

# Data reuse in healthcare

## as urgent as challenging

HERACLES as an example of how we aim to address this in the oncology domain

Ton Peters (J&J) Simon Dalmolen (TNO)



# European Single Market for Data

## Data legislation

Data Act

Data Governance Act

Open Data Directive

GDPR

...

## Common European Data Spaces



Health



Industrial &  
Manufact.



Agriculture



Finance



Mobility



Green  
Deal



Energy



Public  
Admin.



Skills



EOSC



Tourism



Cultural  
heritage



Media



Language

High Value  
Datasets  
from  
public  
sector

## European Data Innovation Board

- Facilitate the sharing of best practices
- Prioritisation of cross-sectoral interoperability standards

## Data Spaces Support Centre

- Development of blueprint, glossary, etc.
- Support of data space projects

## Technical infrastructure

Standards

Digital identity  
(eIDAS)

Smart Middleware  
solutions  
(Simpl)

High-Performance  
Computing

Testing and  
Experimentation  
Facilities

# Reuse of data has become an indispensable cornerstone of our healthcare system, becoming mandatory



Personalized medicine

Cost Effectiveness

Capacity and Resource Allocation

## European Health Data Space: Council and Parliament strike deal

The Council of the EU and the European Parliament have reached a provisional agreement on a new law making it easier to **exchange and access health data** at EU level. The agreement will now need to be endorsed by both the Council and the Parliament.

Cross border collaboration

Coronavirus: Mobility data provides insights into virus spread and containment to help inform future responses



Predictive Analytics

# Meanwhile there is a (growing) Importance of privacy and confidentiality



## Renewed privacy regulations



Home > Kennis > Artikelen

### AI, data en cyber: Europese wetten om in de gaten te houden

Begin december heeft de Europese Unie dan eindelijk een politiek akkoord bereikt over de AI Act. Deze wet zal grote veranderingen met zich brengen voor de toekomst van AI. De AI Act is echter onderdeel van een veel groter pakket aan AI-, data- en cyberwetgeving vanuit de EU. Veel van die wetten zijn minstens net zo interessant als de AI Act. Op welke moet u als bedrijf gaan letten? En op welke regels kunt u zich alvast voorbereiden?

## More public debates

The screenshot shows the homepage of Privacy First. At the top, there's a purple header with the logo 'PRIVACY FIRST' and a navigation bar with links like 'Home', 'Privacy First', 'Surveillance', 'Financeel', 'Automotive', and 'Contact'. Below the header, a red banner reads 'Uitgelicht: Rechtszaak Privacy First tegen ANPR massa-surveillance'. The main content area features several news cards:

- De Verkliksamenleving**: Surveillance, 16 maart, 2024. Shows a large camera lens.
- Inschrijving Nederlandse Privacy Awards 2025 geopend!**: Privacy Awards, 15 maart, 2024. Shows a trophy.
- Rechtszaak Privacy First tegen ANPR massa-surveillance**: Surveillance, 6 maart, 2024. Shows a surveillance camera on a pole.
- TAXUD**: Financieel, 28 februari, 2024. Shows the European Union flag.
- Uw bankrekening: de sluiproute naar uw privéleven (deel 2)**: Financieel, 27 februari, 2024. Shows a car driving on a road.
- Geen 'slim verkeer' zonder jouw voertuig- en locatiegegevens**: Automotive, 27 februari, 2024. Shows a car's dashboard.
- Uw bankrekening: de sluiproute naar uw privéleven (deel 1)**: Financieel, 13 februari, 2024. Shows a car driving on a road.

SecurityIntelligence



Cost of a data breach 2023:  
Pharmaceutical industry  
impacts

Commercial interests prevent data sharing

# Data for Secondary use and AI! nice .... but Health Data are not just data.....



Health Data are telling you how healthy you are! These data can be misused easily by researchers, governments and private sector without clear legislation, secure data sharing and Privacy Enhanced Technologies (PET's).

- Researchers could use your health data and publish the results without having your explicit consent!
- Insurance companies and authorities could categorize the population for purposes you never asked for!
- Your Health Data could be used by Big Tech for their business model!

Therefor we need guardrails like EHDS  
and  
Secure Data Sharing



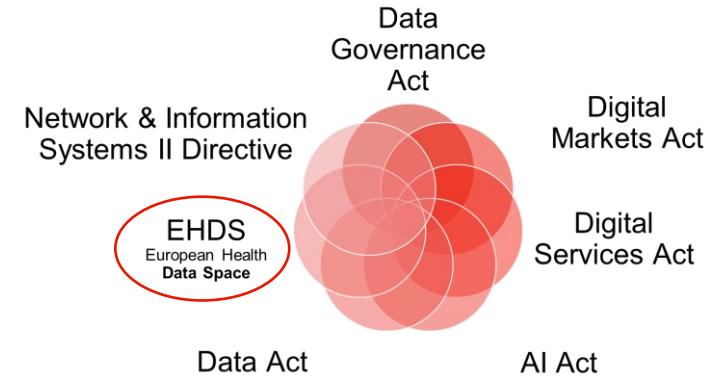
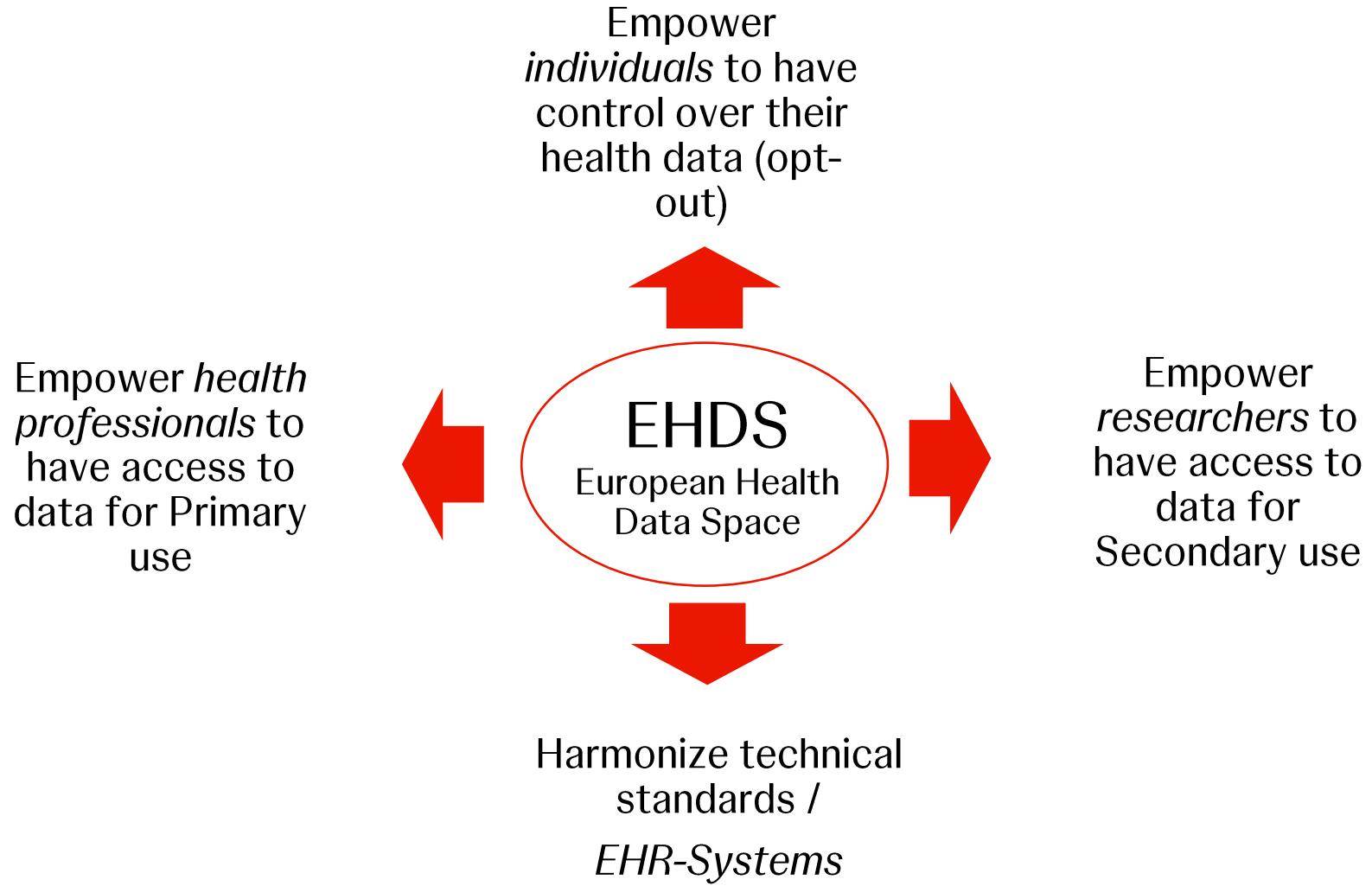
TNO Sustainable ▾ Healthy ▾ Safe ▾ Digital ▾ More ▾ Q EN ▾

... / Newsroom / Insights /

**HERACLES lays foundation for  
secure data sharing in healthcare  
sector**

Data sharing Privacy enhancing technologies 8 February 2024

# The 4 chapters of the new EU-Legislation should empower patients, make health care more efficient and strengthen innovation



# Data fragmentation still persists

## *Skepticism towards data reuse and sharing*

- Initiatives are small and also fragmented
- Lack of standardization
- Lack of Authority & Leadership



SURF



Johnson&Johnson



Health~Holland



Impact

Quality of Diagnosis

Quality of Treatment

Cost reduction in healthcare

Trustworthy ecosystem

Actors

Pharma

Hospital

Infrastructure service provider

Health insurance

National Fund raiser

Patient organizations

Netherlands Cancer Organization

Research Institutes

Applications

Ovarium cancer insight counter

Lung cancer insight counter

Datasets

IKNL

NKR



Pharmo

INSZO-STIZON



RadboudUMC

EPD



UMCG



CZ



Infrastructure

### Health Data Space

*Data Sharing Meta model, including business models and governance structure*

Secure Gateway, identity provisioning, clearing house, registry/broker servers, computing, OS, storage, network

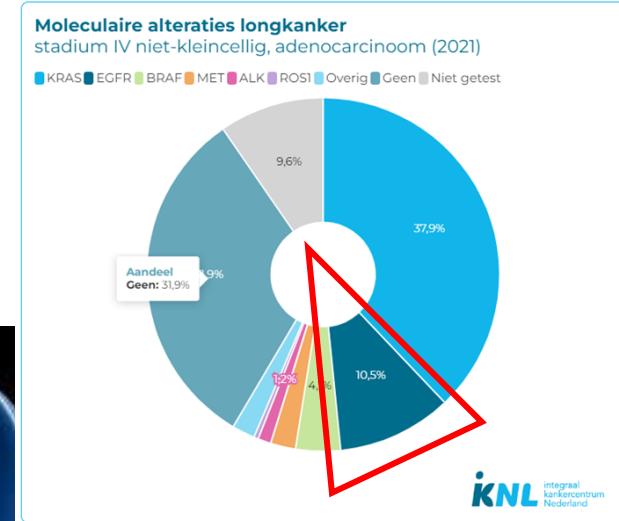
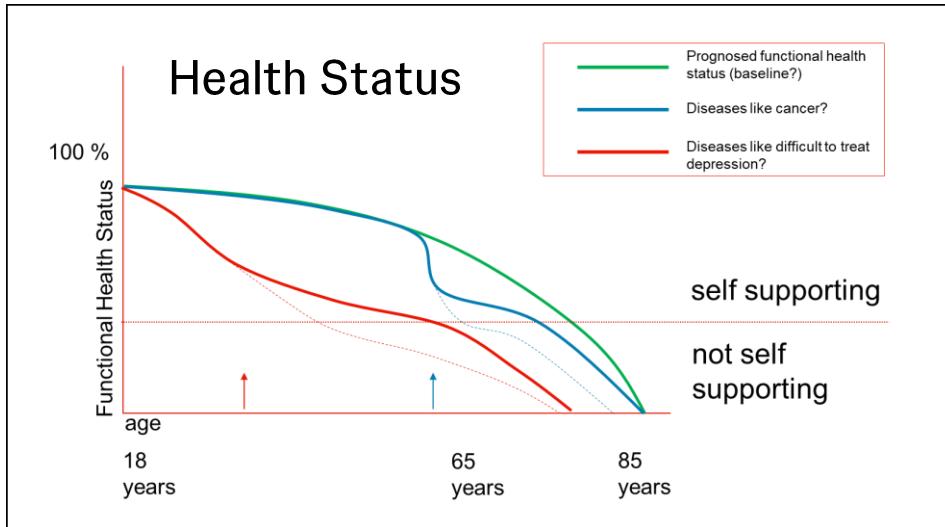
# Why HERACLES?

