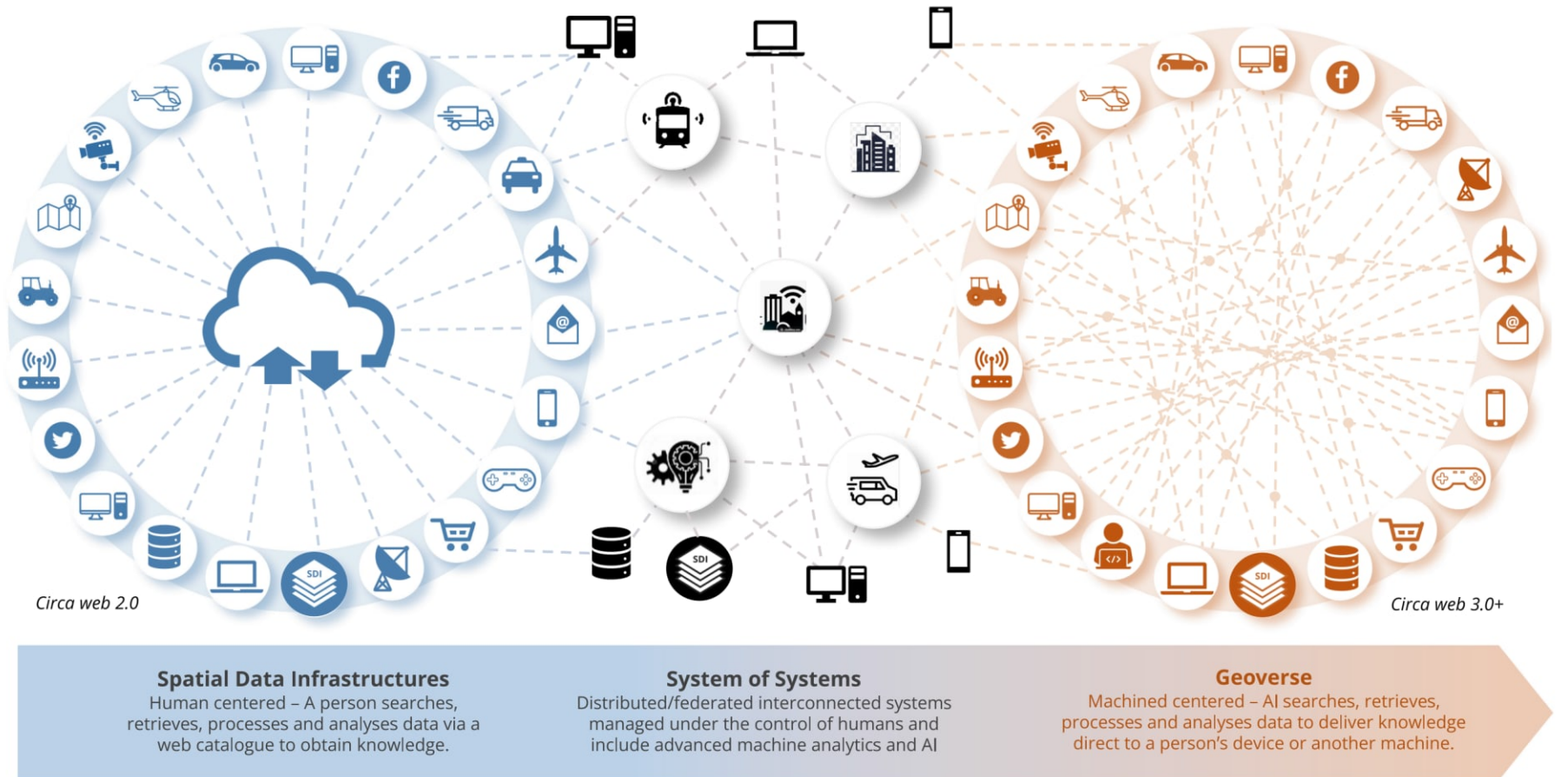
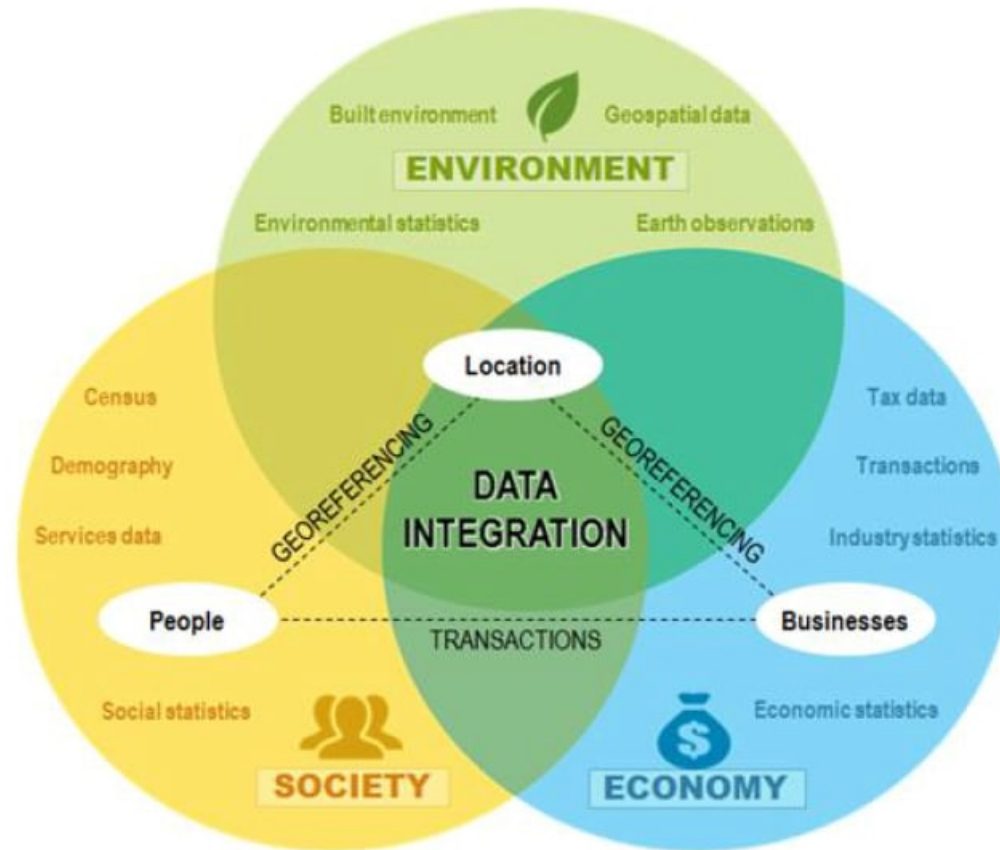


Figure 3. The future geospatial information ecosystem comprising SDIs, SoS and the Geoverse.

https://ggim.un.org/meetings/GGIM-committee/12th-Session/documents/Future_Geospatial_Information_Ecosystem_Discussion_Paper_July2022.pdf

Ein Geoinformations-Ökosystem



Location as a link between society, the economy and the environment,
The Global Statistical Geospatial Framework,
Department of Economic and Social Affairs,
UN Statistics Division, New York, 2019

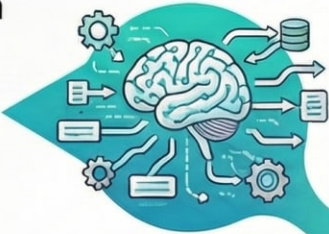
Schwerpunkte/Trends in GGIM

Geospatial 2030: Key Trends Shaping Our World

The Technology & Data Revolution

AI Disrupts Geospatial Production

Machine learning is automating data capture, feature extraction, and change detection.



Digital Twins Create Virtual Worlds

Digital replicas of cities enable simulation, prediction, and optimised urban planning.



Ubiquitous Connectivity is a Game Changer

5G technology will enable a new wave of real-time, data-intensive applications.



The Evolving Human & Policy Landscape

Geospatial Goes Mainstream

'Digital native' users and non-geospatial businesses are driving demand for accessible apps.



Digital Ethics & Privacy Take Centre Stage

The boom in location data raises critical questions about data ownership and cybersecurity.

