i4Trust - Overview

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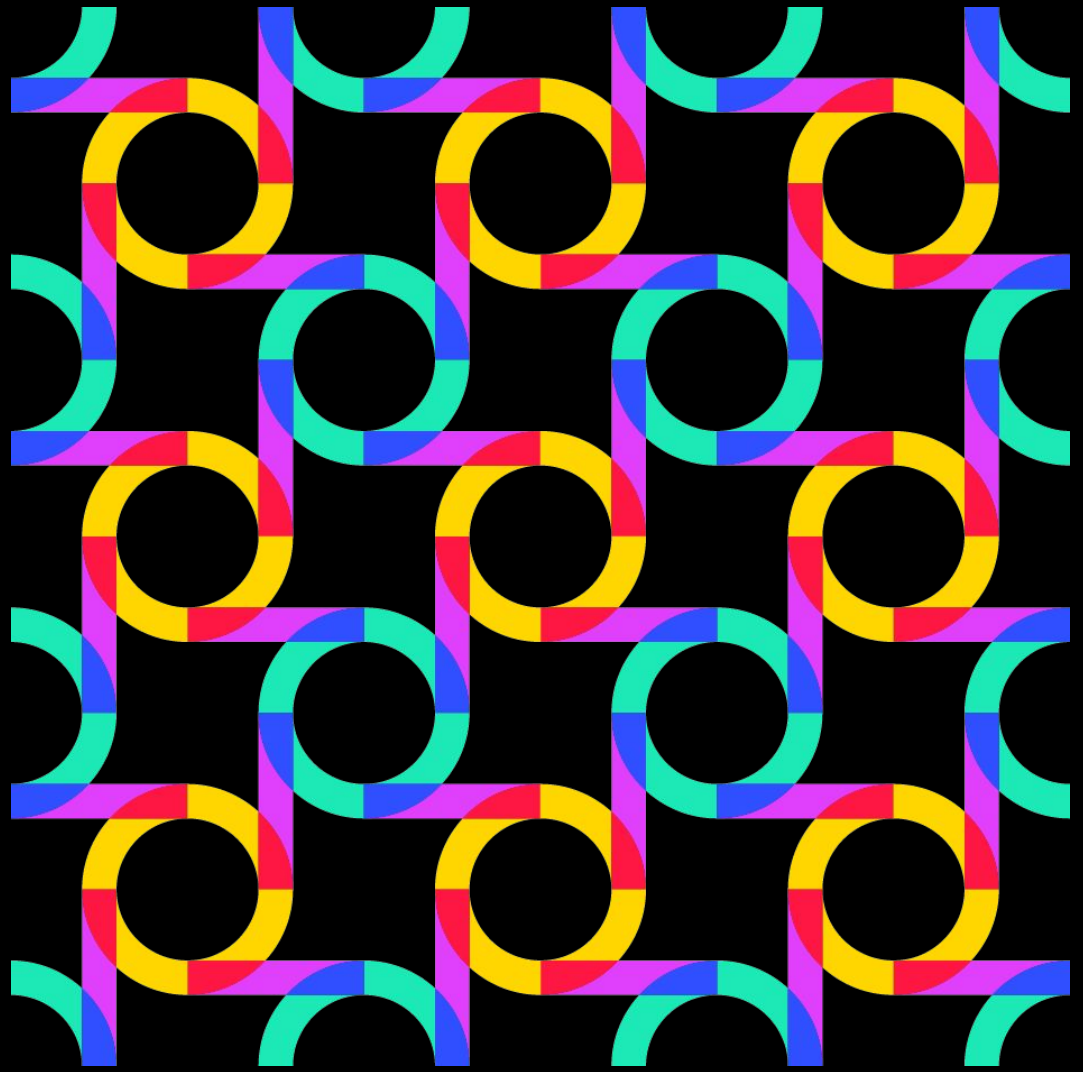
Xabier Chao - CIO Funding Box
Rosa Villaronga - Project Manager Funding Box



i4Trust

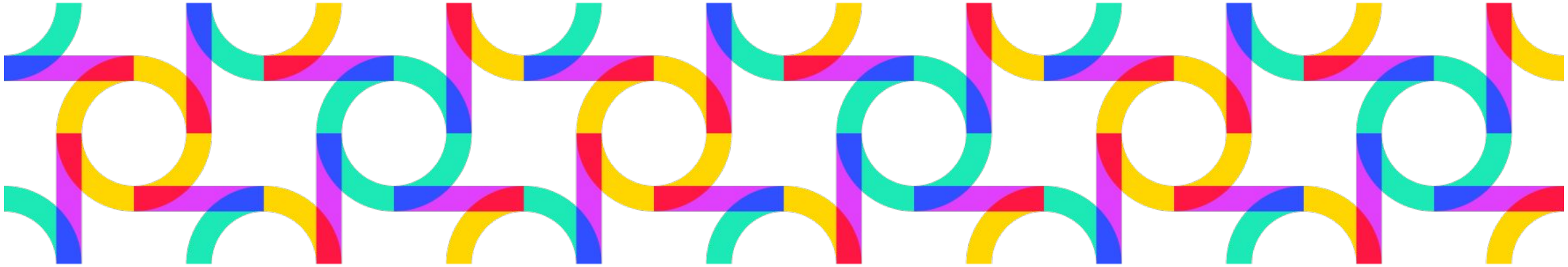
i4Trust Website

i4Trust Community

FIWARE FOUNDATION

iSHARE

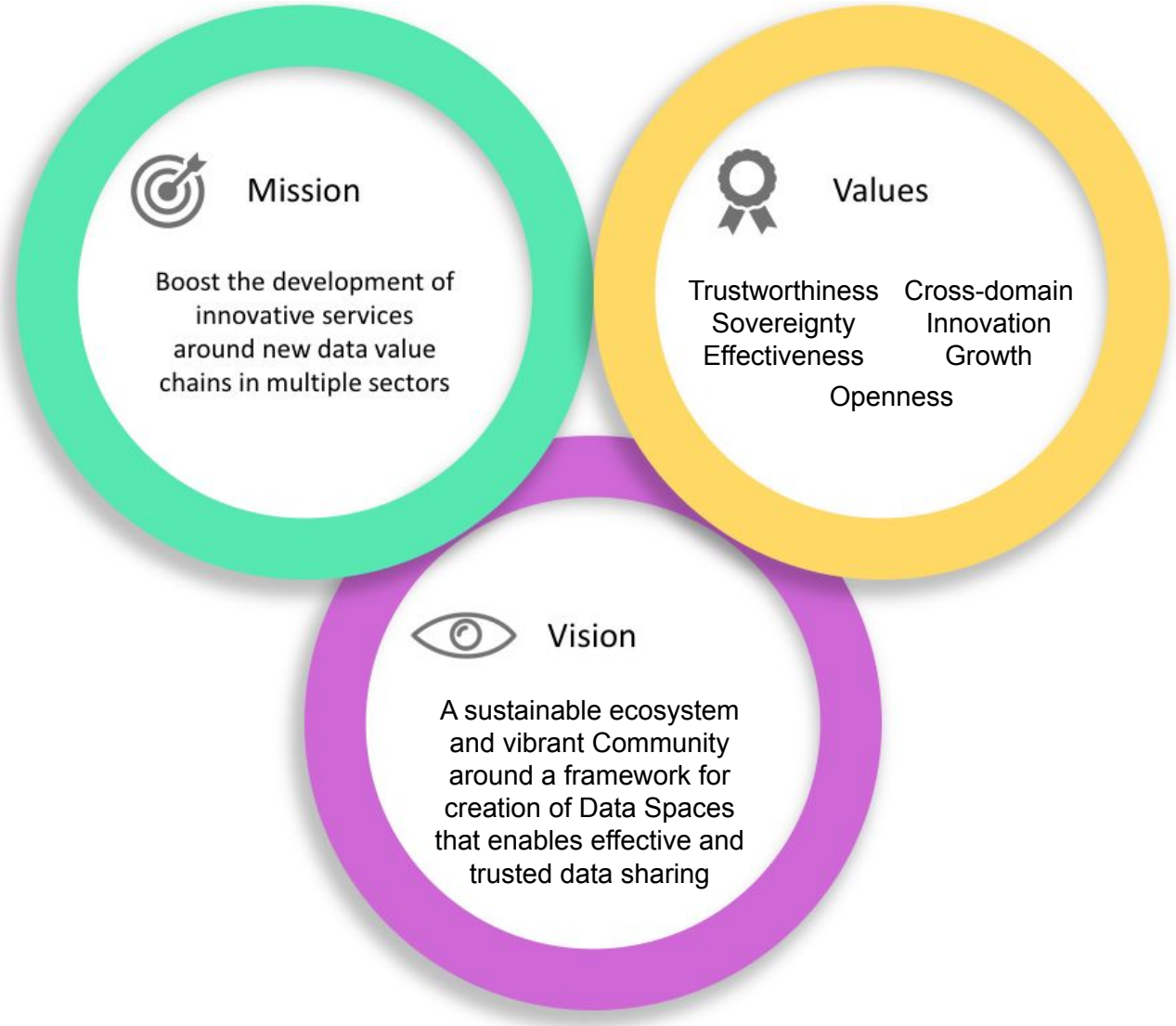
FundingBox



General introduction

i4Trust

i4Trust Mission, Vision, Values



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A data space is an decentralized data ecosystem built by the parties with common purpose