The aim of this project is to **reduce the impact of cancer** by retrieving **novel insights** into peoples' health journey, which can only be gained through **joint analysis of data**

Can we find variables of importance for early detection of cancer in daily practice?

Can we validate the use of a *privacy-by-design* Data Space for secondary-use of data for cancer healthcare research?

# Use-case (why is this so interesting for J&J Innovative Medicine?)



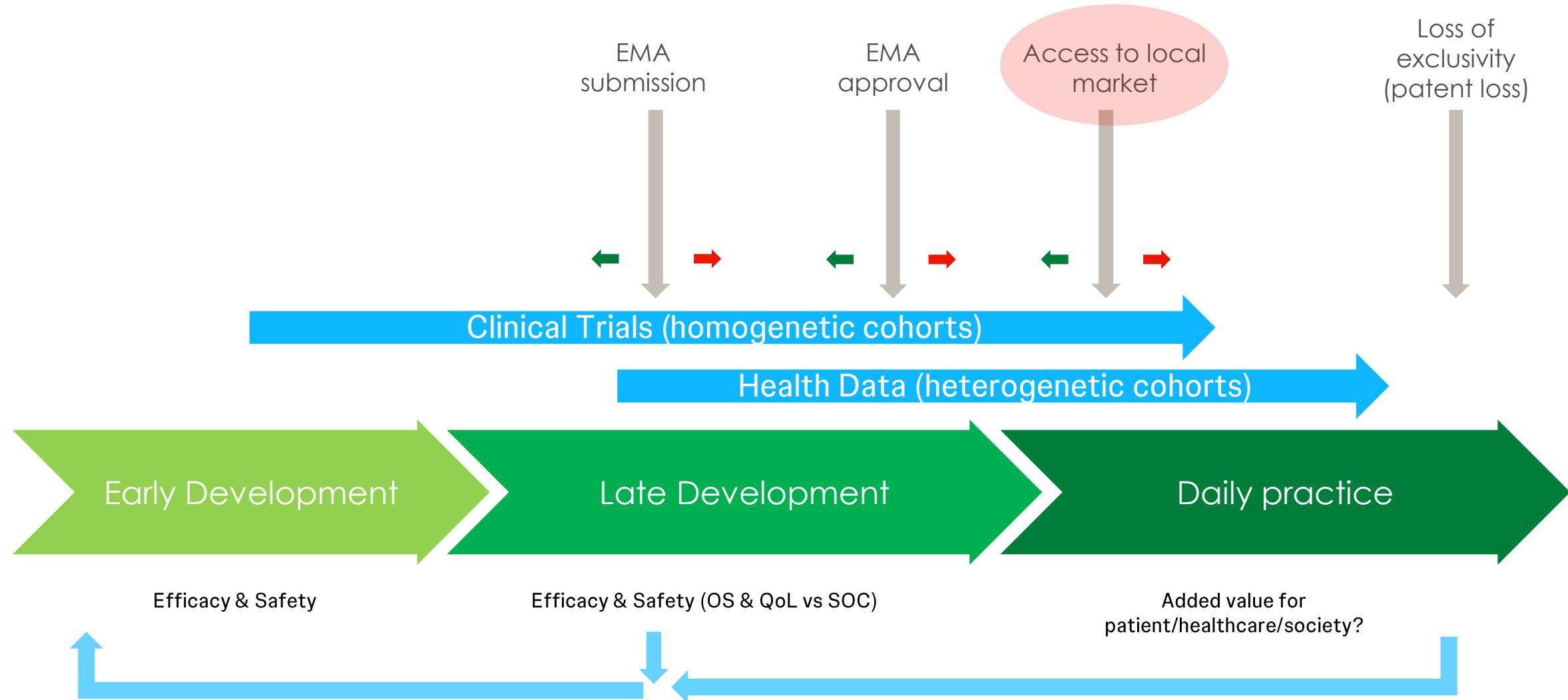
Added value of innovative medicine?

*Which indicators and symptoms are correlated with the development of lung cancer and could be decisive to screen the population for early detection?*

*"I expect the work of physicians to change substantially in the coming years. Specialists will then be able to offer people a more tailored treatment plan."*

**Michel van den Heuvel, Pulmonologist and Head of department at UMCU**

# Early Development → Daily Practice



# Health Data for research!

## Trials, Registries and Claims Databases

### multiple data entry

- Registries (PLCRC/DICA/NKR for colon cancer)
- Product monitoring
- Phase IV trials
- Drug Access Protocol (DAP)
- Drug Rediscovery Protocol (DRUP)

high administrative burden, high cost per RQ, standardized data in centralized data base, not ready for cross border reuse

## Secondary Use Health Data

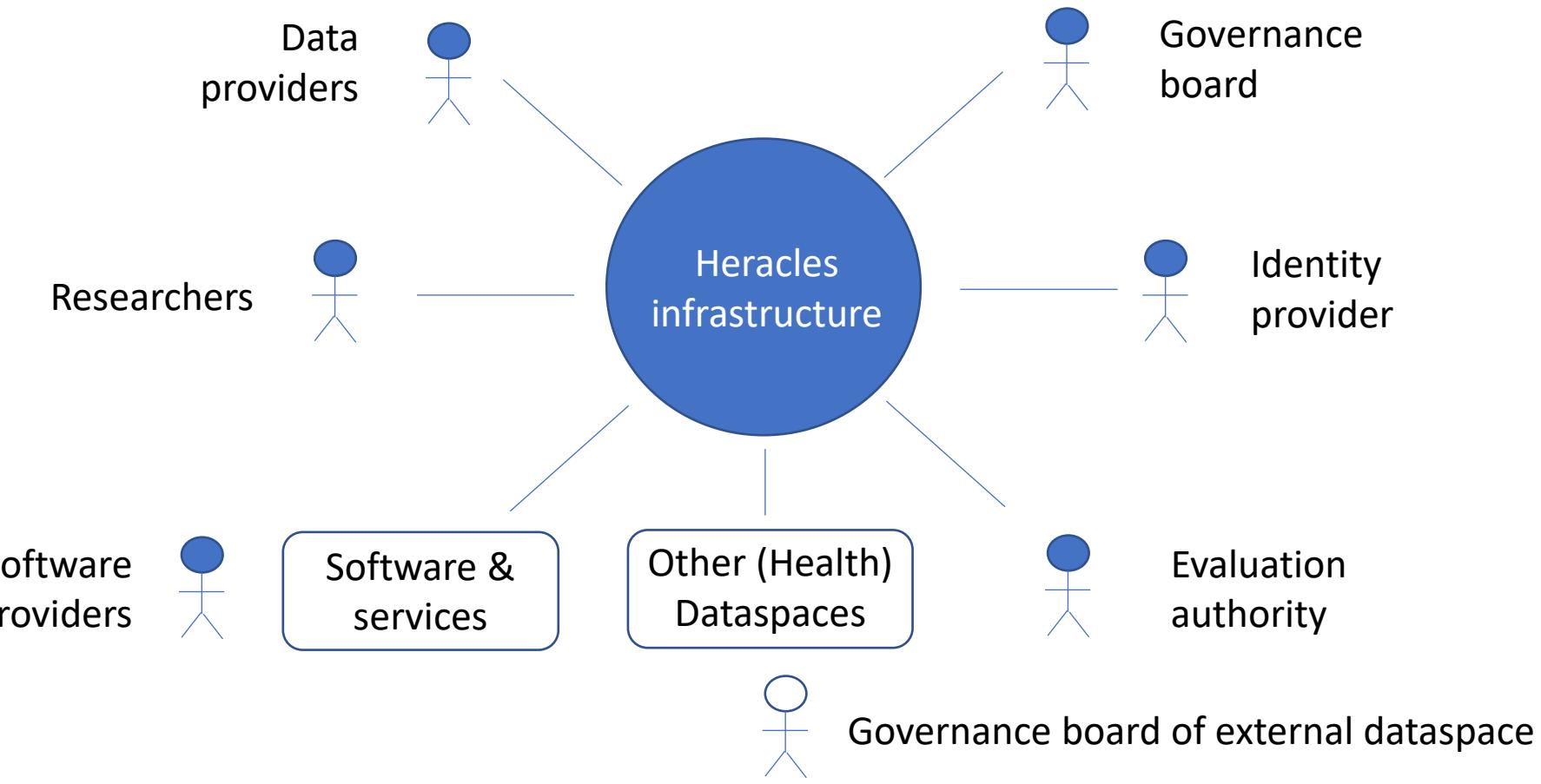
### single data entry

- Data Spaces with Federated Learning (FL\*), computing is with pseudonymized or anonymized decentralized health data
- Data Spaces with Multi Party Computation (MPC\*), computing is with encrypted centralized health data
- Data Spaces with Health Data in secure data environments (HDAB's), computing is with pseudonymized or anonymized centralized health data