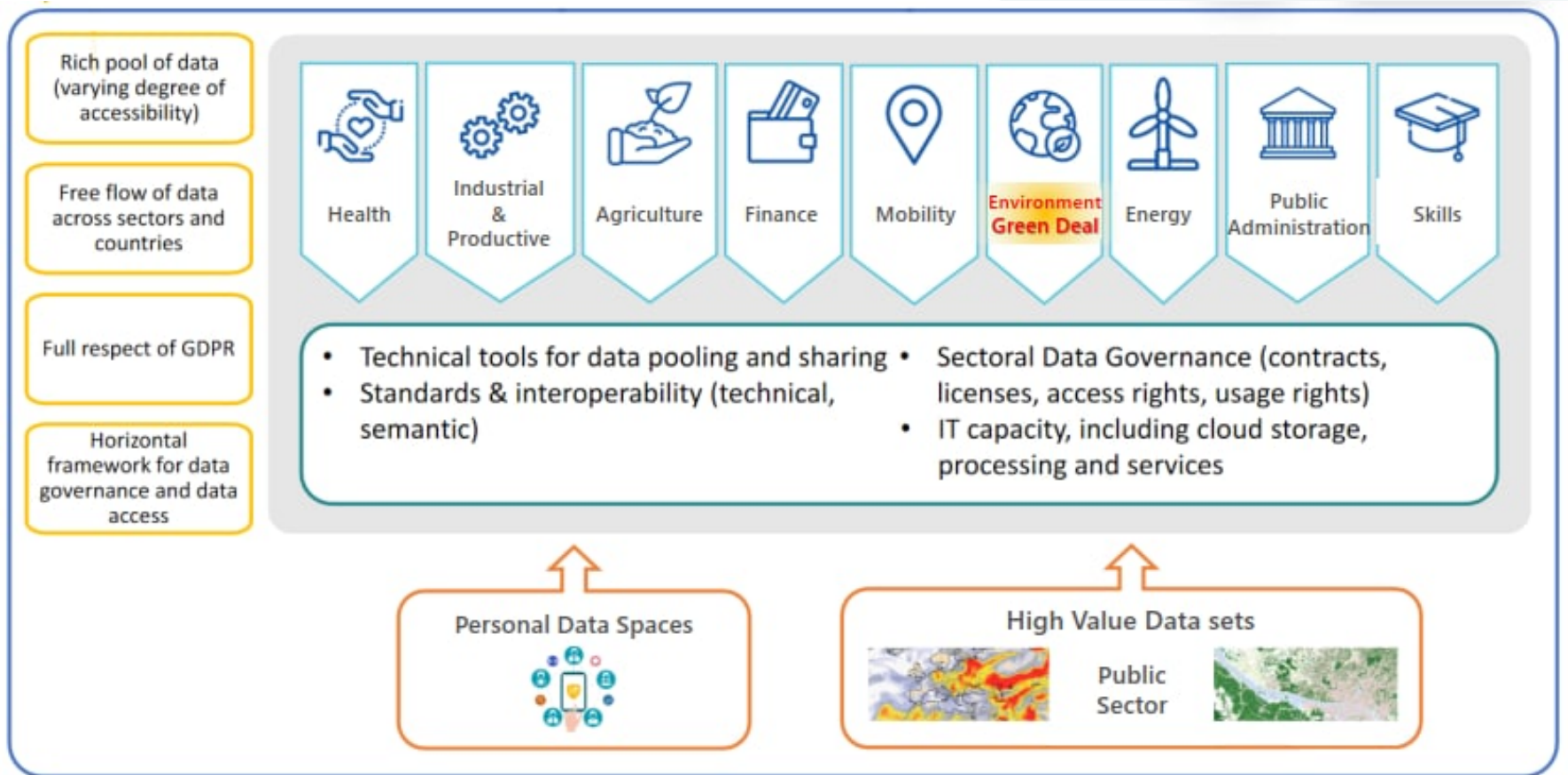


Demand for New Skills Surges

Data science, analytics, and visualisation expertise are now critical for the workforce.



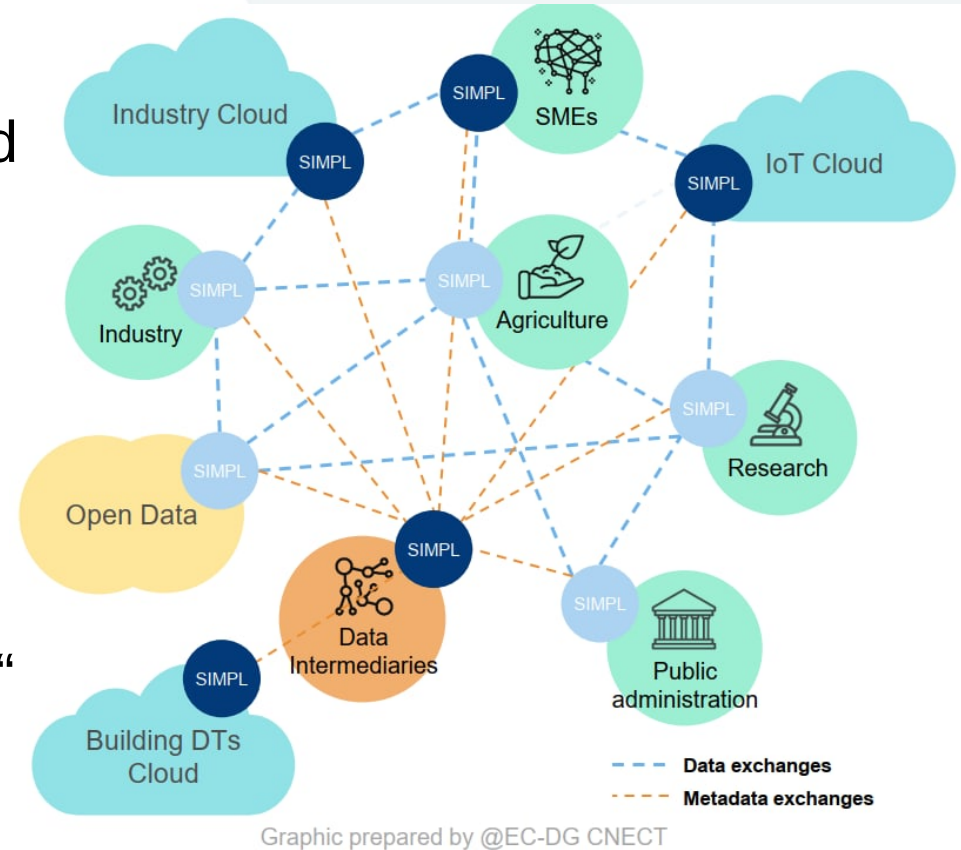
Das Geoinformations-Ökosystem



Jordi Escriu, EC-JRC, Unlocking the full potential of European data, at The role of geospatial in address major challenges facing Europe, EUROGI Conference, 21.11.2024

Visionen und Ziele

- Reibungslose Steuerung und Weiterentwicklung
- Nachhaltige Technologien
- SIMPL (cloud-to-edge)
- Agiler Austausch zwischen „Businesses & Communities“
- Integration „neuer“ Datenquellen



https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/communications-networks-content-and-technology_en

Citizen-generated data



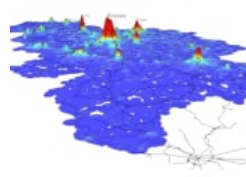
Copernicus



Internet of Things

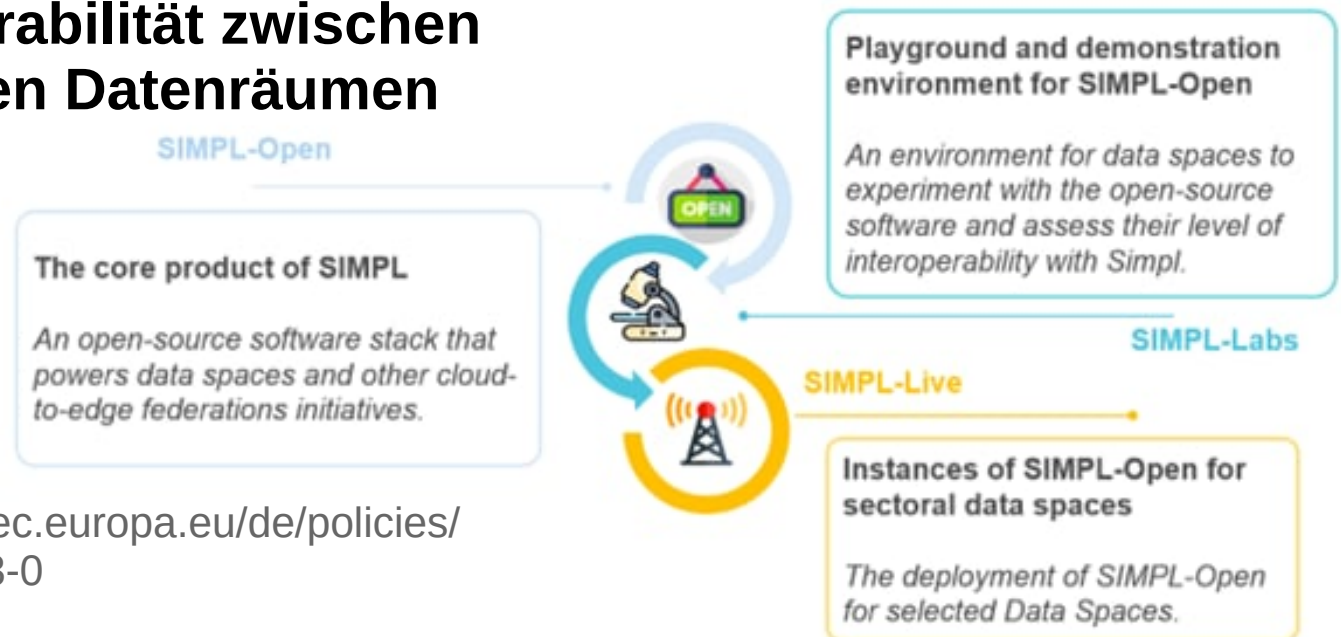


Private data



SIMPL (Cloud-to-Edge federations)

- Simpl ist eine quelloffene, intelligente und sichere **Middleware-Plattform**,
- die den Datenzugriff und
- die **Interoperabilität zwischen europäischen Datenräumen** unterstützt.