- Further, it can be defined as a decentralized data ecosystem built around commonly agreed building blocks enabling an effective and trusted sharing of data among participants.
- Data consumers, data providers and identity and authorisation service providers form an ecosystem with a governance structure in place to create a basic data space
- Additionally, service providers like Marketplaces, Brokers, Billing and Clearing etc. can be part of data space to support variety of use cases
- iSHARE and FIWARE bring the necessary components along with basic governance structure to create **i4Trust data spaces**

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Examples of data spaces in real life

1. Data space logistics : saving CO2 and handling time for goods by working under the same trust framework and based on the same standards. And provide ad hoc access to the data of goods in case of emergencies.

2. Data space Energy : protecting data sovereignty while allowing energy saving services on the data generated by buildings.

3. Data space building : providing access to the detailed materials needed and on that basis provide a better planning, smoother building process and better insights in the circularity of the build.

1. Livestock farming: AI/ML service provider provides predictions on animal growth based on parameters from animals monitored by Smart Farm Management system as well as weather forecast services

Data Spaces Building Blocks

Data Interoperability	Data Sovereignty and Trust	Data Value Creation	Data Spaces Governance
Data Models & formats	Identity Management	Metadata & Discovery Services	Business Agreements
Data Exchange API	Trusted Exchange	Publication & Marketplace Services	Operational Agreements
Provenance & Traceability	Access & Usage Control/Policies	Data Usage Accounting	Organizational Agreements

Technology Building Blocks

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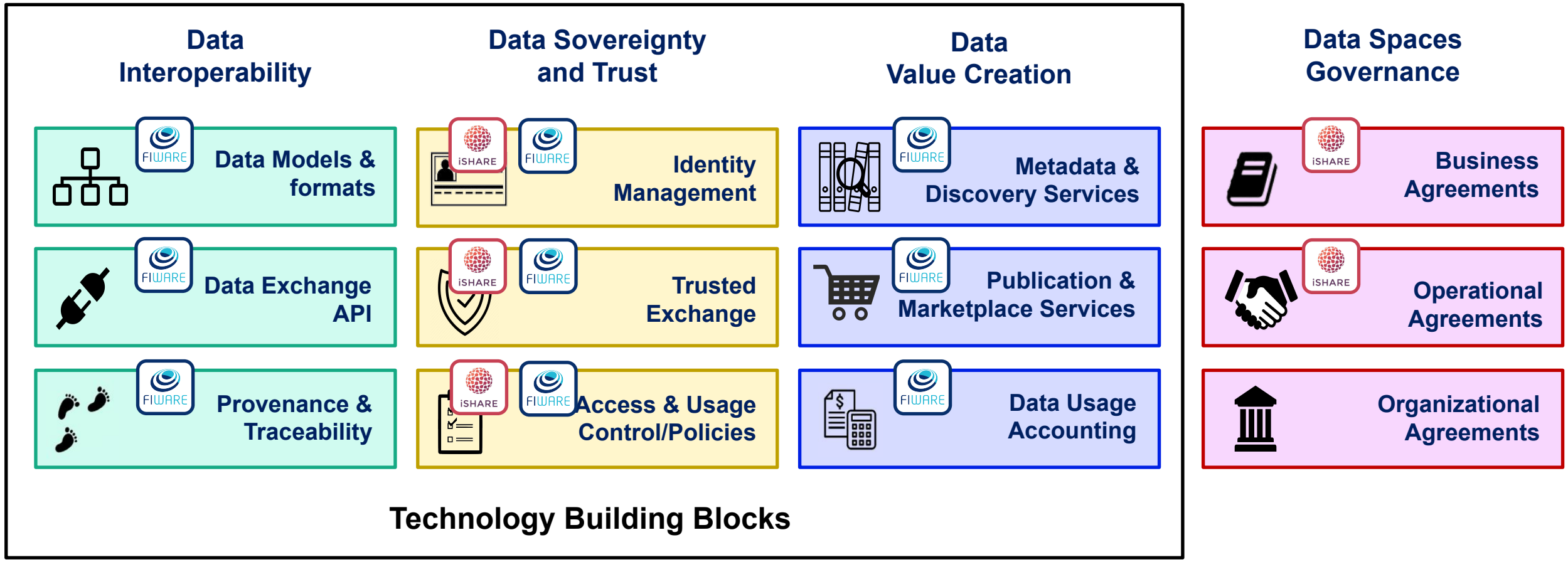
i4Trust: open source, mature technologies



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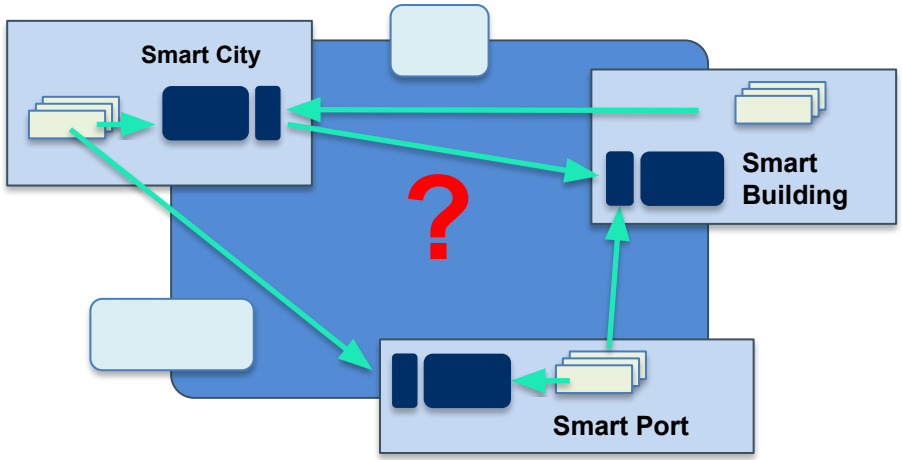
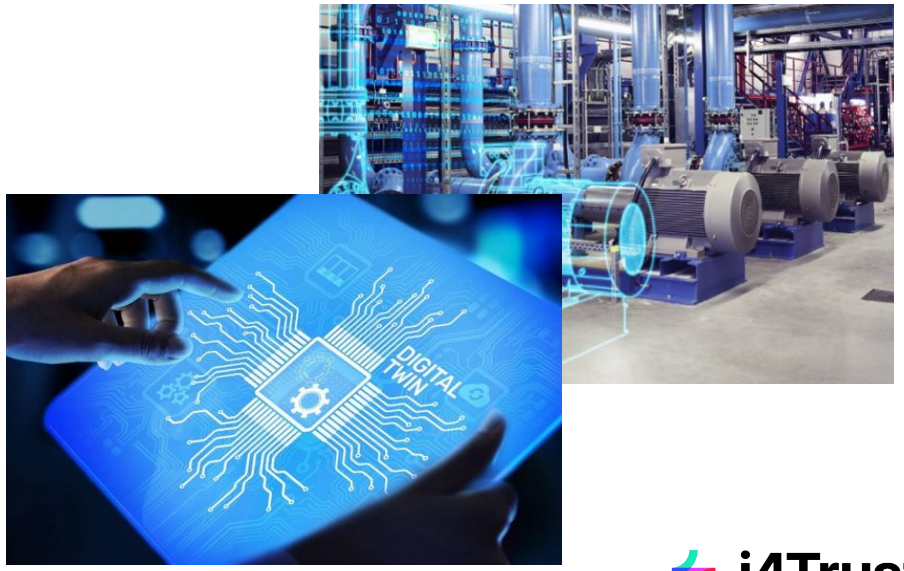
i4Trust: fundamental principles