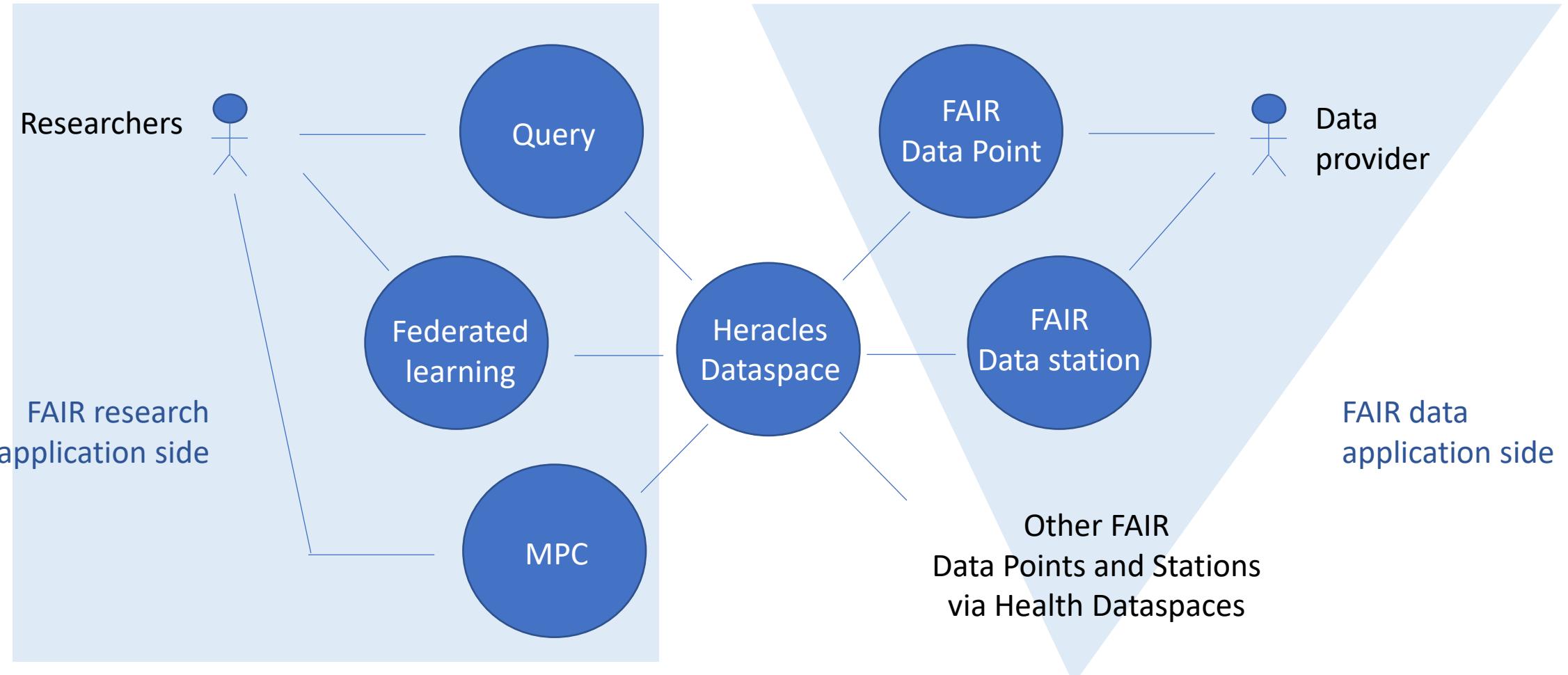
low administrative burden, low cost per RQ, standardized data at the source, ready for cross-border reuse

\* Privacy Enhanced Technology (PET)