<https://digital-strategy.ec.europa.eu/de/policies/simpl#1712822729753-0>

Data Space Support Center - Werkzeuge

Data Spaces Toolbox

Submit a tool 

Filter

29 matching tools

Search

Service


- Federation
- Participant Agent
- Value Creation
- Catalogue
- Vocabulary
- Observability
- Data Space Registry
- Validation and Verification
- Policy Information Point
- Business and organisational support tools
- Control Plane
- Data Plane
- Credential Store

 **OntoPortal**

 Vocabulary

The primary mission of an OntoPortal installation is to host and serve ontologies and semantic artefacts. The portals accept resources in multiple...

 **iSHARE Trust Framework for Data Rights**

 Business and organisational support tools

The iSHARE Trust Framework provides a standardised approach for identification, authentication, and authorisation, enabling organisations to share data...

 **AgroPortal**

 Vocabulary

AgroPortal is an open, community-driven vocabulary service dedicated to the agricultural and agri-food domains, designed to host, share, and interconnect da...

 **PURIS - Predictive Unit Realtime Information Service**

 Value Creation

The introduction of the Predictive Unit Real-Time Information Service (PURIS) enriches a company's resilience strategy through standardized data...

 **Fair Data Publisher**

 Data Plane

A bridging service for publishing and accessing asset meta in the FDO (FAIR Digital Object) global data space data from within an EDC or AAS-based data space.

 **iSHARE Authorisation Registry**

 Policy Information Point

The Authorisation Registry is a key component of the iSHARE Trust Framework, enabling organisations to manage, verify, and delegate access rights withi...

 **sovity Data Space Portal (DSPortal)**

 Catalogue

The Data Space Portal is a comprehensive platform that enables seamless interactions within data spaces, providing tools for data discovery and...

 **IFLEX (Ikerlan Federated Learning EXtensible kit)**

 Value Creation

Ikerlan Federated Learning Extensible KIT provides a solution designed to collaboratively improve AI models across multiple participants in a secure and...

 **PETS (Privacy-Enhancing Data App for Secure Computations in Data Spaces)**

 Value Creation

This data app focuses on enabling privacy-preserving computations in data spaces. It leverages advanced Privacy-Enhancing Technologies (PETs), currently...

 **Apache Syncope**

 **Sitra R fair data**

<https://toolbox.dssc.eu/>

 **Service d...**

 **Business and or...**

 **Participant Agent**

 **Control Plane**

 **Data Plane**

 **Credential Store**

 **Federation**


 **Data Space Reg...**

 **Catalogue**

 **Validation and V...**

 **Policy Informat...**


 **Vocabulary**

 **Observability**

 **Value Creation**

 **Building b...**

 **Business Model**


 **Use Case De...**

 **Data Space O...**

 **Intermediarie...**

 **Organisationa...**

 **Participation ...**

 **Regulatory C...**

 **Contractual fr...**

 **Data Models**

 **Data Exchange**

 **Provenance &...**

 **Identity & Att...**


 **Trust Framew...**

 **Access & Usa...**

 **Co-creation**

 **Align Stakehold...**

 **Develop Use Ca...**

 **Establish Organi...**

 **Functional Anal...**

 **Establish Data S...**

Interoperability Framework Data Spaces



Joint Research Centre

Interoperability Approaches for environmental data sharing and reuse in the European Union

Reitz, T., Escrivá, J., Mirghani, M.
2025



Interoperability Framework ECDS (European Common Data Space)

- Die zweite Kommission von der Leyen (2024–2029) setzt sich für einen **neuen Plan für nachhaltigen Wohlstand und Wettbewerbsfähigkeit Europas** ein.
- Ziel ist es, die Produktivität durch die Verbreitung digitaler Technologien zu steigern und gleichzeitig den **grünen und digitalen Wandel** weiter zu unterstützen.
- **Digitale Infrastrukturen** sollen den Zugang zu sicherer, schneller und zuverlässiger Konnektivität verbessern.
- Bearbeitung von **bürokratischen Hürden** zugunsten von Geschwindigkeit und Flexibilität sowie **Abbau von Hindernissen für den Binnenmarkt** sind weitere wichtige Maßnahmen.

Interoperability Framework ECDS (European Common Data Space)

Es wird erwartet, dass die vorgestellten Vorschläge und Anregungen in der Studie „Interoperability Approaches for environmental data sharing and reuse in the European Union“ zur **Debatte über die Konzeption des EGDDS** sowie zur möglichen **Überarbeitung des Rechtsrahmens** für den Austausch von Umweltdaten (insbesondere INSPIRE) beitragen und diese beeinflussen werden. Diese Debatte wird derzeit unter der Leitung der Generaldirektion Umwelt der Europäischen Kommission (**DG ENV**) geführt.



Interoperability Approaches - Erkenntnisse

- **Bestehende Ansätze haben die Zugänglichkeit und Auffindbarkeit** von Umweltdaten verbessert, Interoperabilität und Wiederverwendbarkeit sind jedoch weiterhin eingeschränkt.
- Technische Interoperabilität wird durch unbeabsichtigte Komplexität, Unklarheiten bezüglich der Einhaltung von Vorschriften und die **Verwendung nicht bewährter Standards und Technologien** beeinträchtigt.

Interoperability Approaches - Erkenntnisse

- **Semantische Interoperabilität** ist aufgrund des Bedarfs an Konsens und konsistenten Definitionen von Schlüsselbegriffen und -konzepten schwer zu erreichen.
- **Governance-Strukturen** und ausreichende Ressourcen sind für die Implementierung und Aufrechterhaltung von Interoperabilitätsanforderungen und -empfehlungen unerlässlich.
- Es bestehen Möglichkeiten zur **Verbesserung der Interoperabilität**, beispielsweise durch die **Wiederverwendung definierter Semantiken** und konzeptioneller Modelle, die Verwendung offener Formate und die **Weiterentwicklung bestehender Domänenstandards** und -werkzeuge.

Interoperability Approaches - Erkenntnisse

- Die Einrichtung eines **Ad-hoc-Governance-Gremiums**, das sich auf Interoperabilitätsfragen konzentriert (z.B. Dateninteroperabilitätsgruppe (DIG) würde jedem Datenraum, einschließlich des EGDDS, zugutekommen, indem sie
- die besten semantischen, technischen und verfahrenstechnischen Aspekte der **Interoperabilität kontinuierlich weiterentwickeln** und überwachen
- Bindeglied zur Etablierung der Interoperabilität zwischen den Datenräumen
- **Übergeordnetes Steuerungsgremium für das EGDDS** (z. B. ein Green Data Advisory Board (GDAB)) oder ein Europäisches Digitales Infrastrukturkonsortium (EDIC)
- **Datenaustausch** zwischen den verschiedenen beteiligten Anbietern und Gemeinschaften erleichtern

Interoperability Framework Methoden

- Ebenen: die konzeptionellen Ebenen einer Datenrauminfrastruktur.
- Community-Ebenen.
- 12 Aspekte der Interoperabilität.
- Iterative Interoperabilität: mögliche Grade der Interoperabilität, die genutzt werden können, um Interoperabilität iterativ zu erreichen.

Table 1 | The Technical Building Blocks of the Data Spaces Support Centre (DSSC) Blueprint v1.5

TECHNICAL BUILDING BLOCKS		
Data interoperability	Data Sovereignty & Trust	Data Value Creation Enablers
Data Models	Identity & Attestation Management	Data, Services & Offerings Descriptions
Data Exchange	Trust Framework	Publication & Discovery
Provenance & Traceability	Access & Usage Policies Enforcement	Value Creation Services

Source: Data Spaces Support Centre (DSSC).

Interoperability Framework Methoden

The mapping to the blueprint is as follows:

“Data Models”

The “Data Models” building block focuses on the vocabulary (1b) aspect of interoperability and touches some others, such as the logical models (2a), open formats (2b), open Application Programming Interfaces (APIs) (2c), mappings (2d) and conceptual models (1c) aspect of interoperability. The building block contains the following elements (DSSC, 2025b):

- **Vocabularies:** common languages to facilitate semantic interoperability in a data space, including ontologies, data models, schema specifications, mappings and API specifications that can be used to annotate and describe data sets and data services.

- **Vocabulary management process:** the management process for creating, managing and updating vocabularies within data spaces.

- **Vocabulary hub:** a technical component providing facilities for publishing, editing, browsing and maintaining vocabularies and related documentation.

Interoperability Framework Methoden

Meta specifications and best practices for the adoption of existing data exchange APIs.

Generic purpose data exchange API, including methods to query, update and delete data.

Tooling to use and maintain data exchange APIs

Technical formats: This building block has a strong relation with the data models building block. It provides the ground of data models in technical formats (payload of the API), e.g. JavaScript Object Notation (JSON).

“Data Exchange”

The “Data Exchange” building block maps to the logical models (2a), open formats (2b) and open APIs (2c) aspects of interoperability. This building block contains the following elements (DSSC, 2025c):

Interoperability Framework Methoden

“Provenance and traceability”

The “Provenance and traceability” building block primarily describes how transactions are logged, authorised and potentially billed. Such rules may partially map to the lifecycle rules for individual data objects (3b), existence of a monitoring and reporting mechanism (3c) and the existence of a well-suited governance mechanism for agreeing on other aspects (3d). According to the Data Spaces Building Blocks documentation, the following elements are part of this (DSSC, 2025d):

- 1. **Framework for requirements for observability:** data transactions in Data Spaces can require the observability of each activity in the transaction including the provisioning of evidence.