- Fundamental principle in Data Spaces for a Data Economy:
  - Data providers publish data resources knowing that consumers, unknown “a priori”, know how to consume them
  - Data consumers know how to discover and consume data resources published by data providers

- This requires all participants to “speak the same language”:
  - Data exchange API (the sentences you construct)
  - Standard data models (what you speak about)
  - Common mechanisms for Identity and Access Management (IAM) (who speaks under what rules)

- i4Trust focuses on secure exchange between smart applications which exchange context / digital twin data:
  - Digital Twin = Digital representation of an real-world asset
  - Digital Twin data = Properties, Relationships
  - Context = Collection of Digital Twins
  - IAM at organization and user level, have a Trust Authority
  - Data Marketplace and Publication services





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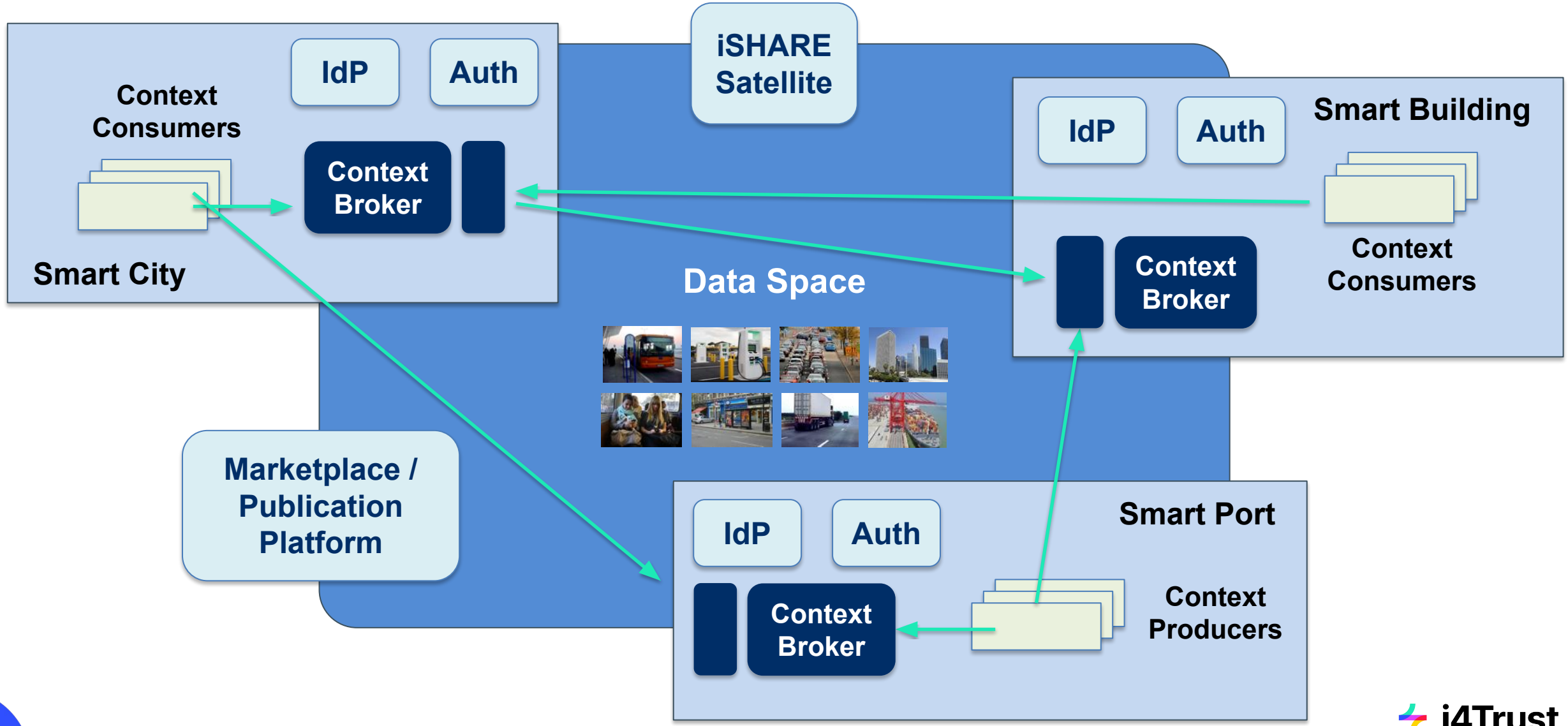
Effective and trusted data sharing



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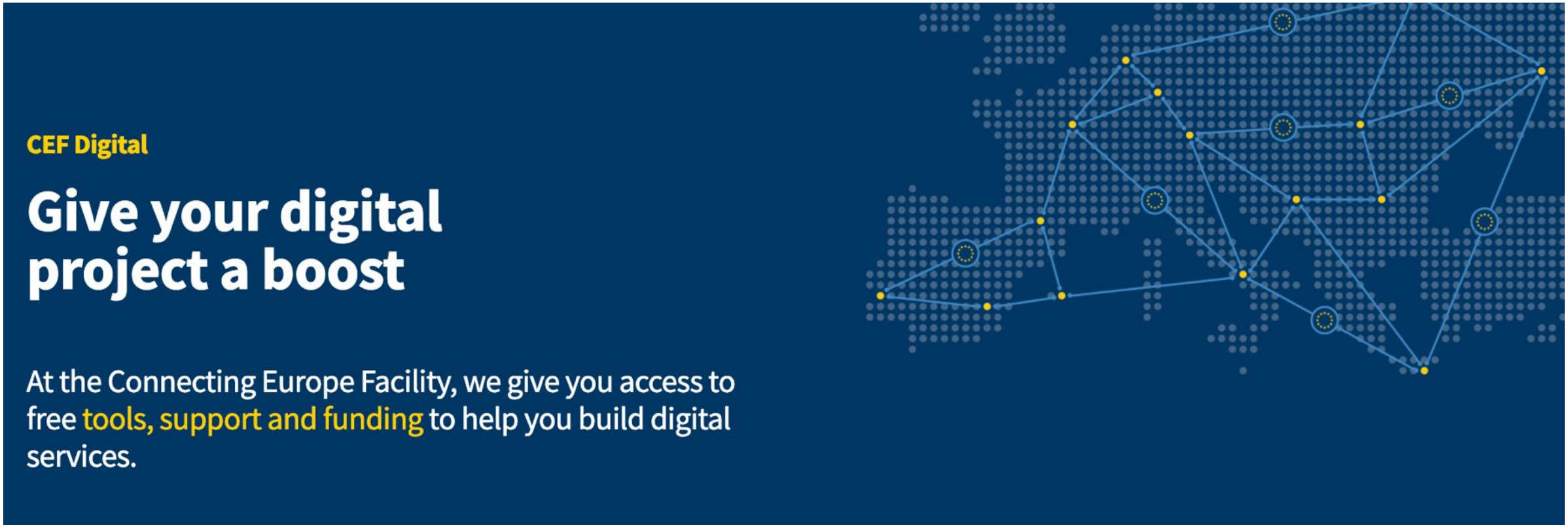
Alignment with CEF Building blocks