# HERACLES infrastructure context diagram

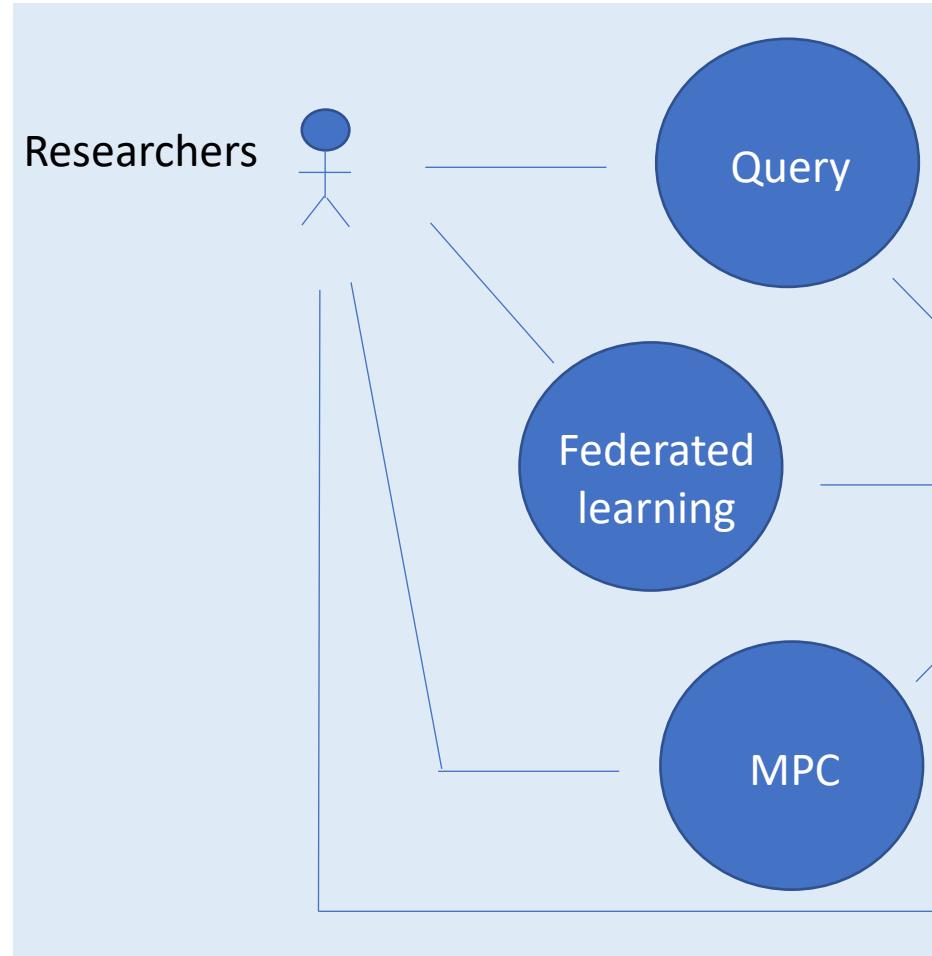


# HERACLES infrastructure decomposition

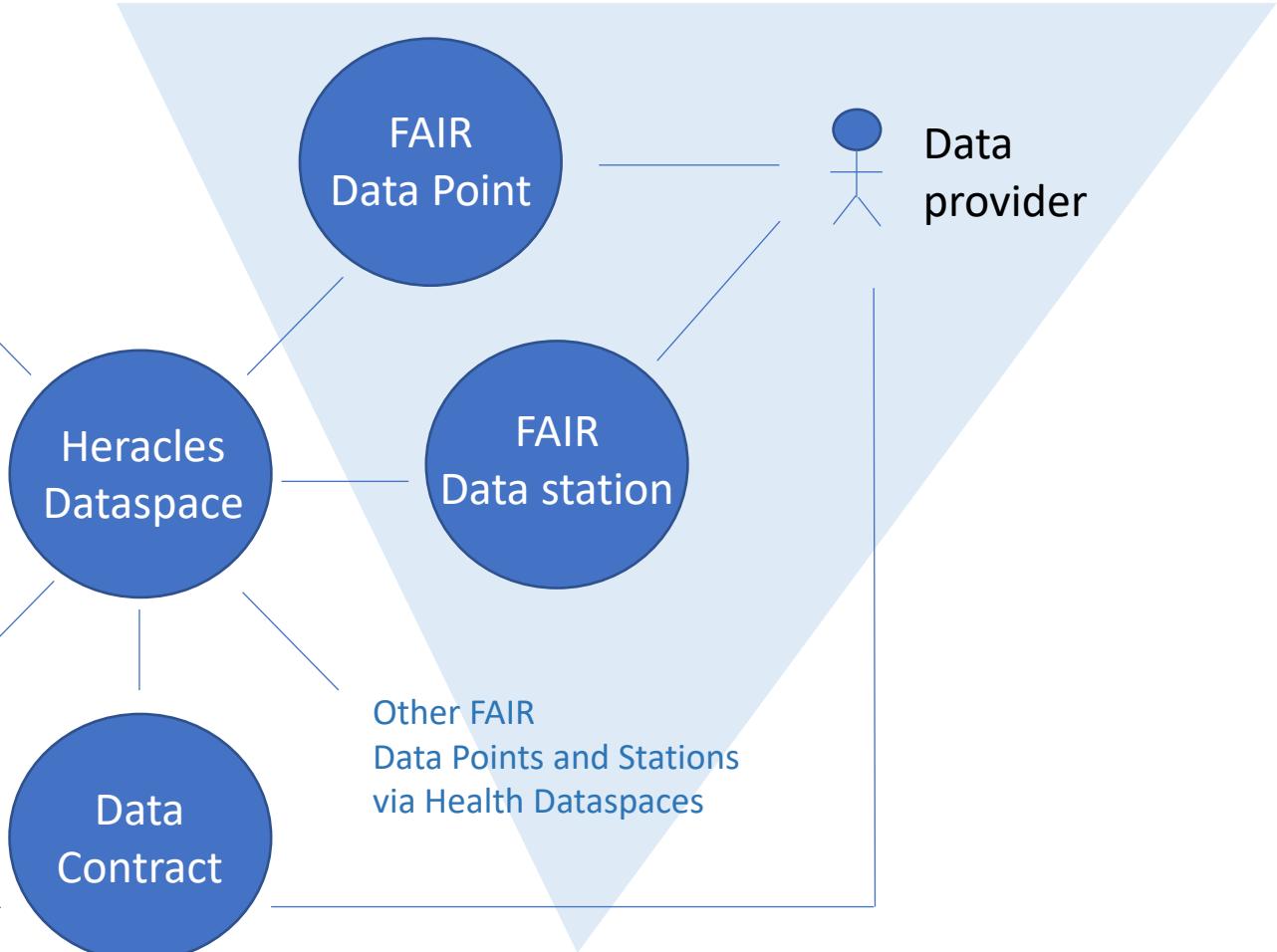


# HERACLES infrastructure decomposition

Research application side



FAIR data application side

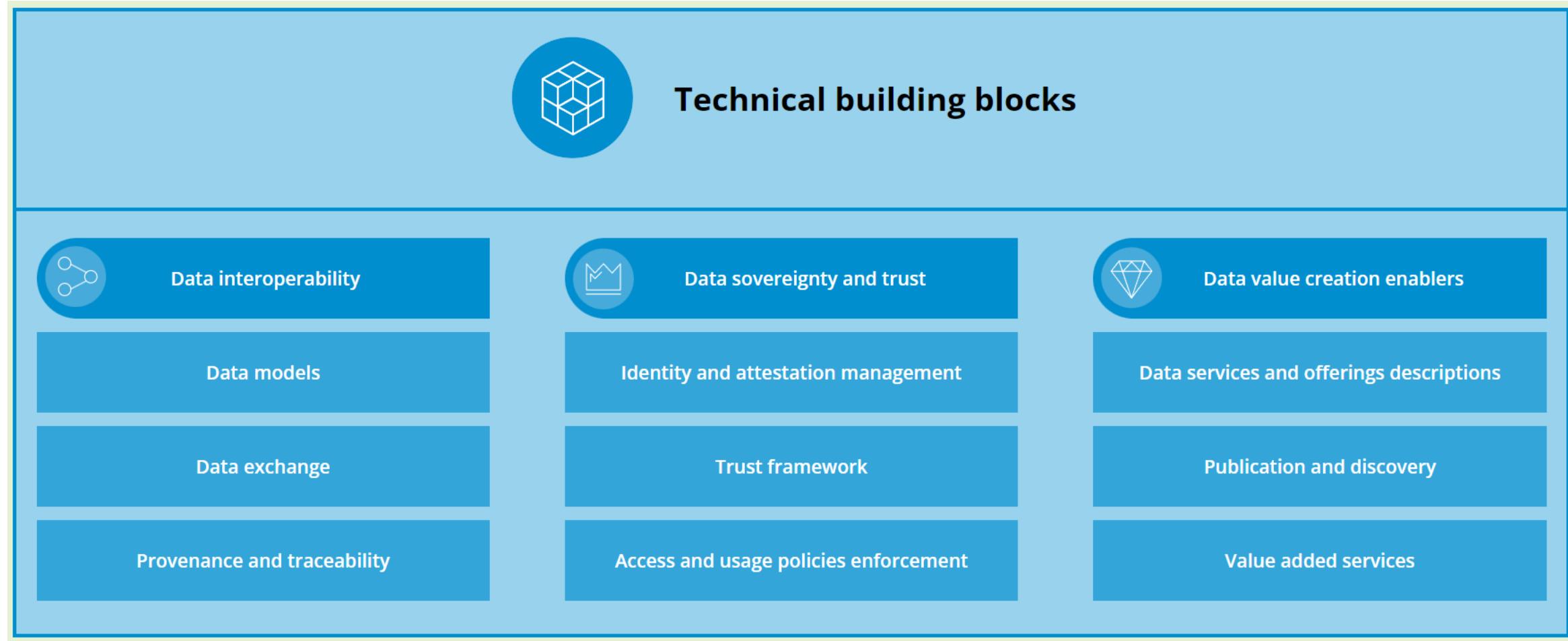


# DSSC Blueprint

a path to European standardisation & collaboration

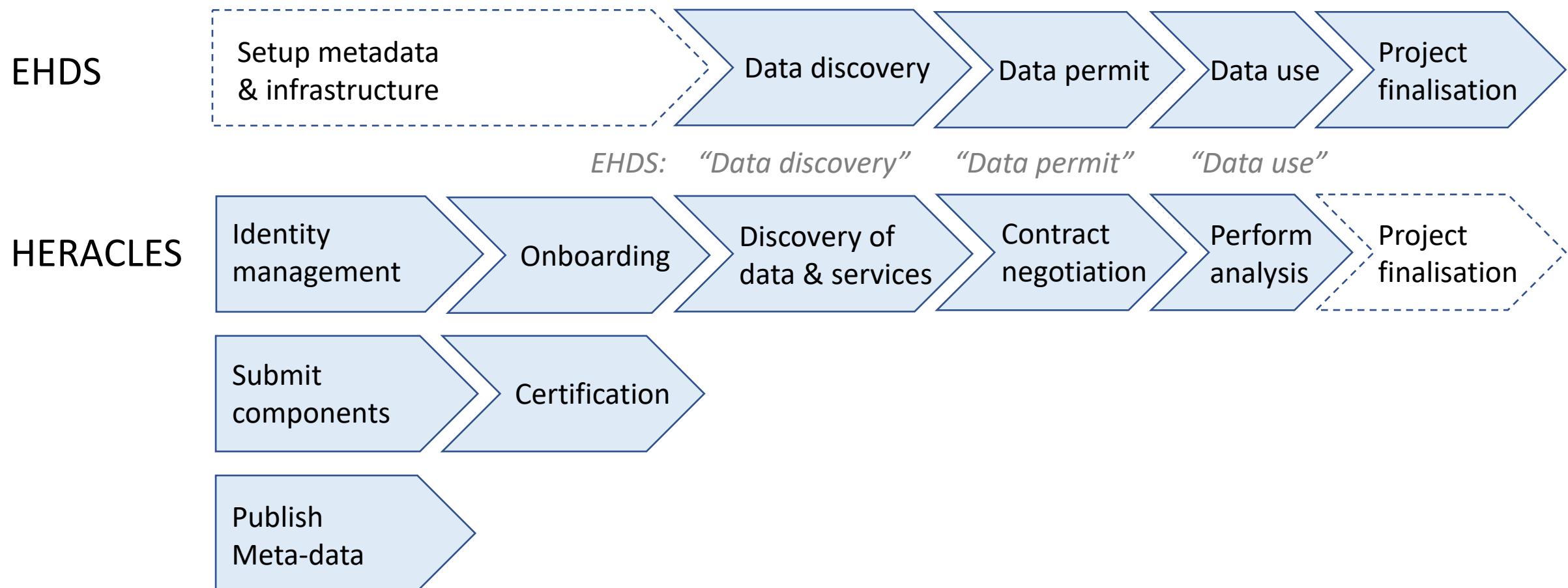


# DSSC Blueprint a path to European standardisation & collaboration



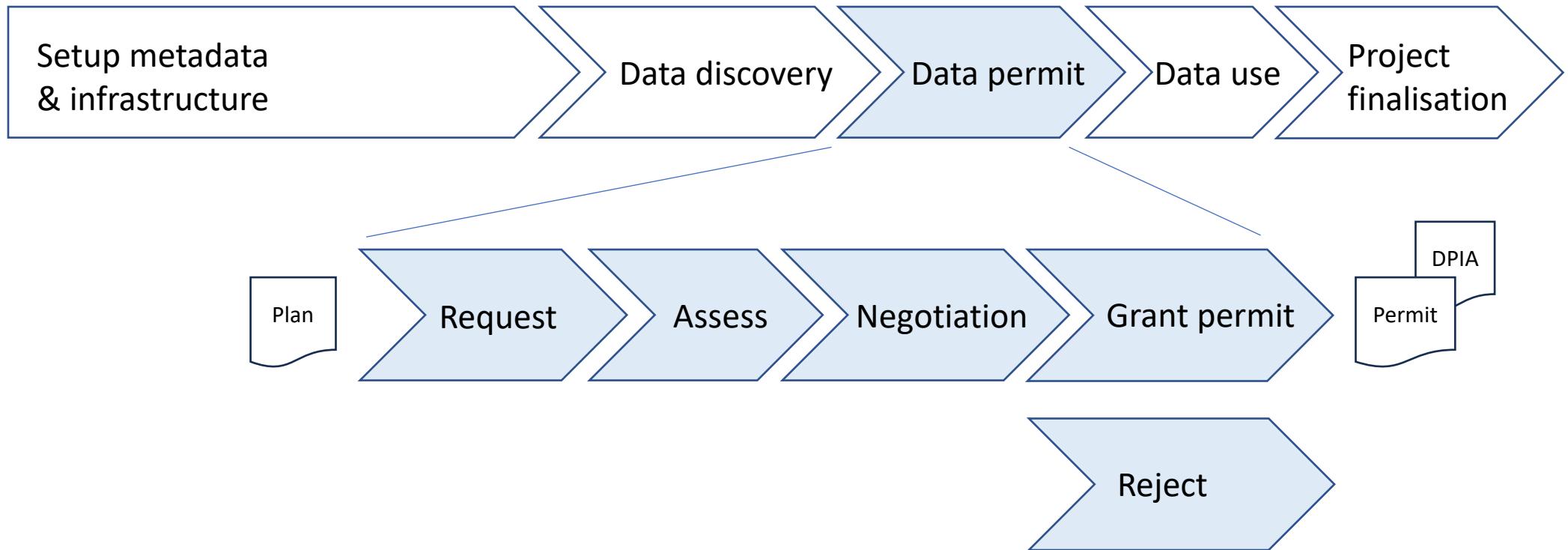
# High level infrastructure process flow

Compliant to European Health Data Space



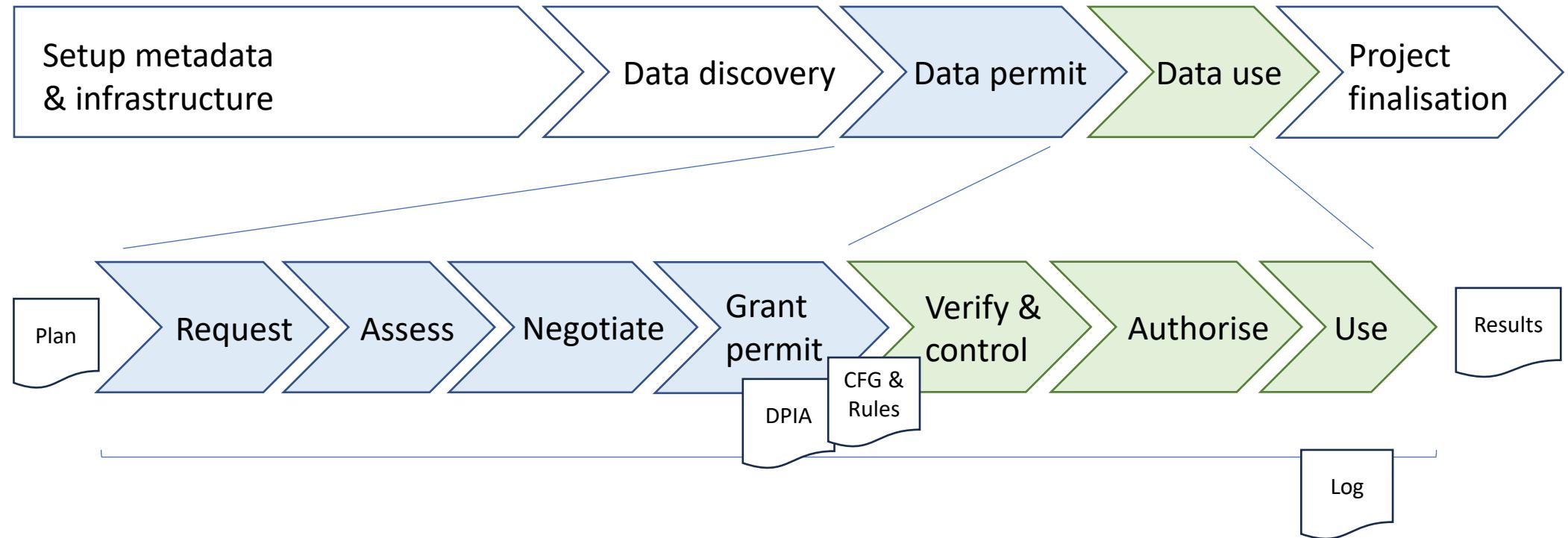
# High level infrastructure process flow