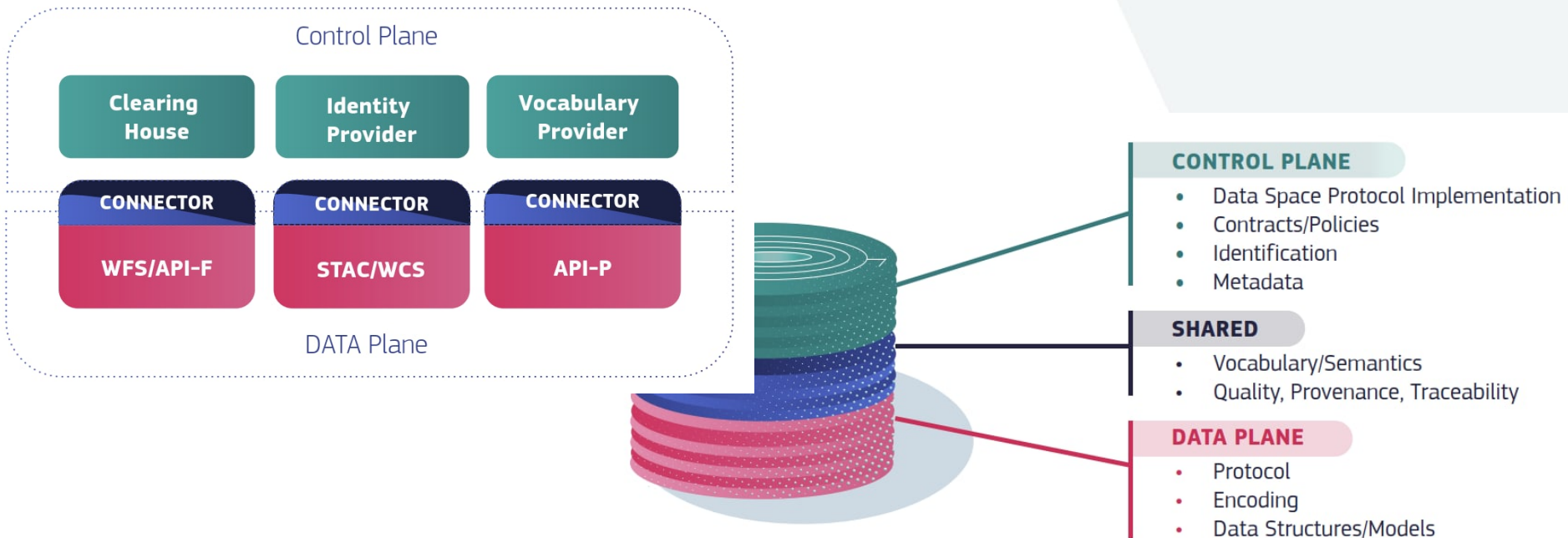
● **Third parties to provision or use evidence:** the provisioning and usage of this evidence can be used by the parties directly involved in the transaction and optionally by a third party, which is not directly involved in the transaction. Such third parties can be involved for different purposes, e.g., auditing, usage accounting and billing, or compliance.

- **Mechanisms to provide and use evidence of the activities of a transaction:** this is particularly relevant when multiple parties are involved in the value creation, so called value chains, as such parties have a different interest.

- Die Rolle des PVP Stammportals?

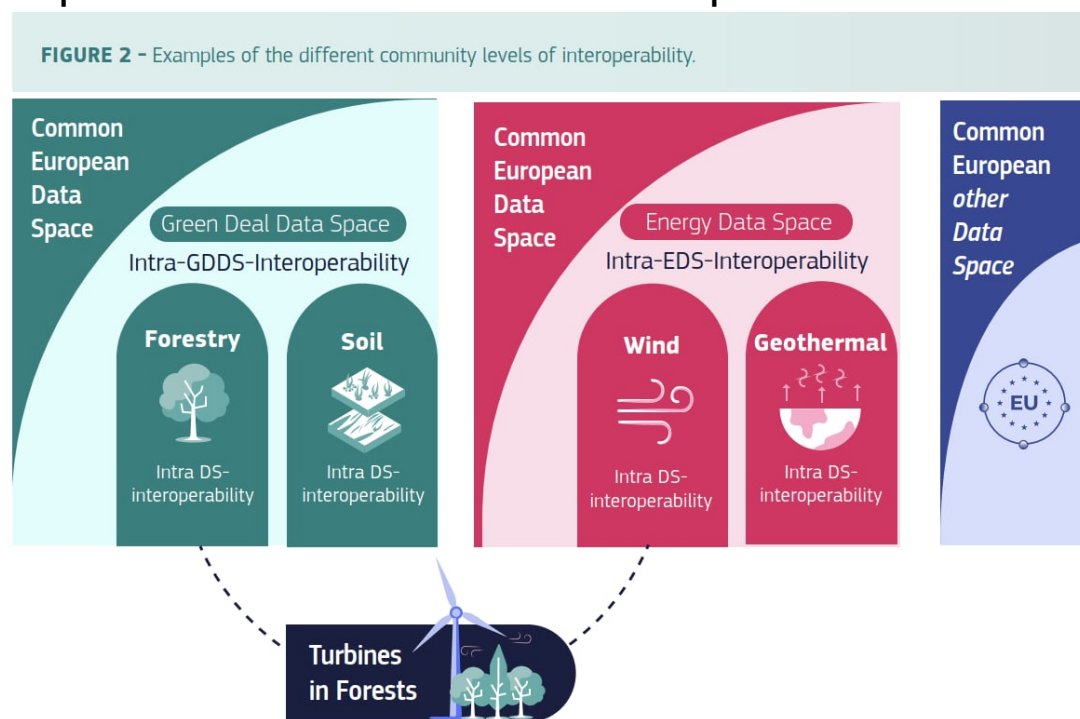
Infrastruktur Ebenen: Daten und Steuerung

- Die Steuerungsebene ist der Ort, an dem Daten ermittelt, die Zugriffskontrolle verwaltet und durchgesetzt sowie die spezifischen Protokolle und Komponenten definiert werden.
- Die Datenebene ist der Ort, an dem die eigentlichen Daten ausgetauscht und verarbeitet werden.



Community Ebenen im Datenraum

- Inter-CEDS: Sektor-übergreifende Common European Data Spaces
- Intra-CEDS: Domänen-übergreifende Common European Data Spaces
- Intra-EGDDS: Interoperabilität im Europäischen Green Deal DS
- Intra-DS: Interoperabilität im einzelnen Data Space



Source: Figure created for the purpose of this study.

12 Aspekte der Interoperabilität

Semantische Interoperabilität

- Verwendung allgemein anerkannter und klar definierter Maßeinheiten und Bezugssysteme.
- Verwendung anerkannter Wörterbücher, Vokabulare und Taxonomien, idealerweise basierend auf gemeinsamen Rechtsnormen (z. B. einer Verordnung der Europäischen Kommission).
- Verwendung konzeptioneller Datenmodelle, dokumentiert unter Verwendung von Standardmethoden, z. B. der Unified Modeling Language (UML).
- Vorhandensein semantischer Zuordnungen von etablierten (nationalen oder regionalen) Standards zum gemeinsamen Standard, die die semantische Ausrichtung verbessern und verbleibende Diskrepanzen dokumentieren.

12 Aspekte der Interoperabilität

Technische Interoperabilität

- Verwendung formal spezifizierter logischer Datenmodelle.
- Verwendung gängiger, offen spezifizierter und universell implementierbarer Datenformate.
- Verwendung gängiger, offen spezifizierter und universell implementierbarer APIs und Protokolle.
- Vorhandensein einer Validierungs- und Qualitätssicherungsinfrastruktur.

12 Aspekte der Interoperabilität

Prozess Interoperabilität

- Anwendung **gemeinsamer Qualitätsstandards** bei der Datenerfassung und -pflege, z. B. hinsichtlich des Mindestmaßstabs für Geodaten oder der räumlichen und numerischen Genauigkeit sowie der Klassifizierungsgenauigkeit für nicht-räumliche Attribute.
- Klar definierte **Lebenszyklusregeln** für einzelne Datenobjekte.
- Vorhandensein eines Überwachungs- und Berichtsmechanismus.
- Vorhandensein eines geeigneten **Governance-Mechanismus** zur Abstimmung aller weiteren Aspekte.
- Stabile und verlässliche Governance?
- Prozess Standards? Interoperabilität von Prozessen?

Interoperability Framework EU-GDDDS

Connecting Environmental Data: A Blueprint for the EU Green Deal Data Space

To achieve the European Green Deal's objectives, environmental data from various sources must be easily shared and reused.

The Interoperability Challenge

Data is Accessible, but Not Always Usable



While past efforts improved data discovery, true interoperability and reusability remain limited.

Speaking Different 'Data' Languages



A primary barrier is the difficulty of achieving community agreement on common definitions and concepts.