eID

Offer services capable of electronically identifying users across Europe

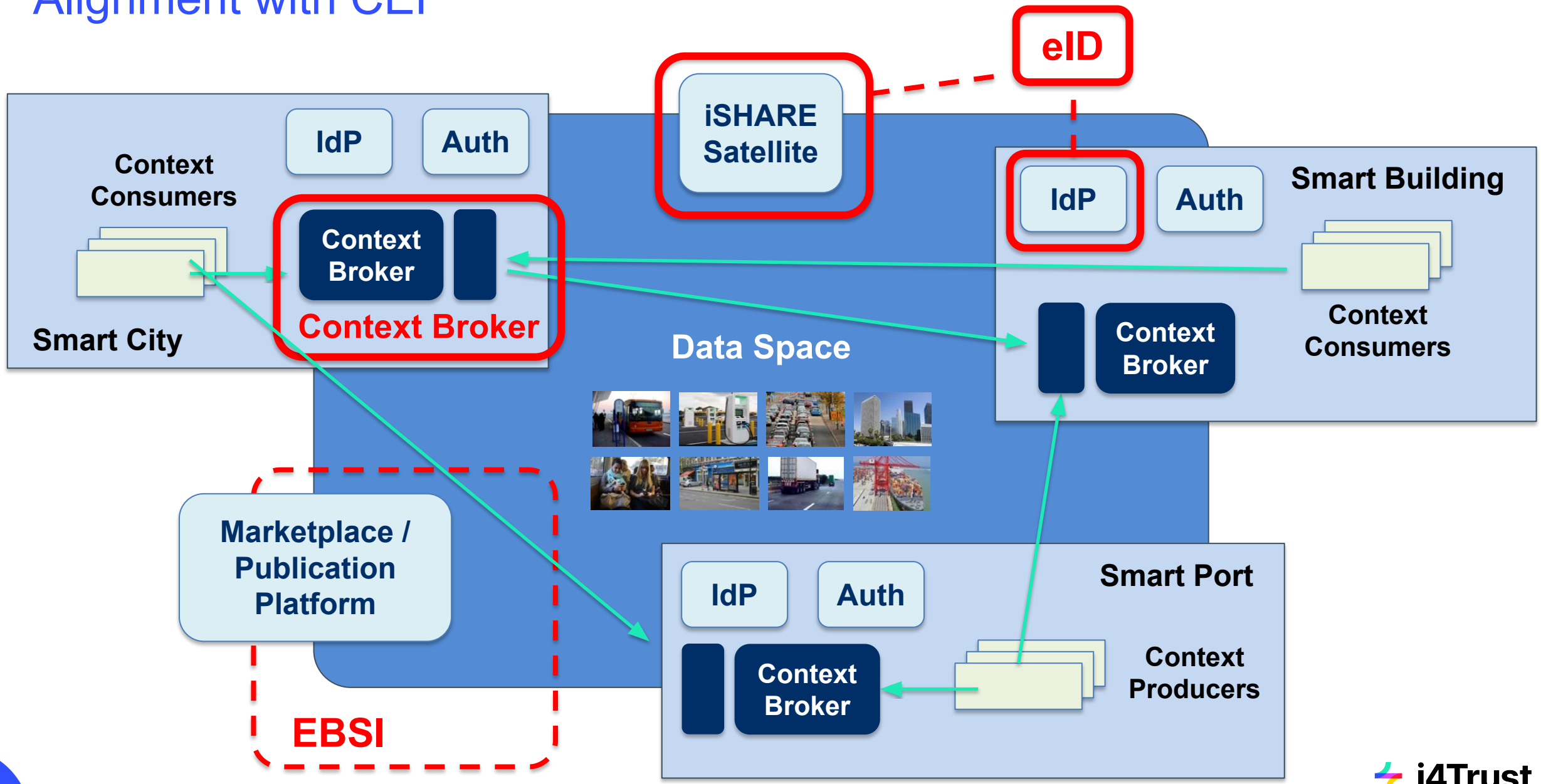
Context Broker

Gather and share data in real-time from all your smart applications and sensors

EBSI

Build the next generation of European blockchain services

Alignment with CEF



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i4Trust: standard-based, CEF Compatible technologies

Data Interoperability	Data Sovereignty and Trust	Data Value Creation
Data Models & formats JSON-LD, Smart Data Models	**Identity Management** OpenId Connect, OAuth2	**Metadata & Discovery** DCAT, DCAT-AP
Data Exchange API NGSI-LD, Context Broker*	**Trusted Exchange** eIDAS*	**Publication & Marketplace** DCAT, TM Forum Open APIs
Provenance & Traceability EBSI*^	**Access & Usage Control** JWT, XACML	**Data Usage Accounting** EBSI*^

(*) CEF Buillding Block
(^) planned for 2nd phase

Technology Building Blocks

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Going beyond the technology: a vibrant Community

Training
Technical Support

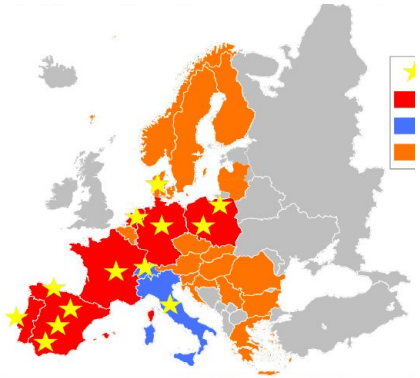
FIWARE iSHARE

Digital Innovation Hubs
(DIHs)

i4Trust
Community

32 BuE – 150+ SMEs
(Bottom-up Experiments

Future experiments
Market solutions



Community Platform
Community Mgmt

FundingBox

FIWARE iSHARE

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i4Trust Values (our DNA)

TRUSTWORTHINESS

Thanks to the unified framework for identification and the robust legal frameworks that i4Trust brings, you can **trust the participants** you exchange data with.

SOVEREIGNTY

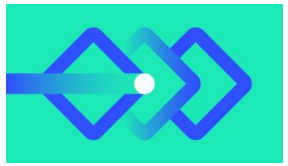
i4Trust brings the means for enforcing the data access and usage policies you want to define, bringing you the power to **be the sovereign of your data**.

EFFECTIVENESS

Designed for the exchange of data among Smart Solutions, i4Trust brings a standard data exchange API and data models guaranteeing you to **effectively share data**

OPENNESS

i4Trust is open, based on open-standard and implemented as Open Source, allowing you to **avoid vendor lock-in**, thus protecting your investment and reducing costs.

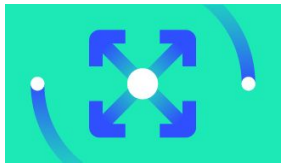


CROSS-DOMAIN

i4Trust unleashes the potential of data sharing among different participants in multiple domains, allowing you to **define cross-domain data value chains.**

INNOVATION

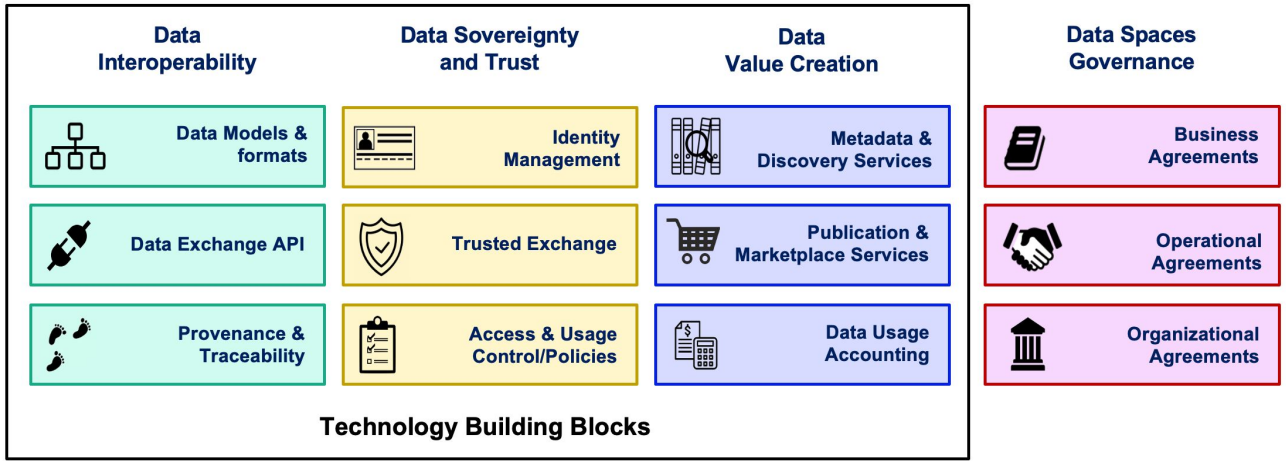
By combining tools enabling multi-side markets and the ability to monetize data, i4Trust will bring you the opportunity to **create innovative business models.**