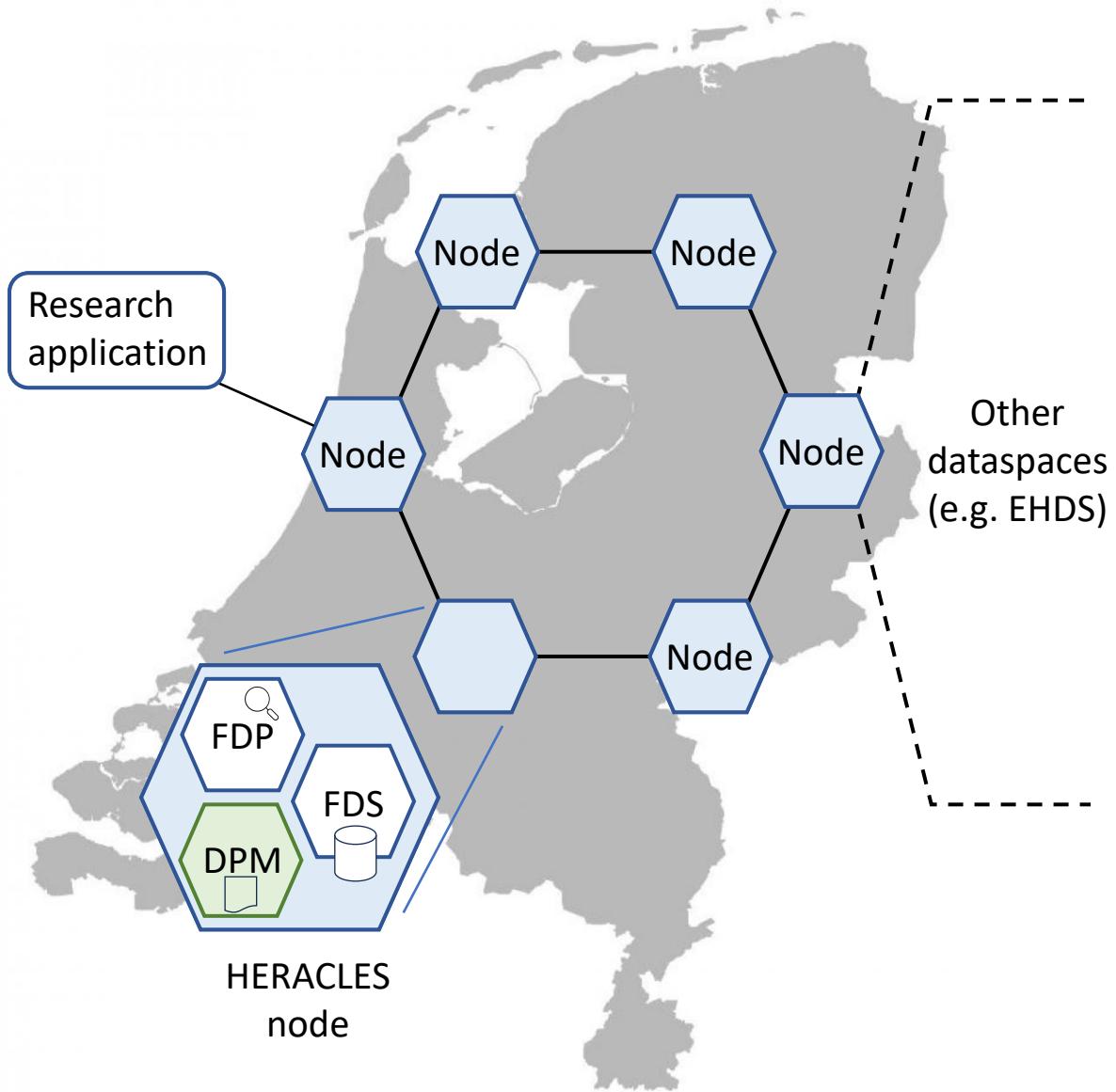
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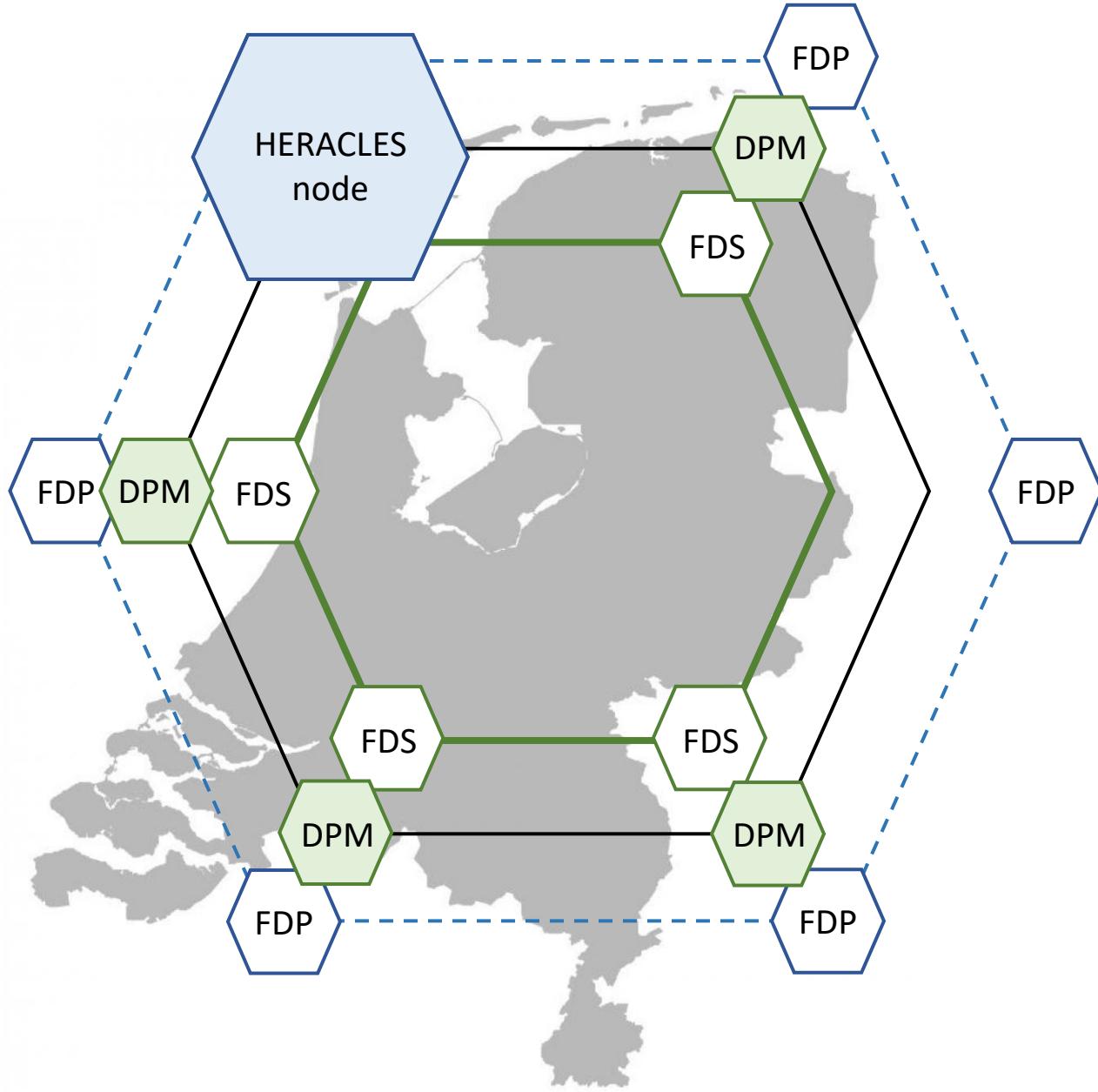


# High level infrastructure process flow

*Data Permit process is key to accelerate getting approval*







# What is Data Space Interoperability?

- **Legal Interoperability**
  - Contracts allow exchange with partners within your data space and from other spaces
  - Potential need for addendums to data space contracts
- **Organizational Interoperability**
  - Identify the partner and validate his identity
  - Define rules for accepting each other's credentials and Trust Frameworks
- **Semantic Interoperability**
  - Mappings between rules and policies from the two spaces
- **Technical Interoperability**
  - Data Exchange, Data Discovery, Data Models



# Learnings

- Data standardization is essential, also for the application of MPC and FDN
- Data linkage is essential for a learning health care system → data space
- Data quality is often lacking, no focus on patient journeys
- High costs at start and therefore the added value should be shown fast
- Data spaces should fit the (inter)national context (HDAB)
- Acceptance by all stakeholders is key (citizens, data controllers)

# Final remarks – Why the search for a privacy-preserving data sharing mechanism is failing (Stadler, Troncoso, 2022)

They conclude that going forward privacy researchers and policy makers should rethink their current approach to support data holders in their goal to share data in a privacy-preserving manner.

- Both groups should abandon the futile search for a ***silver bullet solution to all-purpose-utility high-privacy sharing of fine-grained data.***
- Instead, data holders ***need to accept*** that the set of use cases solvable under ***strict privacy guarantees may be restricted***, and thus so the ***data-driven business models linked*** to them.
- Privacy researchers should hence refocus their efforts on developing tools that help data holders to identify those use cases that can be tackled under good privacy and good utility simultaneously.
- Finally, they recommend that policy makers, together with technical experts, ***develop guidelines that assist data holders*** in navigating the ***complex landscape of PETs***.
- These guidelines should ***focus not only on*** matching uses cases to their suitable sharing technologies but also comprise recommendations for ***empirical evaluation methods*** that can assure the public that any loss in privacy is ***weighed off by the promised societal benefits***.



HERACLES

Thank you for your attention



J&J

# Contact



✉ [simon.dalmolen@tno.nl](mailto:simon.dalmolen@tno.nl)

[tpeters3@its.jnj.com](mailto:tpeters3@its.jnj.com)

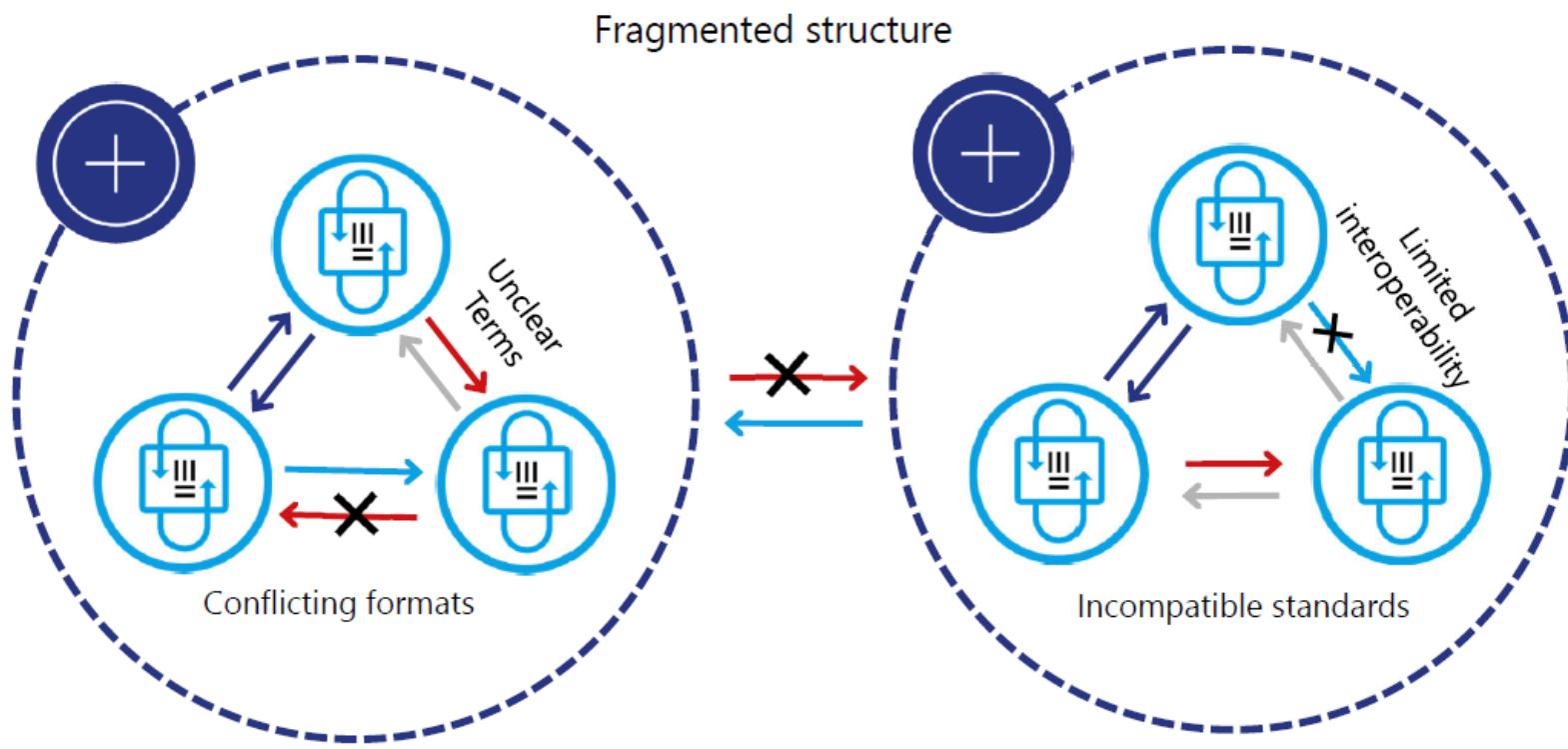
# Back up

# What is the Dataspace Protocol?

*The essence for interoperability*



INTERNATIONAL DATA  
SPACES ASSOCIATION



## Data Spaces Require:

- Data Sovereignty
- Interoperability
- Scalability
- Trustworthiness

## Remember these:

- SWIFT
- HTTP, TCP/IP
- GSM
- Bluetooth

# Dataspace Protocol

## *Protocol's Structure*

INTERNATIONAL DATA  
SPACES ASSOCIATION



### *Catalog Protocol*

- » Defines how data is listed and organized by the provider.
- » Makes data easy to find and understandable for potential consumers.
- » Ensures data is described in a consistent, standard format.
- » **You prepare and offer what is available**