Fragmented Governance and Resources

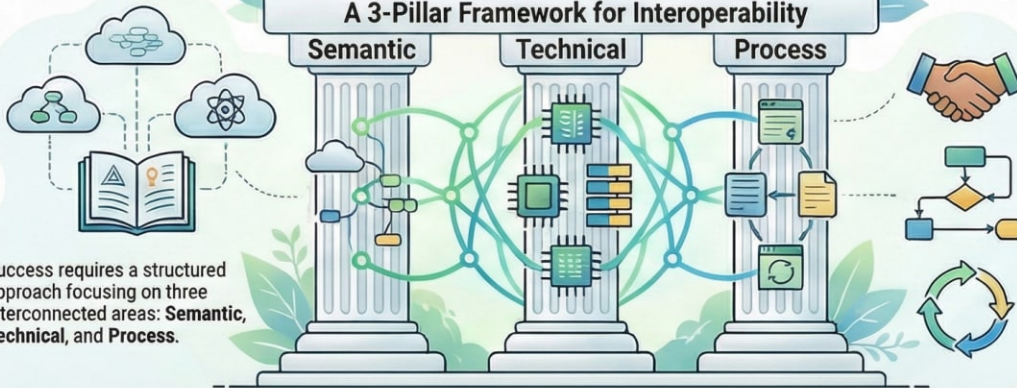


Unclear responsibilities and insufficient resources are key obstacles to implementing and maintaining interoperability standards.

A Blueprint for Success

A 3-Pillar Framework for Interoperability

Semantic Technical Process



Success requires a structured approach focusing on three interconnected areas: **Semantic, Technical, and Process.**

Establish Dedicated Governance Bodies



Data Interoperability Group (DIG)
For technical work



Green Data Advisory Board (GDAB)

Priority Actions

	Impact score	Difficulty score
Standardise Units & Reference Systems	4.5	2.0
Adopt Open Data Formats	4.5	2.2
Use Open APIs & Protocols	3.5	1.6

Wirkung auf die Geodateninfrastruktur (INSPIRE)

Evaluierung von Interoperabilitäts-Rahmen

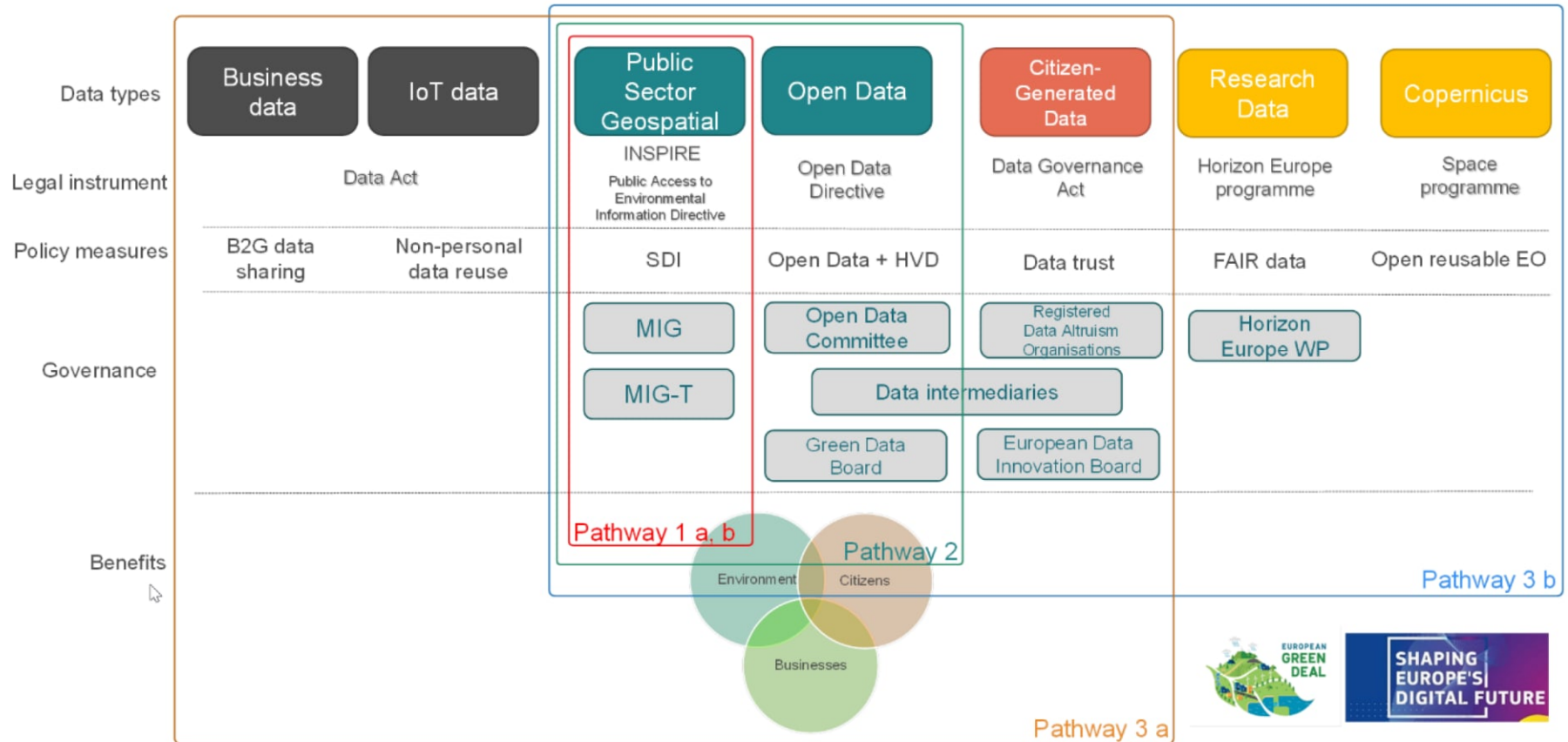
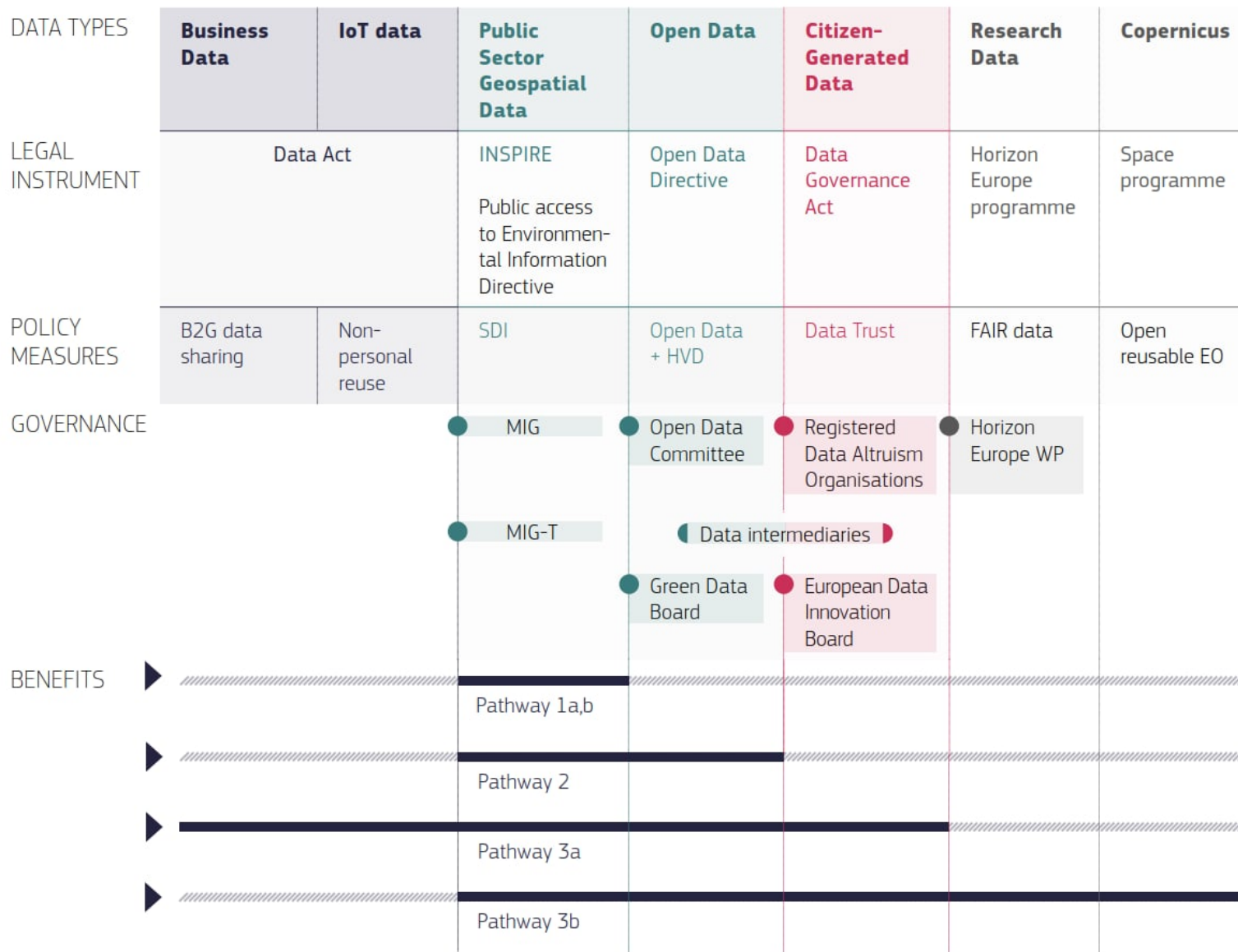


Figure 1. Policy pathways for establishment of the European Green Deal Data Space. Initial reflection. Source: Author's own elaboration.