GROWTH

i4trust Community is formed by experts engaged in a process of collective learning and human endeavor to **scale your business** and gain stronger position in the market.

i4Trust Building Blocks



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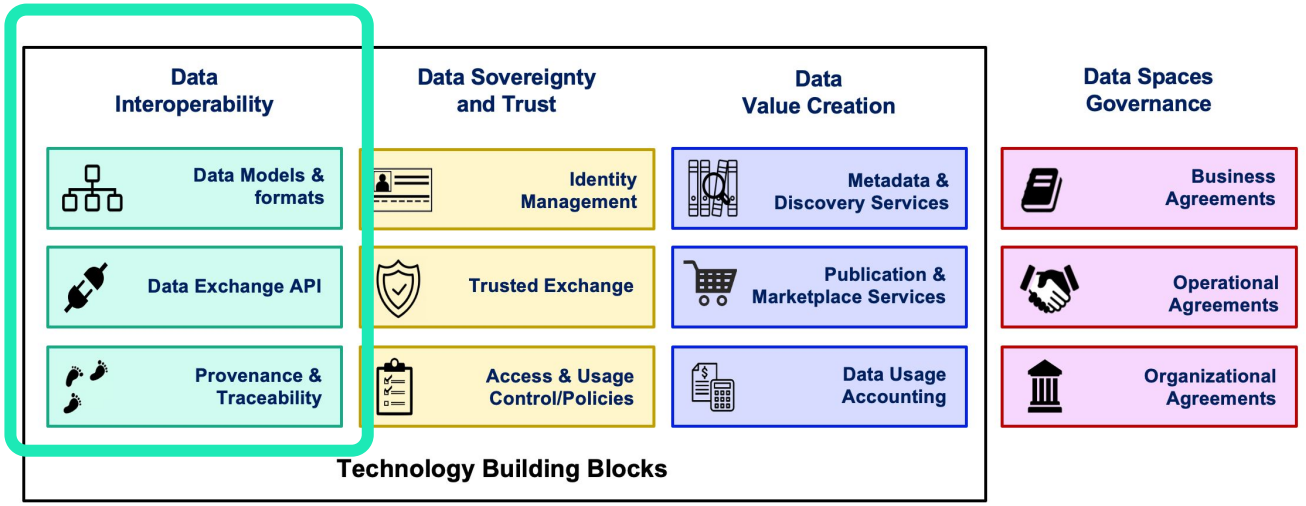
Data Interoperability



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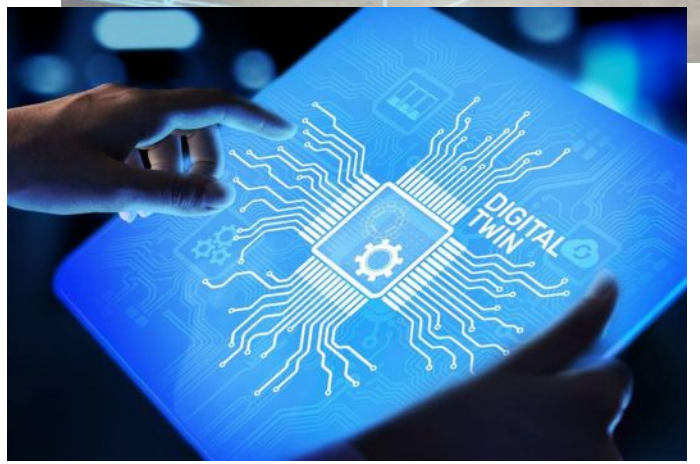
What are we referring to as Digital Twin?

- **Digital Twin** = Digital representation of an asset
  - Characterized by attributes
    - Properties
    - Relationships (Linked Data)
  - Values of attributes may change over time (or not)
  - Typically have a location (but it is not a must requirement)
- (digital representation of) **Context** = Digital Twins Collection
- **Cornerstone for the development** of interoperable and replicable (portable) Smart Solutions:
  - **Standard API** for getting access to Digital Twin data (context)
  - **Common Data Models** associated to Digital Twin classes
- **FIWARE** has driven standardization+adoption:
  - **NGSI: ETSI NGSI-LD API** (based on initial NGSIv2)
  - **Smart Data Models initiative** (500+ data models)



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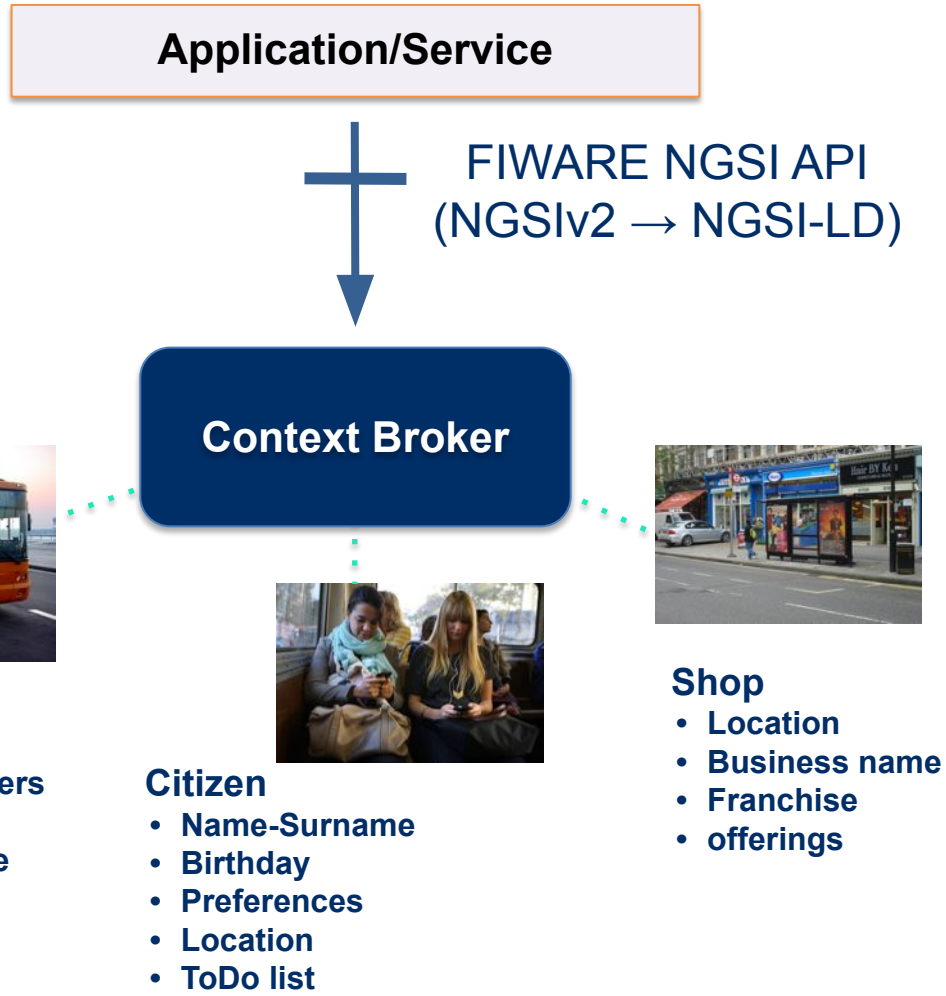
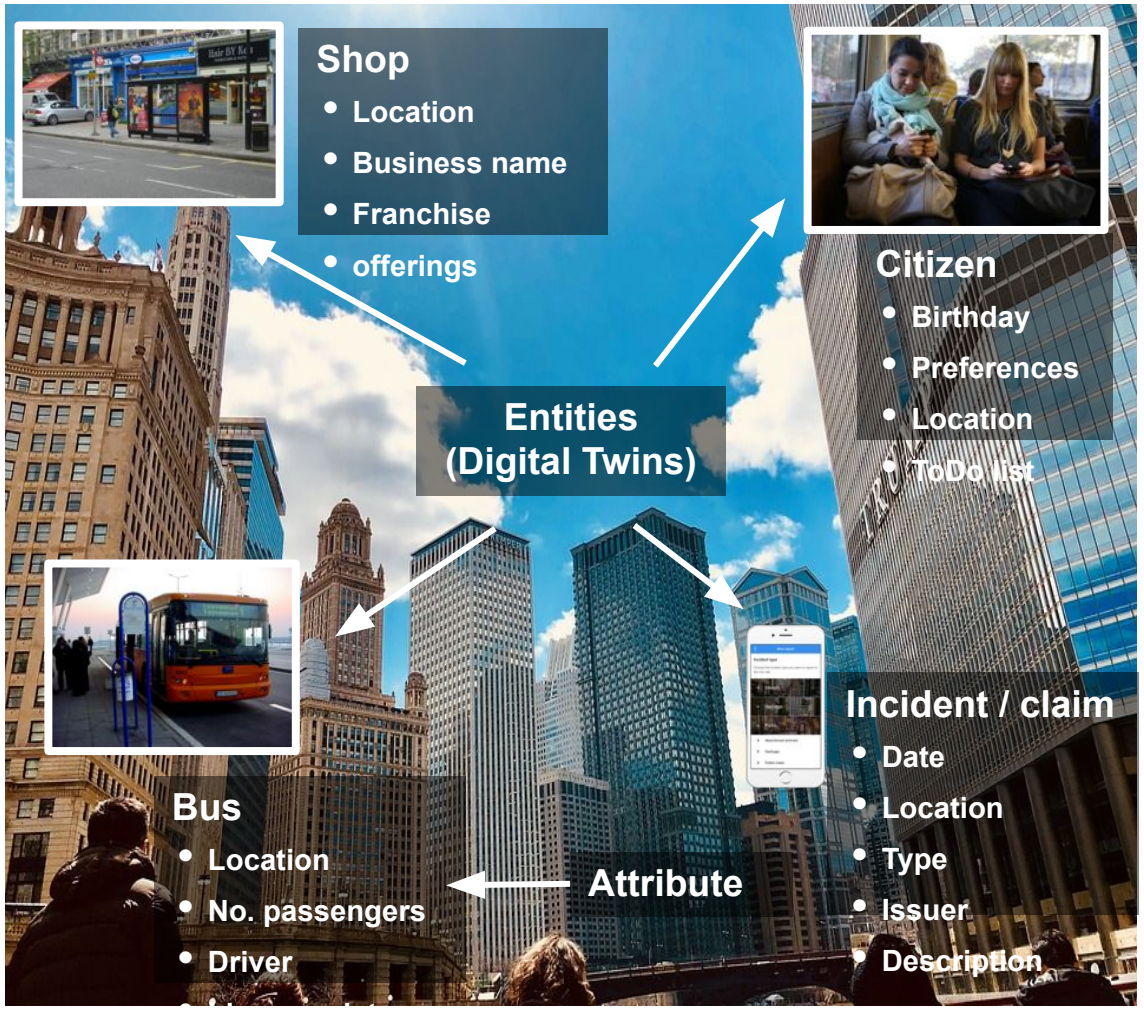
Data Exchange API: ETSI NGSI-LD