### *Contract Negotiation Protocol*

- » Facilitates the agreement on data usage terms between provider and consumer.
- » Defines how long, for what purpose, and under what conditions data can be used.
- » Provides a clear process to negotiate and finalize these terms.
- » **You negotiate and agree on how the data will be used**

### *Transfer Process Protocol*

- » Manages the actual transfer of data once terms are agreed upon.
- » Ensures data is shared securely and follows the negotiated rules.
- » Supports different types of data transfers (e.g., one-time or continuous).
- » **You execute the data transfer according to the agreed terms**

# Driving data spaces innovation

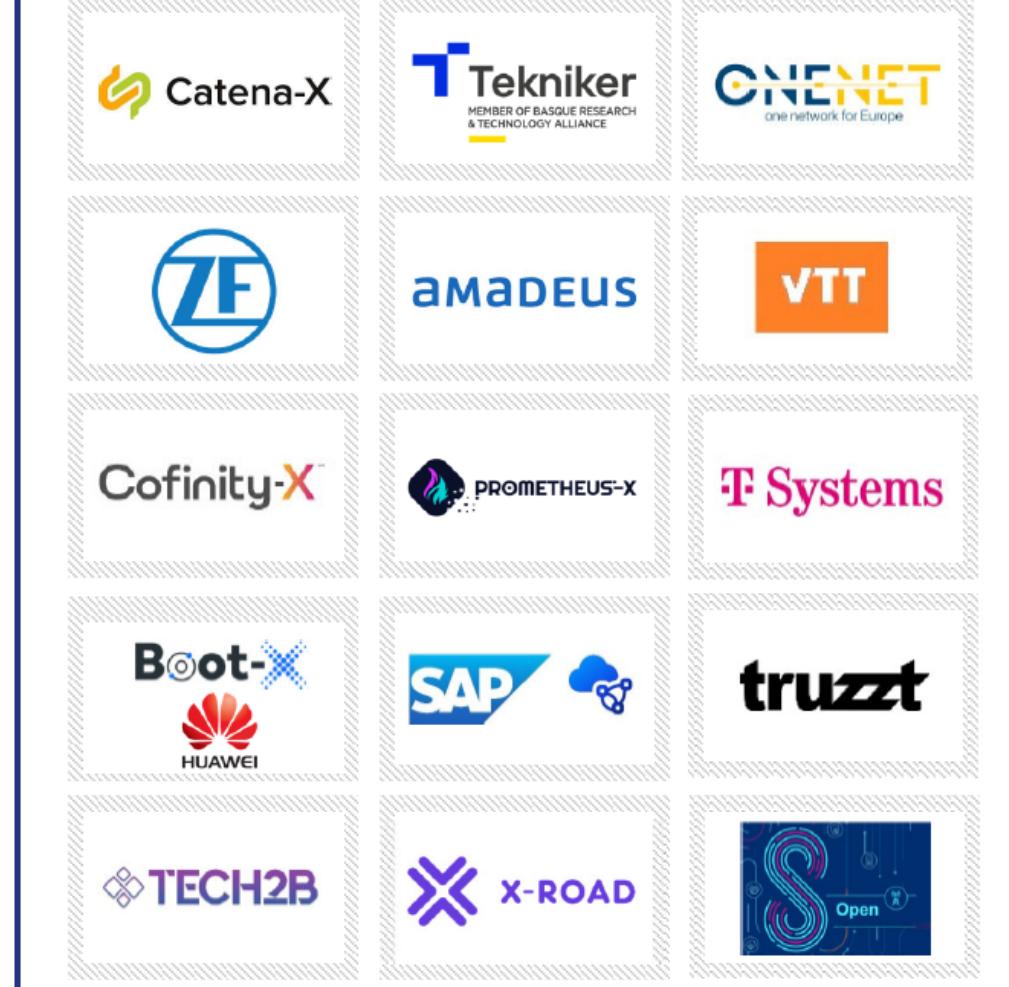
*Collaborators defining and embracing the Dataspace Protocol*

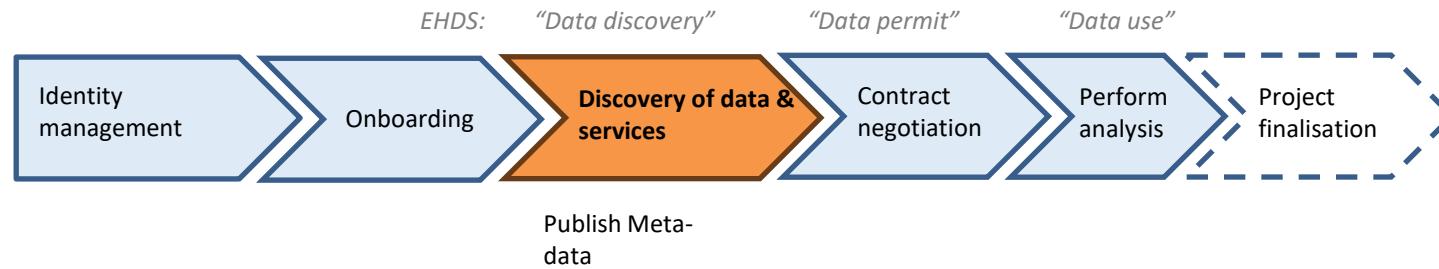
INTERNATIONAL DATA  
SPACES ASSOCIATION

**Who co-defined it?**



**Who is currently using it?**





# ≡ TSG Control Plane DataGuard Innovations

**HOME**

- Dashboard

**DATASPACE PROTOCOL**

- Catalog Request**
- Negotiations
- Transfers

**DATAPLANES**

- Dataplanes

**REGISTRY**

- Registry

**Catalog Request**

Use this page to find other catalogs. You can search for other Control Planes using the Registry, or enter an access URL and a DID manually if you already know which party you want to query. Submit your request according to the Catalog Protocol in the Dataspace Protocol.

Url of Catalog to Request      DID identifier

           **Submit**

**Health Harbor Medical Center**

Health Harbor Medical Center connector

**Parsed View**

Publisher  
did:web:healthharbormc.heracles.dataspac.es

**IKNL NCR Synthetic Dataset**

Policies: 1

References

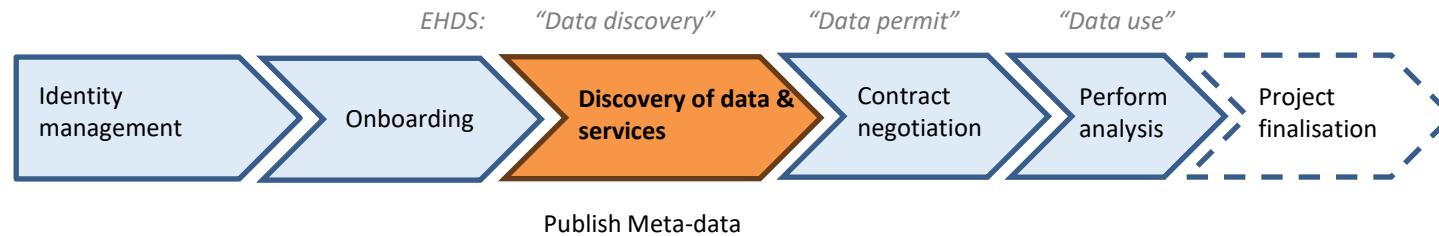
Model

Format

Keywords

Netherlands Cancer Registry    Synthetic

Health Harbor Medical Center



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- HOME**
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**Catalog Request**

Use this page to find other catalogs. You can search for other Control Planes using the Registry, or enter an access URL and a DID manually if you already know which protocol to use.

Request according to the Catalog Protocol in the Dataspace Protocol.

Url of Catalog to Request      DID identifier

**Health Harbor Medical Center**

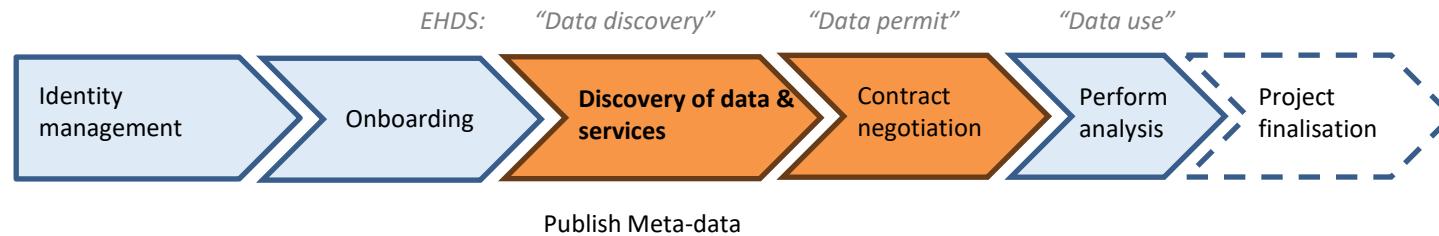
Health Harbor Medical Center connector

**Parsed View**

```

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    ],
    "dct:conformsTo": [
      "https://healthharbormc.herales.dataspace.es/fdp/metadataFormat/0ca809b3-dbce-4451-a72b-85d9a6aa5880.lmf"
    ],
    "dct:format": "heracles:CohortService",
    "dct:title": "Cohort Definition Service"
  },
  "prov:wasGeneratedBy": {
    "@type": "prov:Activity",
    "prov:actedOnBehalfOf": "did:web:IKNL.nl",
    "prov:endedAtTime": "2023-08-01T00:00:00Z"
  },
  "healthdcatap:hasCodingSystem": [
    "https://www.wikidata.org/wiki/Q1753883",
    "https://www.wikidata.org/wiki/Property:P563"
  ],
  "healthdcatap:numberOfRecords": 84000,
  "healthdcatap:numberOfUniqueIndividuals": 20000,
  "healthdcatap:healthTheme": [
    "https://www.wikidata.org/wiki/Q12078",
    "https://www.wikidata.org/wiki/Q128581"
  ],
  "dcat:description": "A synthetic dataset that mimics a part of the Netherlands Cancer Registry (NCR) is available for research purposes.",
  "owl:sameAs": "urn:uuid:3fbde162-57c2-4923-8239-23f0df41177b"
}

```



### Catalog Request

Use this page to find other catalogs. You can search for other Control Planes using the Registry, or enter an access URL and a DID manually if you already know which party you want to query. Submitting the Request according to the Catalog Protocol in the Dataspace Protocol.