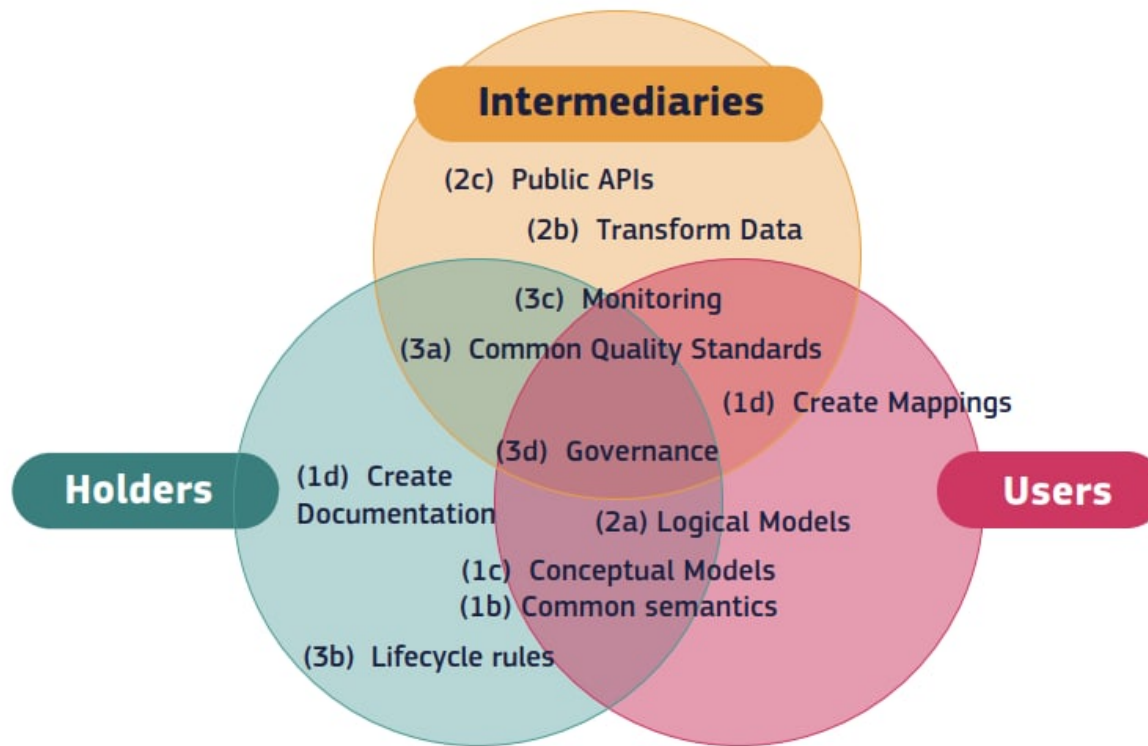
<https://publications.jrc.ec.europa.eu/repository/handle/JRC133958>

Ev **FIGURE 3 - Policy pathways for the evolution of INSPIRE and the establishment of the Green Deal Data Space**



Evaluierung von Interoperabilitäts-Rahmen

FIGURE 4 - An example for assigning responsibilities for activities that contribute to interoperability.



Evaluierung von Interoperabilitäts-Rahmen

Diskussionsbedarf

Table 2 | Interoperability approaches - The environmental data sharing initiatives

Aspects	PSIE ⁵	INSPIRE ⁶	END ⁷	HVD ⁸	TN-IT ⁹	XPlanung ¹⁰
1a UoM/CRS	None	Full	Full	None	Full	Full
1b Dictionaries	None	Major	Full	Minor	Full	Full
1c Conceptual Models	None	Full	Full	Minor	Full	Full
1d Semantic Mappings	None	None	Major	None	None	Minor
2a Logical Models	None	Full	None	Minor	Major	None
2b Open Formats	Minor	Major	Full	Minor	Full	Full
2c Open APIs/Protocols	None	Major	Full	None	Full	Full
2d Validation	None	Minor	Full	None	Major	Major
3a Quality Standards	None	Minor	Major	None	Major	Minor
3b Lifecycle Rules	None	Minor	Full	Minor	Full	Major
3c Monitoring	None	Major	Major	None	Minor	None
3d Governance	None	Minor	None	None	Major	Major

Source: Table created for the purpose of this study.

The impact levels are defined as follows:

- **None:** No discernible impact.
- **Minor:** Partial impact on some (10-50%) resources.
- **Major:** Substantial impact on some resources.
- **Full:** Substantial impact on most (50%+) resources.

Evaluierung von Interoperabilitäts-Rahmen

Diskussionsbedarf

Table 3 | MATURITY OF EXISTING APPROACHES - Difficulty and impact of proposed approaches.

Aspect	Maturity	Difficulty	Impact
1a Units/Reference Systems	HIGH	OVERALL DIFFICULTY: LOW (2.0) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Specialist domain knowledge: 2 Specialist technical knowledge: 2 Broad Agreement: 1 → SI units, base standards Complexity of the domain: 3 Tooling/Methods maturity: 2 	OVERALL IMPACT: HIGH (4.5) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Understanding: 4 Automation: 5 Combination: 5 Usage: 4
1b Dictionaries	MODERATE	OVERALL DIFFICULTY: MEDIUM (3.4) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Specialist domain knowledge: 4 → vocabularies need to be added or extended Specialist technical knowledge: 3 → for more complex taxonomies Broad Agreement: 4 → in the remaining domains, this is difficult Complexity of the domain: 4 → the domains missing such lists are complex Tooling/Methods maturity: 2 	OVERALL IMPACT: HIGH (4.25) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Understanding: 5 Automation: 4 Combination: 4 Usage: 4
1c Conceptual Models	MODERATE	OVERALL DIFFICULTY: MEDIUM (3.2) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Specialist domain knowledge: 4 → extensions, simplifications Specialist technical knowledge: 3 Broad Agreement: 3 Complexity of the domain: 4 Tooling/Methods maturity: 2 	OVERALL IMPACT: HIGH (3.75) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Understanding: 5 Automation: 2 Combination: 3 Usage: 4

Difficulty	Impact
OVERALL DIFFICULTY: MEDIUM (2.2) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Specialist domain knowledge: 3 → useful simplifications are not trivial to define Specialist technical knowledge: 4 → tools are mature but very technical Broad Agreement: 2 Complexity of the domain: 3 → useful simplifications are not trivial to define Tooling/Methods maturity: 2 	OVERALL IMPACT: HIGH (3.75) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Understanding: 3 Automation: 4 Combination: 3 Usage: 5
OVERALL DIFFICULTY: MEDIUM (2.2) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Specialist domain knowledge: 2 Specialist technical knowledge: 2 Broad Agreement: 3 Complexity of the domain: 2 Tooling/Methods maturity: 2 	OVERALL IMPACT: HIGH (4.5) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Understanding: 3 Automation: 5 Combination: 5 Usage: 5
OVERALL DIFFICULTY: LOW (1.6) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Specialist domain knowledge: 2 Specialist technical knowledge: 1 Broad Agreement: 2 → some new APIs are coming up Complexity of the domain: 2 Tooling/Methods maturity: 1 	OVERALL IMPACT: MEDIUM (3.5) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Understanding: 2 Automation: 5 Combination: 3 Usage: 4
OVERALL DIFFICULTY: MEDIUM (2.6) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Specialist domain knowledge: 2 	OVERALL IMPACT: HIGH (4.0) INDIVIDUAL FACTORS: <ul style="list-style-type: none"> Understanding: 3

Perspektiven

Perspektiven - SHACL

SHACL steht für Shapes Constraint Language und

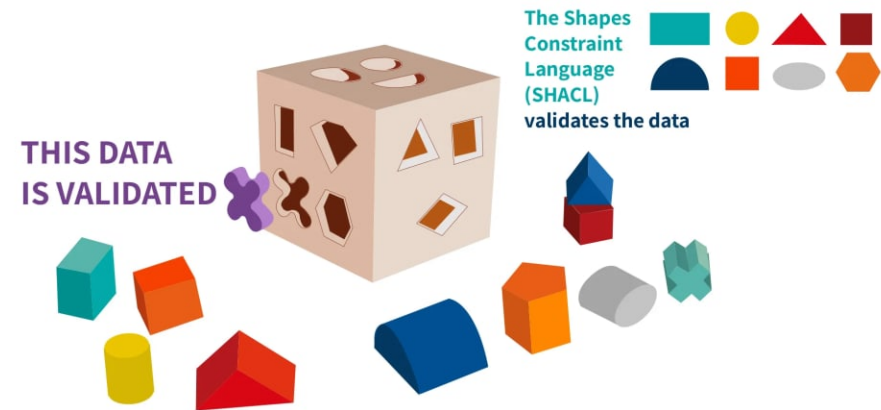
ist eine W3C-Standard-Sprache zur Validierung von RDF-Graphen

Einschränkungen und Regeln (sogenannte "Shapes") zu definieren, um die Struktur und den Inhalt von Daten zu beschreiben und zu überprüfen.