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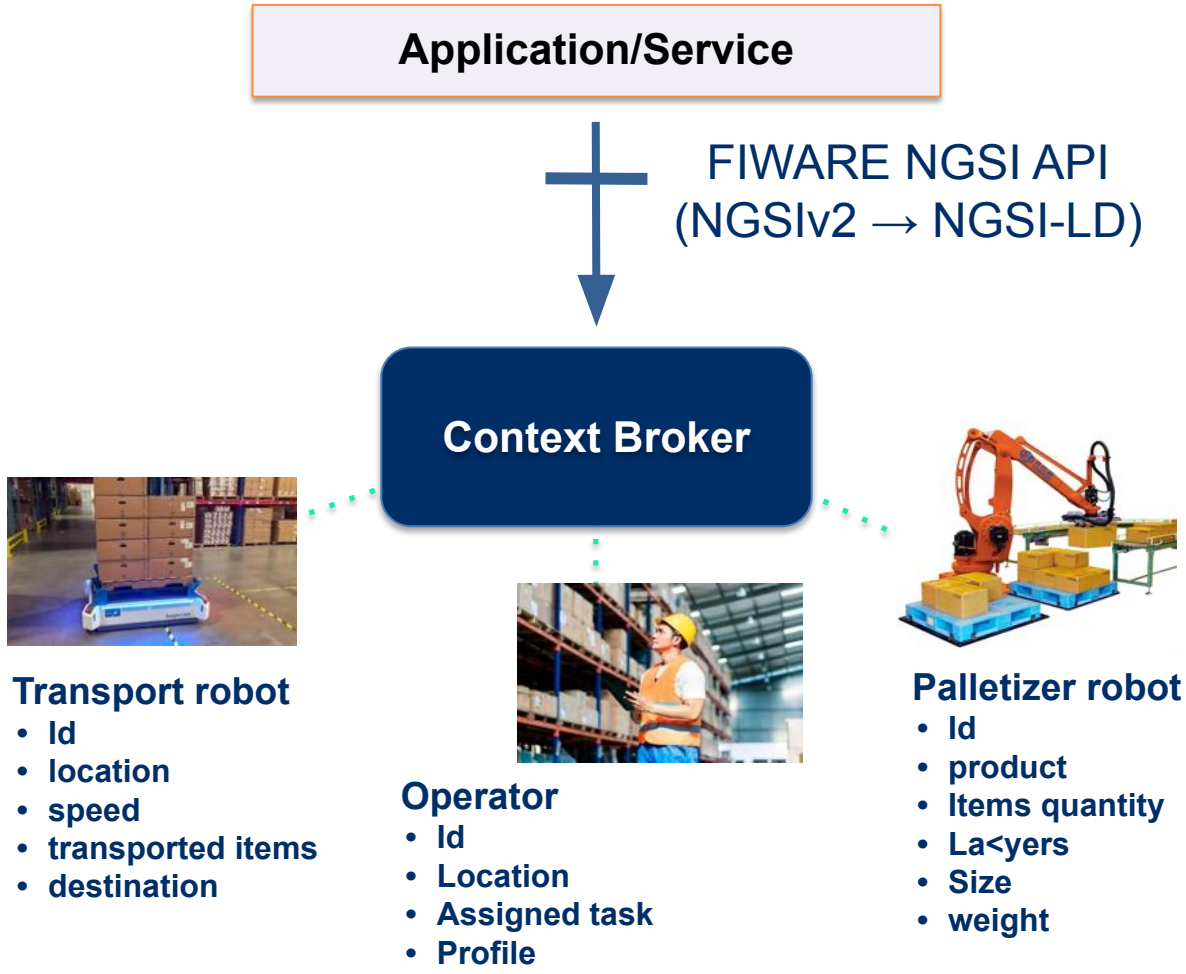