Url of Catalog to Request      DID identifier

**IKNL NCR Synthetic**

Endpoint URL: TSG Federated Learning Data Platform

Conforms to: <https://healthharbormc.heracles.es:80/lmf>

**Policies**

Permission

Assigner: did:web:healthharbormc.heracles.dataspac.es

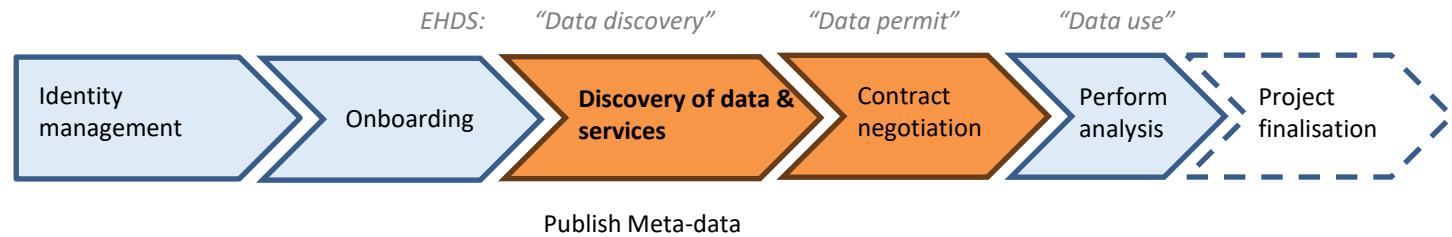
Target

Action: odrl:use

Are you sure you want to send the following negotiation message?

```

1  {
2    "@type": "odrl:Offer",
3    "@id": "urn:uuid:21f1ad91-8822-44f2-9341-d1499649a3e4",
4    "odrl:assigner": "did:web:healthharbormc.heracles.dataspac.es",
5    "odrl:permission": [
6      {
7        "@type": "odrl:Permission",
8        "odrl:action": "odrl:use"
9      }
10    ],
11    "@context": "https://w3id.org/dspace/2024/1/context.json"
12  }
```



The screenshot shows the TSQ Control Plane interface for the Health Harbor Medical Center. The main navigation bar includes the TSQ logo, Control Plane, Health Harbor Medical Center, and user icons.

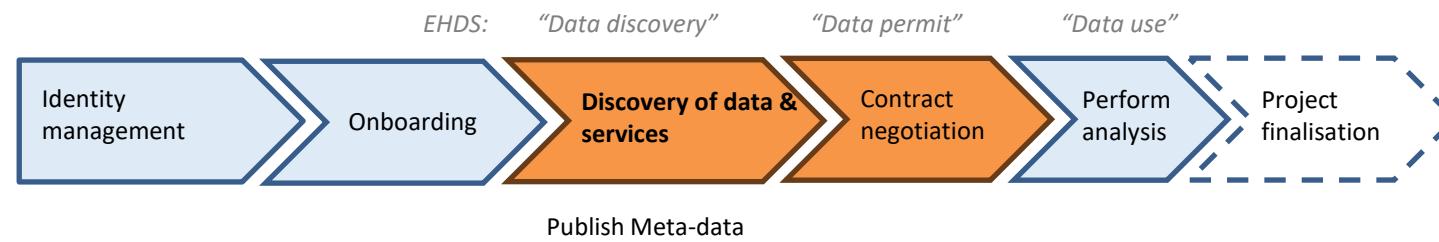
The left sidebar contains links for HOME, Dashboard, DATASPACE PROTOCOL (Catalog Request, Negotiations 1), TRANSFERS, DATAPLANES (Dataplanes), and REGISTRY (Registry).

The right panel displays the "Contract Negotiations" page, which lists negotiations for the Control Plane. One negotiation is shown in detail:

- REQUESTER:** 11/20/2024, 9:54:35 PM
- Offer Details:** did:web:dataguard.healthharbormc.heracles.dataspac.es wants to access https://healthharbormc.heracles.dataspac.es/1265-4762-b9...
- Offer Content (JSON):**

```

1  {
2     "@context": [
3         "https://w3id.org/dspace/2024/1/context.json",
4         "https://tsq.dataspac.es/contexts/next/tsq.json",
5         "https://tsq.dataspac.es/contexts/next/health.json"
6     ],
7     "@type": "odrl:Offer",
8     "@id": "urn:uuid:21f1ad91-8822-44f2-9341-d1499649a3e4",
9     "odrl:assigner": "did:web:healthharbormc.heracles.dataspac.es",
10    "odrl:assignee": "did:web:dataguard.heracles.dataspac.es",
11    "odrl:permission": [
12        {
13            "@type": "odrl:Permission",
14            "odrl:action": "odrl:use"
15        }
16    ],
17    "odrl:target": "https://healthharbormc.heracles.dataspac.es/fdp/dataset/00064cd3-1265-4762-b"
18 }
```
- Action Buttons:** X Decline (red) and ✓ Accept (green).
- Status:** REQUESTED (11/20/2024, 9:54:35 PM) and FINALIZED (11/19/2024, 6:26:14 PM).



≡ TSG Control Plane DataGuard Innovations ⚡ heracles ⚙

HOME

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DATASPACE PROTOCOL

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## Contract Negotiations

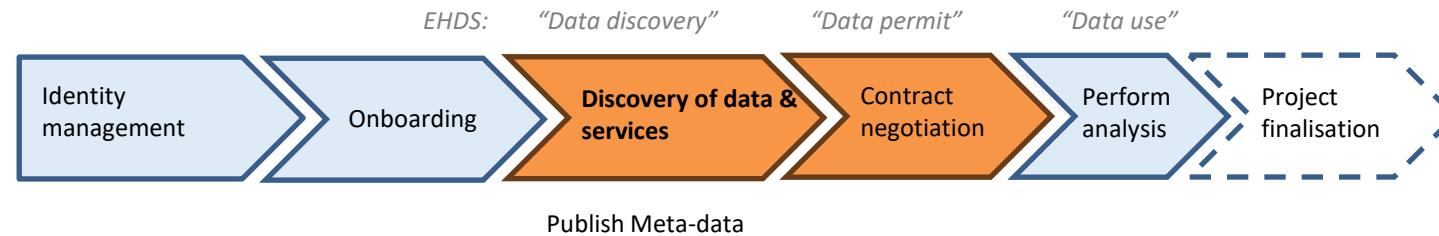
This page shows (the history of) the negotiations that are present for the Control Plane. If there are actions required from you, they will appear above the negotiation history. All the actions that can be done on this page are implementations of the Contract Negotiation part of the Dataspace Protocol.

### Negotiation History

Here you can find the history of the contract negotiations. Contracts that are finalized also allow the option to start a Transfer Process.

Agreement	Local Signature	Remote Signature	Date	Status
<pre>1 { 2   "@context": [ 3     "https://w3id.org/dspace/2024/1/context.json", 4     "https://tsg.dataspac.es-contexts/next/tsg.json", 5     "https://tsg.dataspac.es-contexts/next/health.json" 6   ], 7   "@type": "odrl:Agreement", 8   "@id": "urn:uuid:21f1ad91-8822-44f2-9341-d1499649a3e4", 9   "odrl:assigner": "did:web:healthharbormc.heracles.dataspac.es", 10  "odrl:assignee": "did:web:dataguard.heracles.dataspac.es", 11  "odrl:permission": [ 12    { 13      "@type": "odrl:Permission", 14      "odrl:action": "odrl:use" 15    } 16  ], 17  "odrl:target": "https://healthharbormc.heracles.dataspac.es/fdp/d 18  "dspace:timestamp": "2024-11-20T20:55:01.229Z" 19 }</pre>			11/20/2024, 9:55:16 PM	FINALIZED
			11/20/2024, 9:55:11 PM	VERIFIED
			11/20/2024, 9:55:01 PM	AGREED
			11/20/2024, 9:54:35 PM	REQUESTED

**Request Transfer**



did:web:healthharbormc.heraclies.dataspac.es - https://healthharbormc.heraclies.dataspac.es/fdp/dataset/00064cd3-1265-4762-b969-40d6a7d7fc56 FINALIZED 11/20/2024, 9:55:16 PM

Agreement Local Signature Remote Signature

1 {  
2 "type": "DataIntegrityProof",  
3 "proofPurpose": "assertionMethod",  
4 "created": "2024-11-20T20:55:11.785Z",  
5 "verificationMethod": "did:web:dataguard.heraclies.dataspac.es#key-  
6 "cryptosuite": "eddsa-rdfc-2022",  
7 "proofValue": "z3afKXBXpXp82JhTYAYaaqVeJcnRjBNcuwVhkgXcFDHeEfupUpC  
8 }

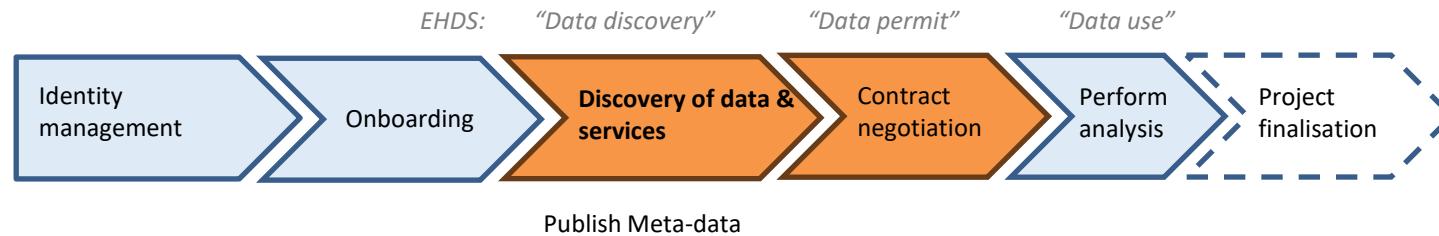
11/20/2024, 9:55:16 PM FINALIZED

11/20/2024, 9:55:11 PM VERIFIED

11/20/2024, 9:55:01 PM AGREED

11/20/2024, 9:54:35 PM REQUESTED

Request Transfer



## Negotiation History

Here you can find the history of the contract negotiations. Contracts that are finalized also allow the option to start a Transfer Process.

did:web:healthharbormc.heracles.dataspac.es - https://healthharbormc.heracles.dataspac.es/fdp/dataset/00064cd3-1265-4762-b969-40d6a7d7fc56 FINALIZED 11/20/2024, 9:55:16 PM

Agreement	Local Signature	Remote Signature
		11/20/2024, 9:55:16 PM <span style="color: green;">FINALIZED</span>
		11/20/2024, 9:55:11 PM <span style="color: blue;">VERIFIED</span>
		11/20/2024, 9:55:01 PM <span style="color: blue;">AGREED</span>
		11/20/2024, 9:54:35 PM <span style="color: lightgray;">REQUESTED</span>

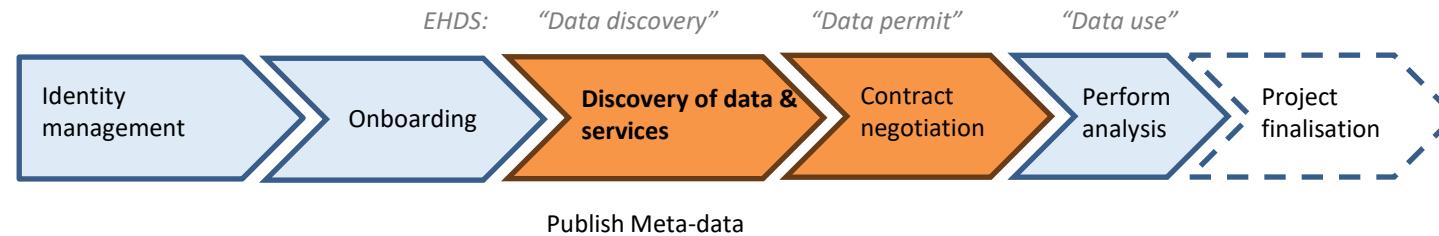
```

1  {
2    "type": "DataIntegrityProof",
3    "proofPurpose": "assertionMethod",
4    "created": "2024-11-20T20:55:16.469Z",
5    "verificationMethod": "did:web:healthharbormc.heracles.dataspac.es",
6    "cryptosuite": "eddsa-rdfc-2022",
7    "proofValue": "z4MShmpC4BcQnDLRok3gsRX4Nq9jc8HZwbDBT8k6mxkeYBfpesc"
8  }

```

Request Transfer

did:web:healthharbormc.heracles.dataspac.es - https://healthharbormc.heracles.dataspac.es/fdp/dataset/00064cd3-1265-4762-b969-40d6a7d7fc56 FINALIZED 11/19/2024, 6:26:13 PM



## Sign document

The form below can be used to sign JSON-LD or plain documents. A DataIntegrityProof or JsonWebSignature2020 proof is created with the default key of the wallet.