Organisationen nutzen SHACL, um die Datenqualität sicherzustellen und Datenharmonisierung zu ermöglichen

Prüfung, ob Wissensgraphen bestimmten Anforderungen entsprechen

z. B. das Überprüfen, ob ein Geburtsdatum nicht nach einem Sterbedatum liegt.

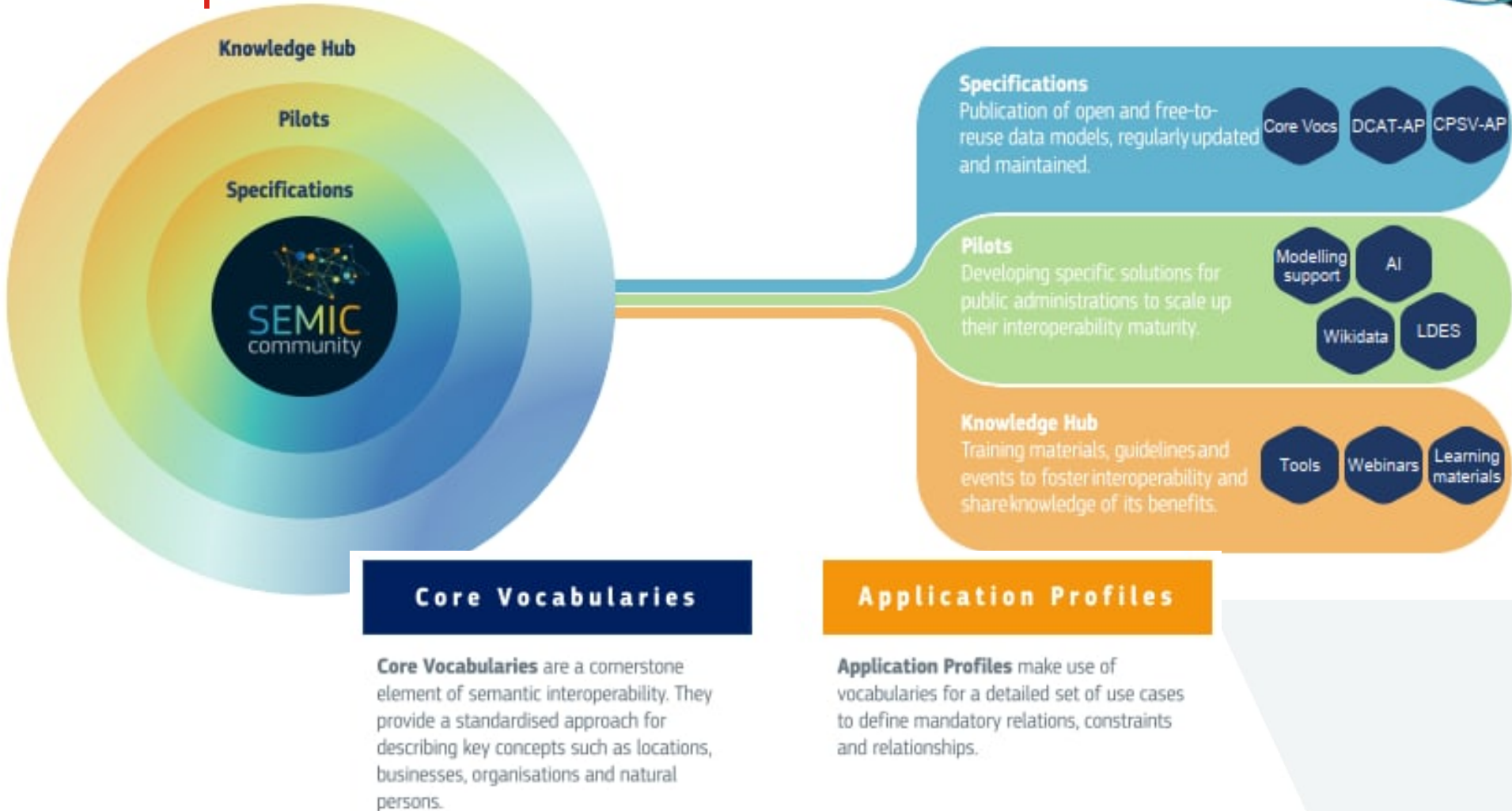


SEMIC20
conference 25

3 kinds of SHACL specs for different objectives

- « ETL SHACL » objectives :
 1. validate the expected content of one named graph in the ETL process
 2. specify and document the mapping of the input data to the target SHACL graph
- « Application profile SHACL » objectives :
 1. Provide an inventory of all classes and properties used inside the knowledge graph
 2. Generate public documentation of this « inventory »
 3. Ensure consistency of the properties and classes used throughout every ETL and DSD SHACL
 4. ongoing : generate JSON-LD @context
- « DSD SHACL » objectives :
 1. provide a public documentation of the content of the dataset
 2. ongoing : generate JSON schema of the corresponding API
 3. (automate the extraction of the dataset content from the global knowledge graph)

Perspektiven - SEMIC



SEMIC Support Center: <https://interoperable-europe.ec.europa.eu/collection/semic-support-centre>

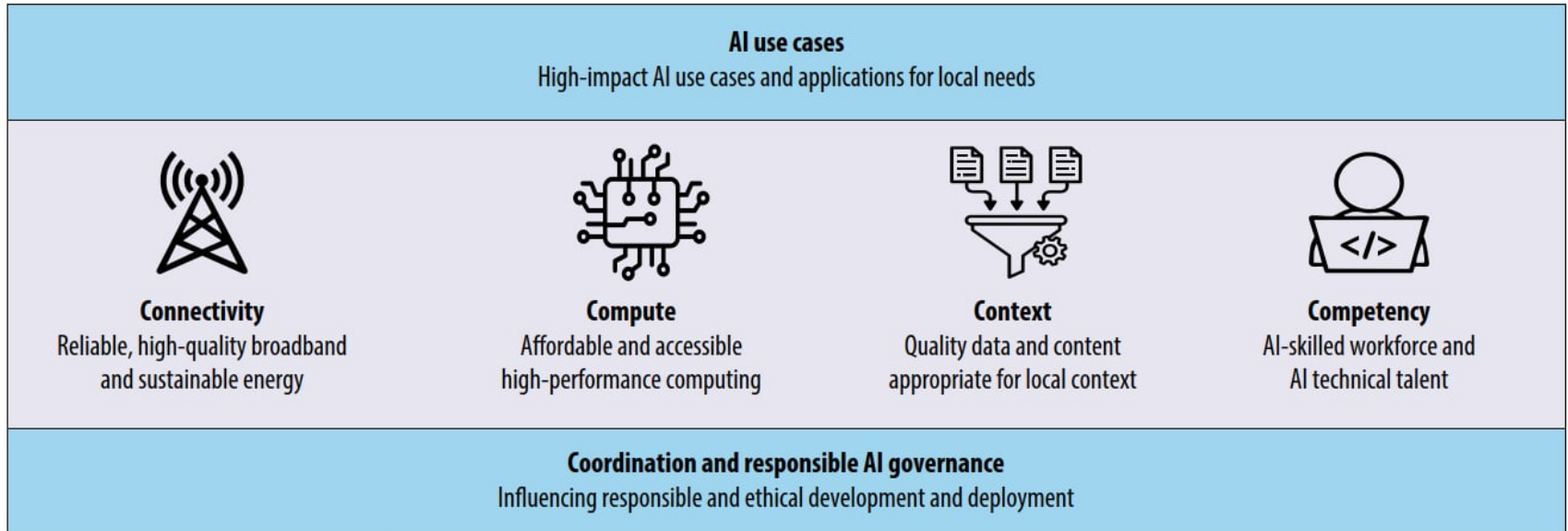
Perspektiven - EC

SOME EU AI AND RELATED TOPICS REPORTS AND LEGISLATION SINCE 2018

1. **General Data Protection Regulation (GDPR)** - 2018
2. **Coordinated Plan on Artificial Intelligence** - 2018
3. **Ethics Guidelines for Trustworthy AI** - 2019
4. **Cybersecurity Act** - 2019
5. **White Paper on Artificial Intelligence** - 2020
6. **Report on the safety and liability implications of AI, IoT, and robotics** - 2020
7. **Digital Services Act (DSA)** - 2020
8. **Digital Markets Act (DMA)** - 2020
9. **European AI Strategy** - 2020
10. **EU Strategy for Data** - 2020
11. **Artificial Intelligence Act** - 2021
12. **AI Watch: Estimating AI Investments in the European Union** - 2022
13. **EU AI Act** - 2024
14. **Special report 08/2024: EU Artificial intelligence ambition** - 2024
15. **AI investment: EU and global indicators** - 2024

Bruce McCormack (EUROGI),
HOW GEOSPATIAL CAN HELP ADDRESS EUROPEAN, AND GLOBAL MAJOR CHALLENGES,
EUROGI Conference, Brussels, 21 November 2024