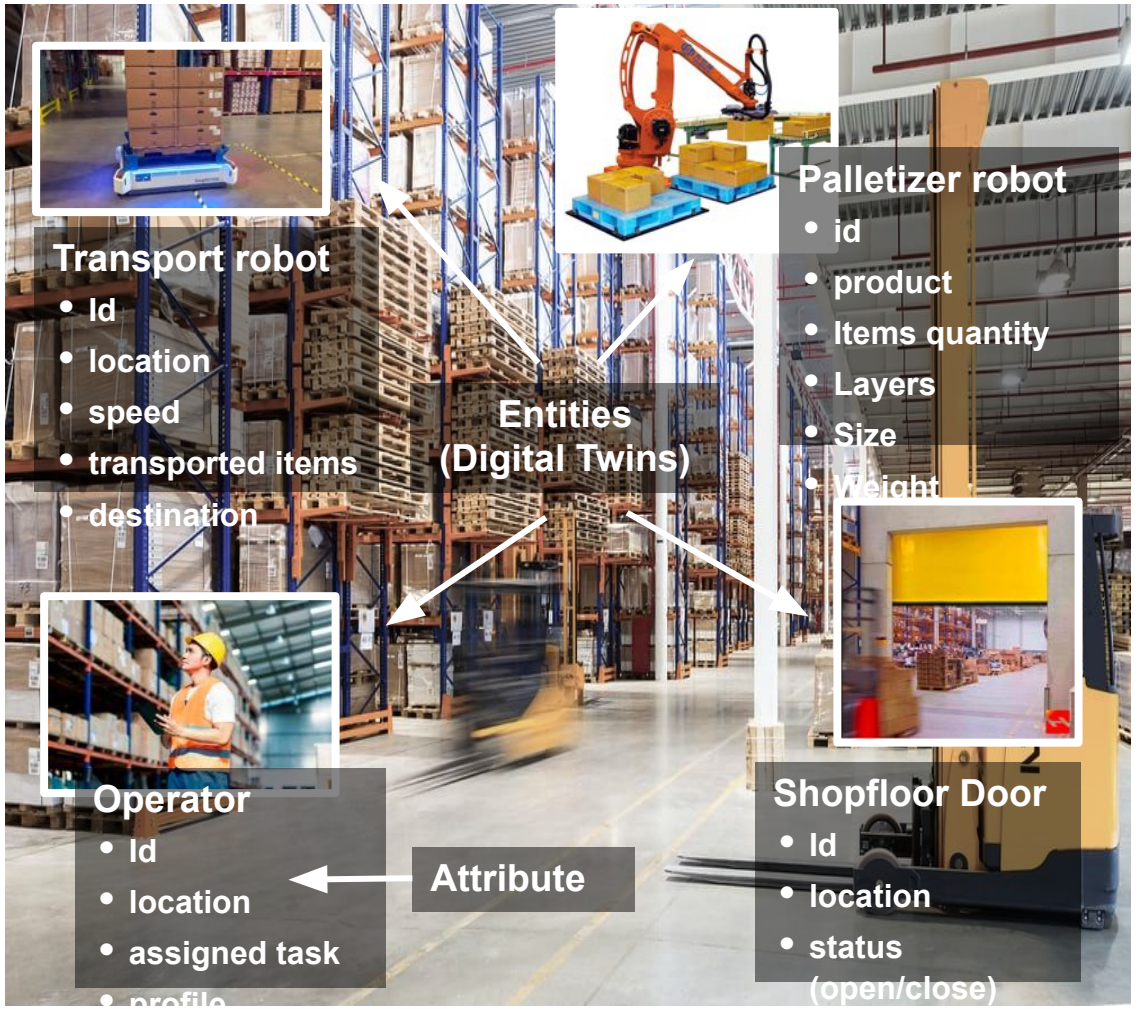

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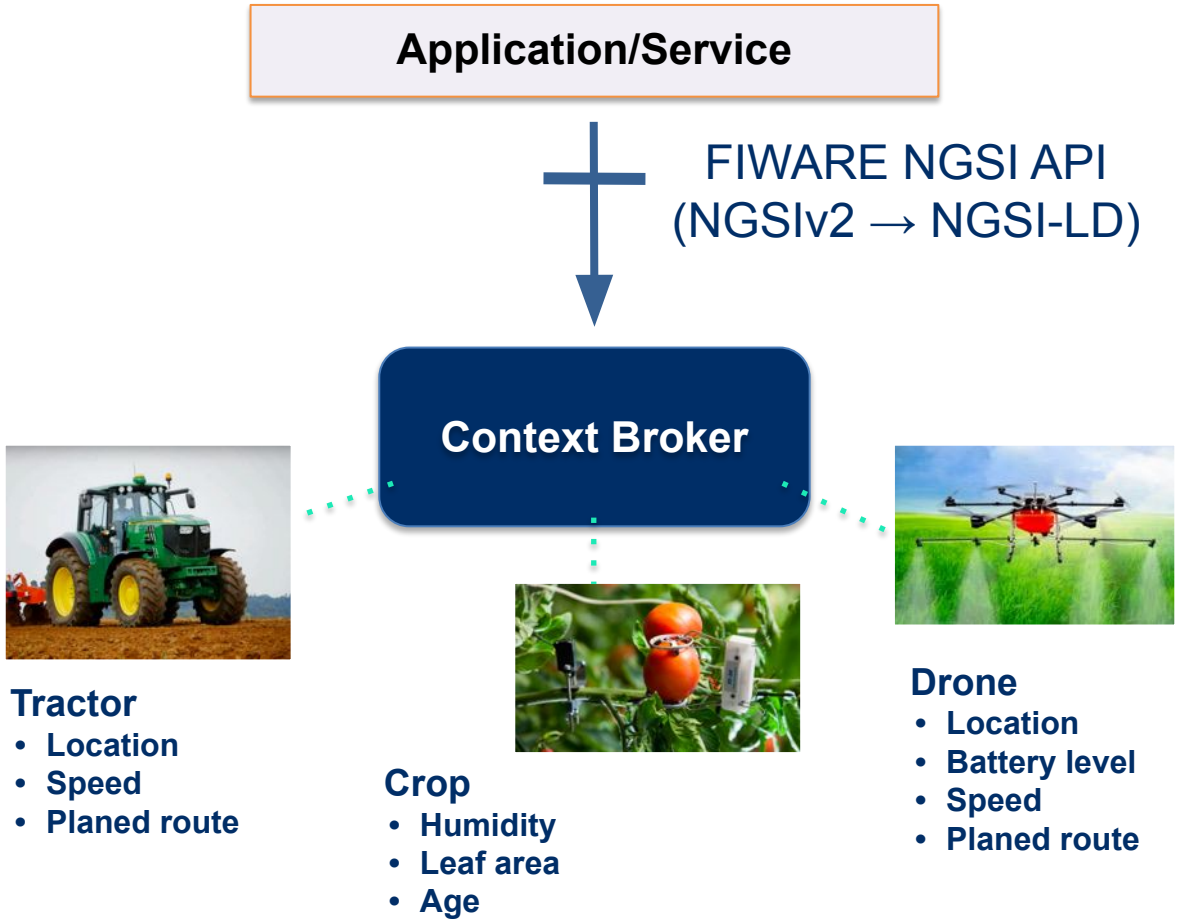
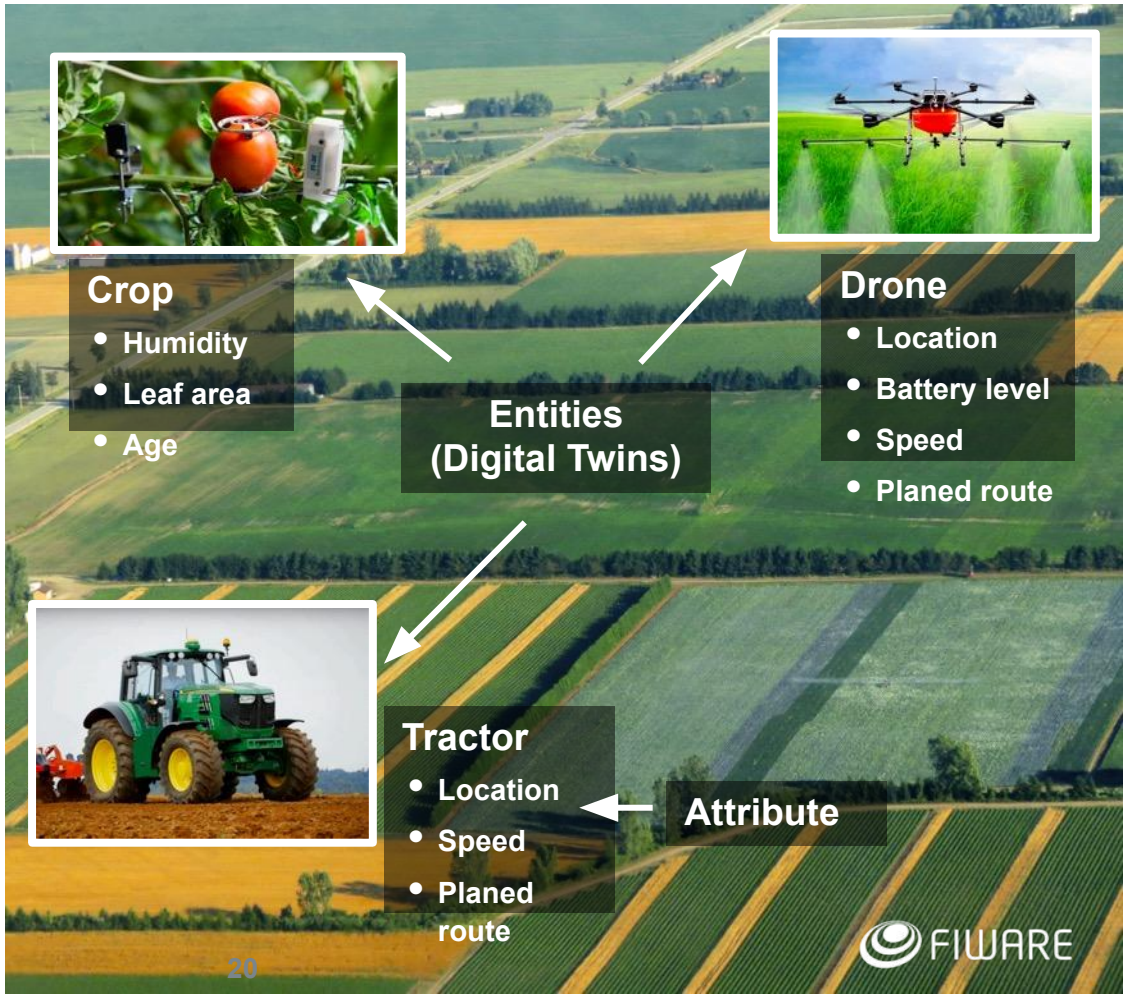
Data Exchange API: ETSI NGSI-LD