To sign the digest of a file, choose a file below. The file will be processed locally within your browser to calculate the digest. A sample JSON-LD document is generated which can be signed.

For RDF canonicalization, the input document must be valid JSON-LD. Its context should include the relevant context for the proof. For JsonWebSignature2020, the input must always be in JSON-LD form. For DataIntegrityProofs also the non JSON-LD variant JSON Canonicalization Scheme may be used.

Sign binary document

↑

Signature type

Data Integrity Proof
JSON Web Signature 2020

Normalization

RDF Canonicalization
JSON Canonicalization Scheme

Proof purpose

assertionMethod

```

1  {
2    "@context": [
3      {
4        "tsg": "https://tno-tsg.gitlab.io/#"
5      },
6      "https://w3id.org/security/data-integrity/v2"
7    ],
8    "tsg:digest": "c423540679a462cf8b89d2bc0d5ae6445aa443000bb3e082828c5eb8c3e40fe",
9    "tsg:fileName": "Permit.pdf",
10   "tsg:type": "application/pdf"

```

Plain document

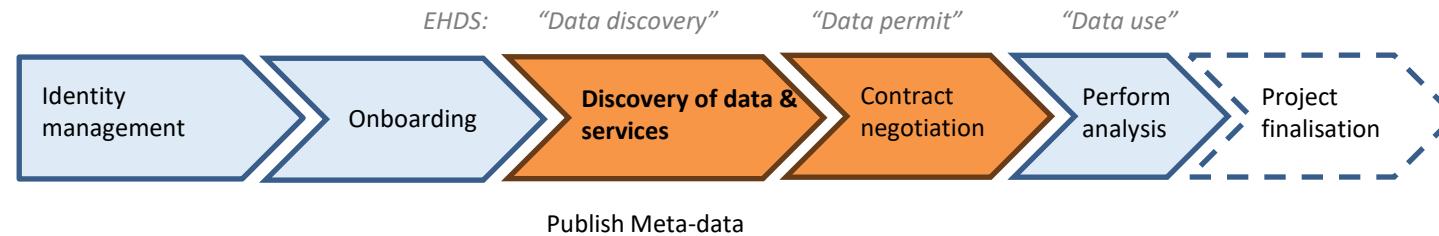
```

1  {
2    "@context": [
3      {
4        "tsg": "https://tno-tsg.gitlab.io/#"
5      },
6      "https://w3id.org/security/data-integrity/v2"
7    ],
8    "tsg:digest": "c423540679a462cf8b89d2bc0d5ae6445aa443000bb3e082828c5eb8c3e40fe",
9    "tsg:fileName": "Permit.pdf",
10   "tsg:type": "application/pdf"

```

Sign document

40



Sign binary document

Signature type  Data Integrity Proof  JSON Web Signature 2020

Normalization  RDF Canonicalization  JSON Canonicalization Scheme

Proof purpose assertionMethod

```

1  {
2    "@context": [
3      {
4        "tsg": "https://tno-tsg.gitlab.io/#"
5      },
6      "https://w3id.org/security/data-integrity/v2"
7    ],
8    "tsg:digest": "c423540679a462cf8b89d2bc0d5ae6445aa443000bb3e082828c5eb8c3e40fe",
9    "tsg:fileName": "Permit.pdf",
10   "tsg:type": "application/pdf"
  
```

Plain document

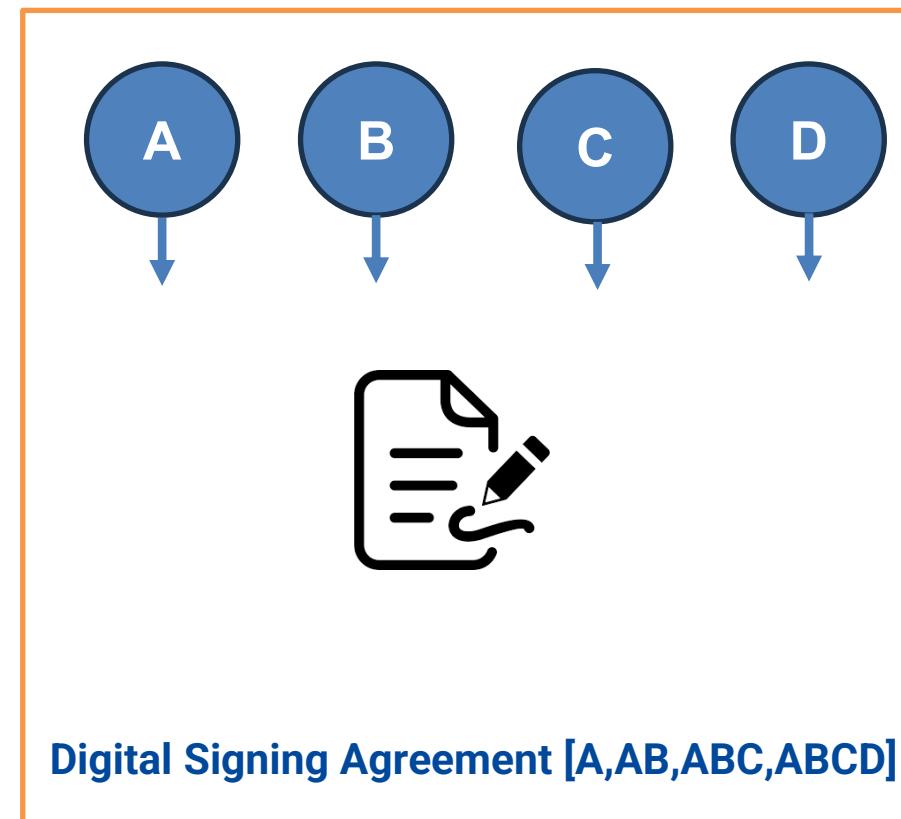
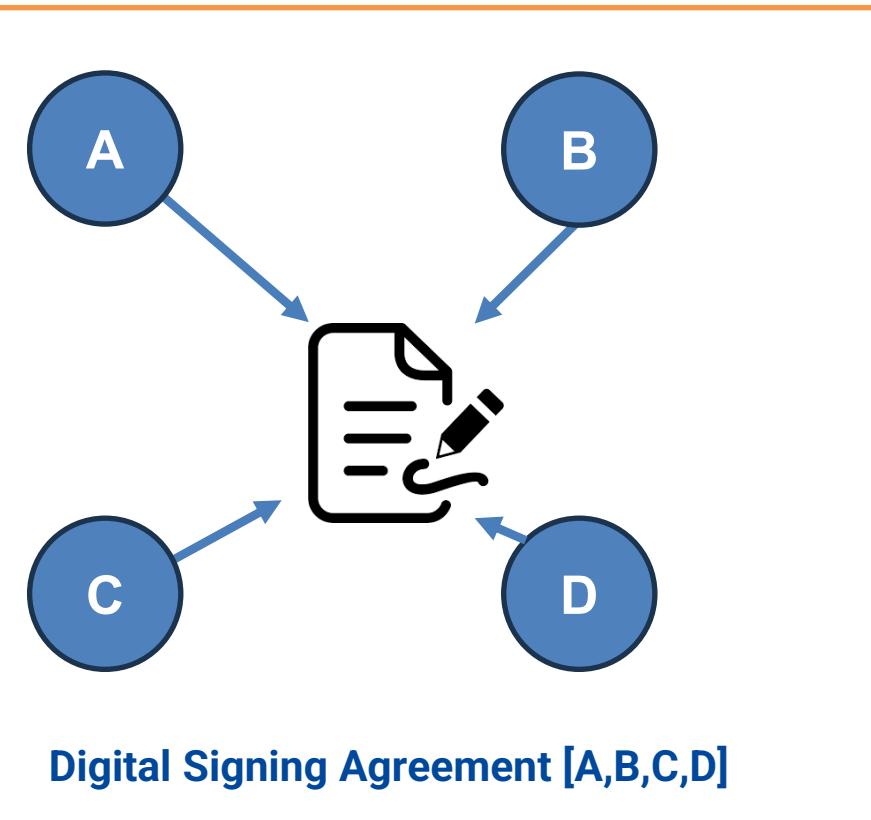
```

1  {
2    "@context": [
3      {
4        "tsg": "https://tno-tsg.gitlab.io/#"
5      },
6      "https://w3id.org/security/data-integrity/v2"
7    ],
8    "tsg:digest": "c423540679a462cf8b89d2bc0d5ae6445aa443000bb3e082828c5eb8c3e40fe",
9    "tsg:fileName": "Permit.pdf",
10   "tsg:type": "application/pdf",
11   "proof": {
12     "type": "DataIntegrityProof",
13     "proofPurpose": "assertionMethod",
14     "created": "2024-11-20T20:57:25.832Z",
15     "verificationMethod": "did:web:dataguard.heraclies.dataspac.es#key-0",
16     "cryptosuite": "eddsa-rdfc-2022",
17     "proofValue": "z5xkNpPAsa6jNU7sYF2yBBLuZX7QFb3mvwQfd1iM43tvMY7Bej6dwjHvH4MsQWdPqhtSPRtNLTqJArNtbRjTRUaJD"
18   }
  
```

Signed document

## Types of signing

A chain of signatures? Or just the signatures?



## Conclusion & links

### Legal Identity. What are we going to use? EIDAS 1.0 or 2.0

- EIDAS 2.0 at latest it will be in force in November '26, but is foreseen earlier on due to the implementation acts e.g. European Digital Identity Wallet (EDIW).
- In the current demonstrator the technology is used. However, we are waiting for some specific implementation parameters.
- EIDAS 1.0 can use PAdES this is the electronic signature design for PDF Advanced Electronic Signatures.

### Data Space Protocol & Standardisation

<https://github.com/International-Data-Spaces-Association/ids-specification?tab=readme-ov-file>

<https://www.cencenelec.eu/news-and-events/news/2024/brief-news/2024-09-25-jtc-25/>

<https://docs.internationaldataspaces.org/ids-knowledgebase/dataspace-protocol>