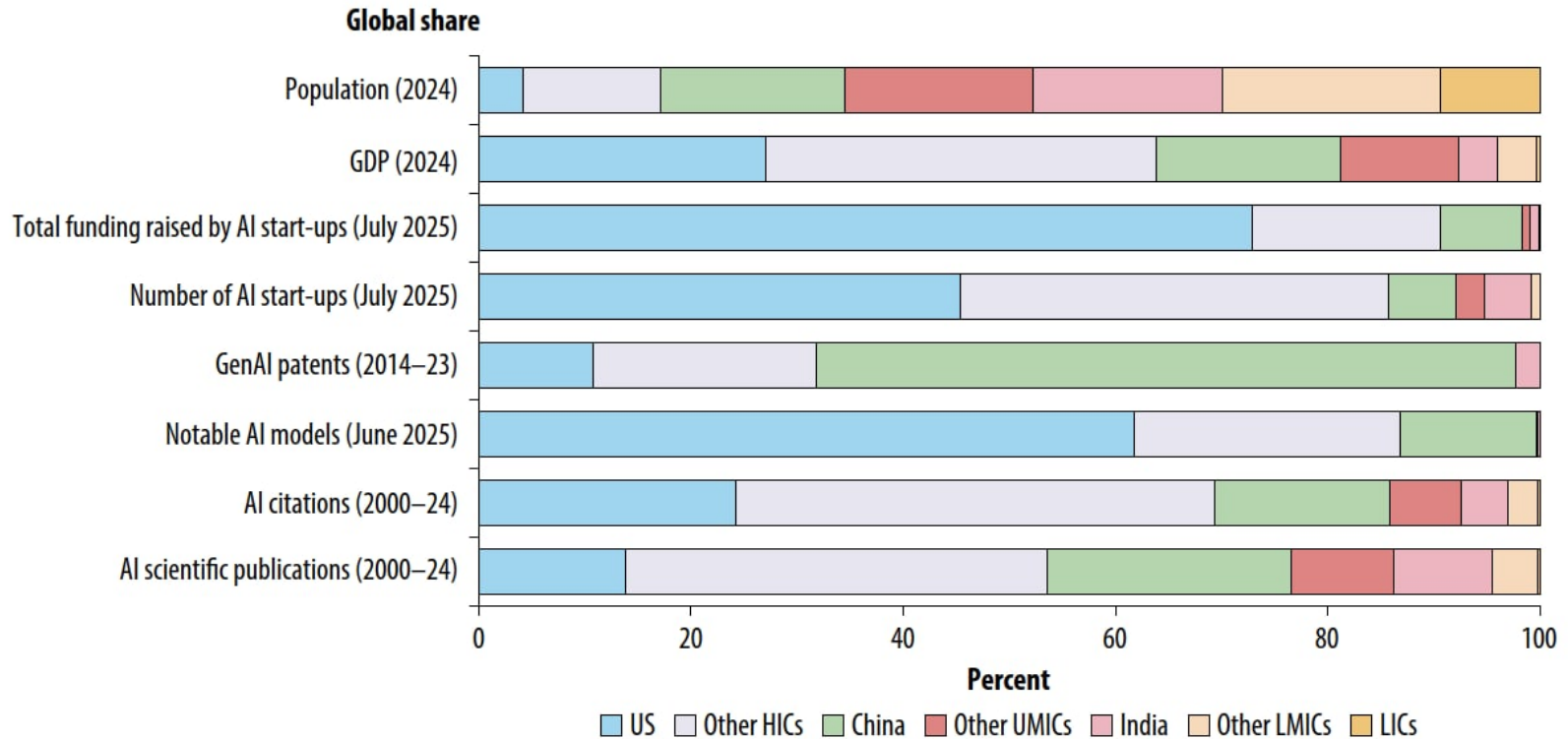
Perspektiven AI



Source: Original figure for this publication.

Note: The “coordination and responsible AI governance” topic is covered in a companion publication (World Bank 2024, <https://hdl.handle.net/10986/42500>). AI = artificial intelligence.

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Sources: Original figure for this publication based on analysis of various indicators from Epoch (<https://epoch.ai/>), OECD.AI (<https://oecd.ai/en/>), and WIPO (<https://www.wipo.int/en/web/ip-statistics>).

Note: For models with multiple contributors, only the nationality of the first or leading contributor is counted. AI = artificial intelligence; GDP = gross domestic product; GenAI = generative artificial intelligence; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries; US = United States.

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FIGURE B01.1 Country AI readiness level, 2024



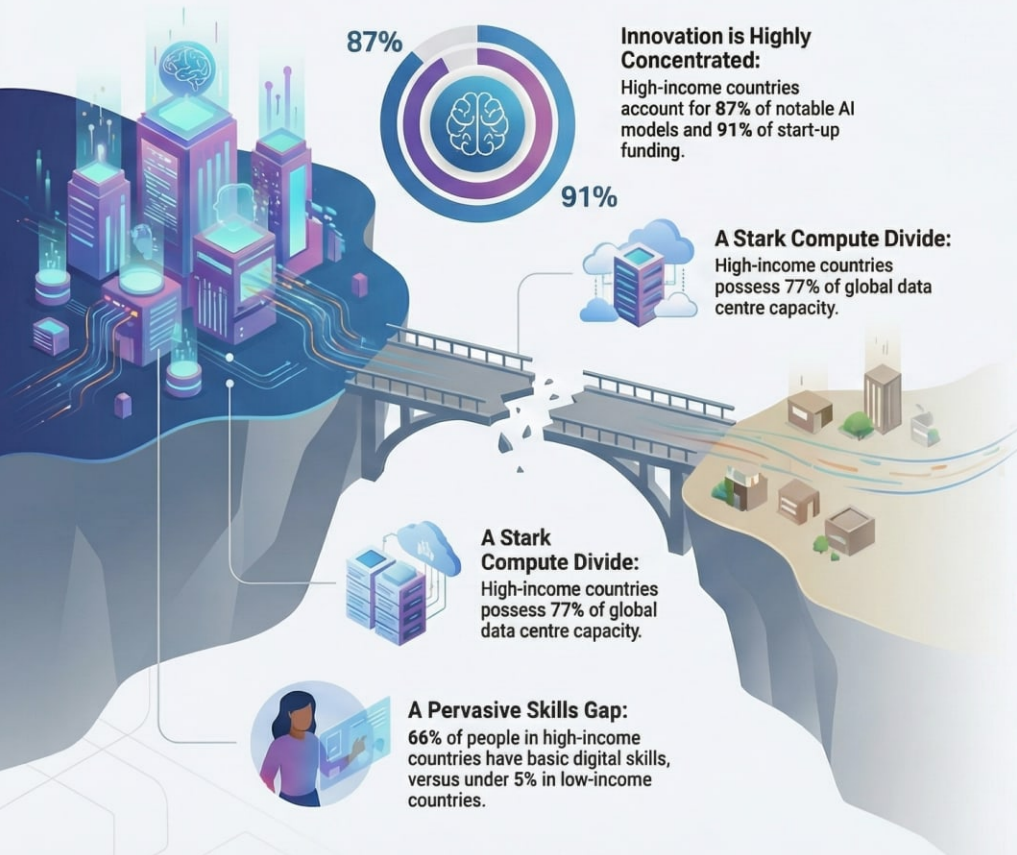
Source: Original figure for this publication using calculations from the Tortoise Media's Global AI Index (<https://www.tortoisemedia.com/data/global-ai>).

Note: AI = artificial intelligence.

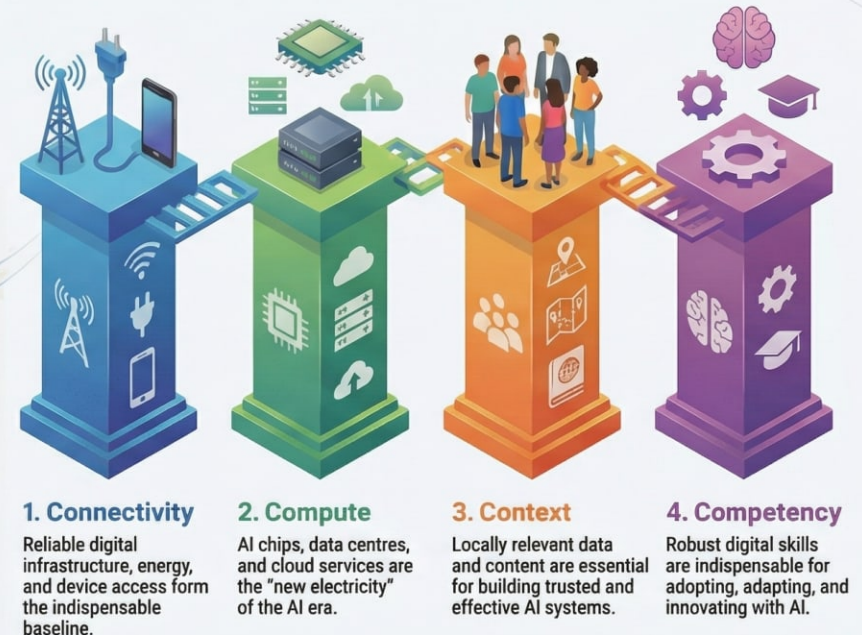
Perspektiven AI - Lückenschluss

Bridging the Global AI Divide: The 4Cs Framework for Development

The Widening AI Divide



Building AI Foundations: The 4Cs



Agenda

- Rückblick Geo-Ökosystem
- Interoperabilität und seine Dimensionen
- Wirkung auf INSPIRE
- Perspektiven
- Resümee