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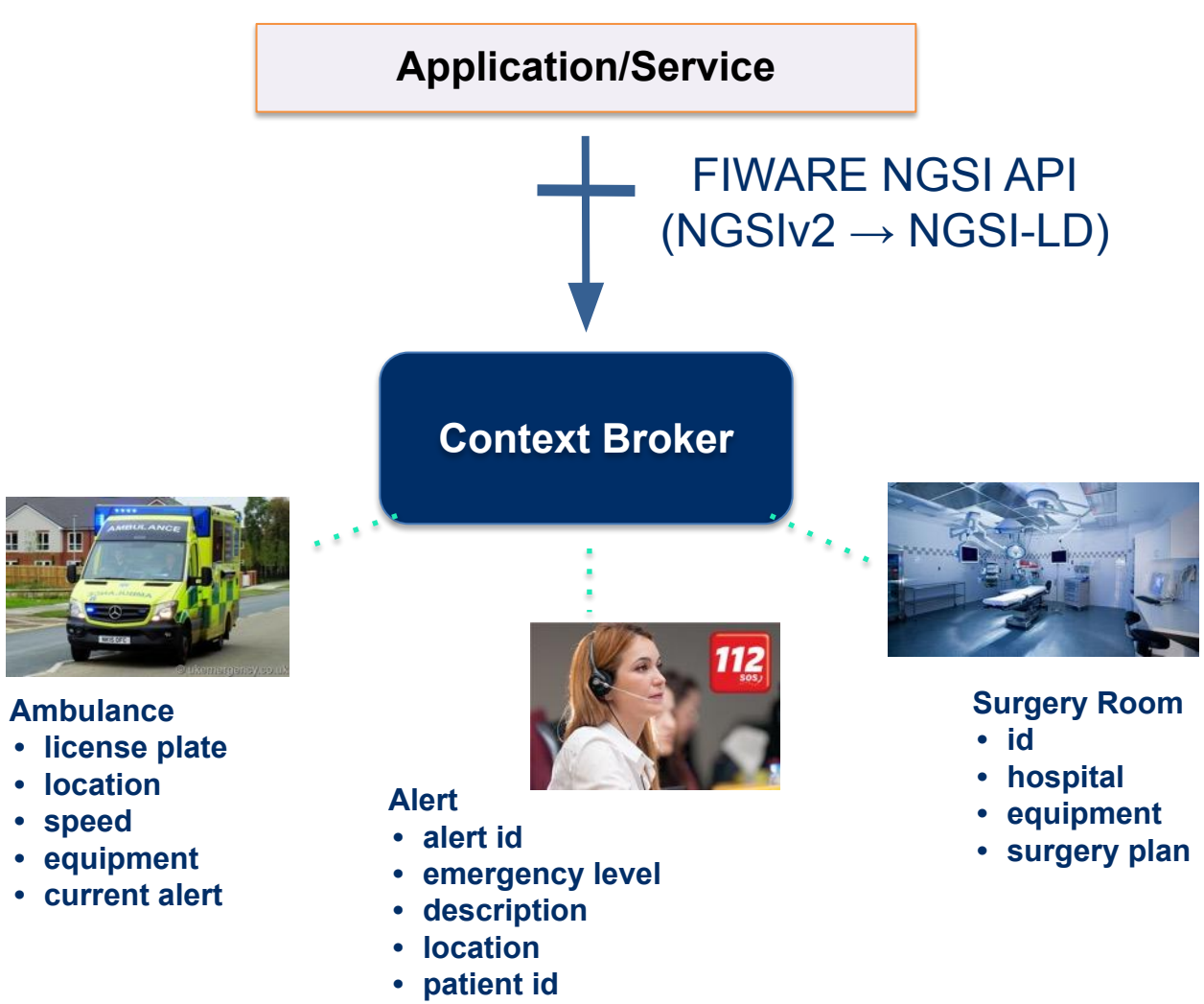
Data Exchange API: ETSI NGSI-LD



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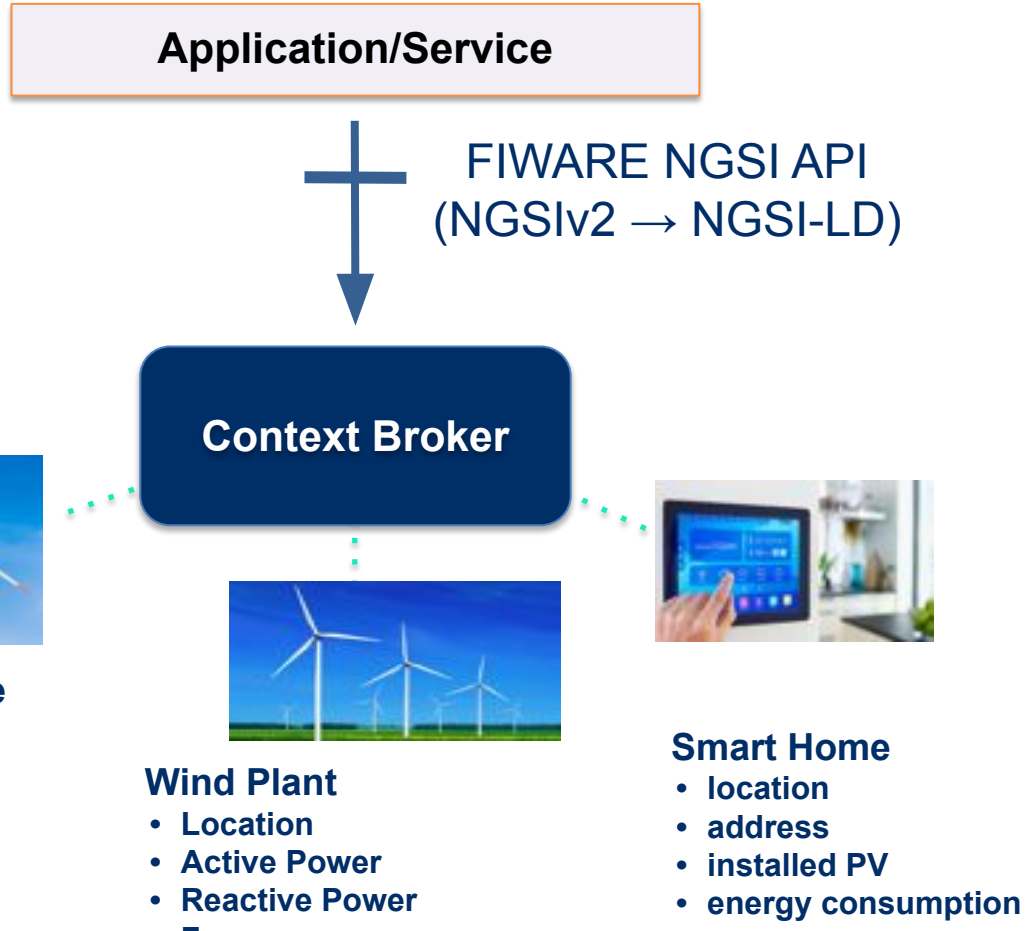
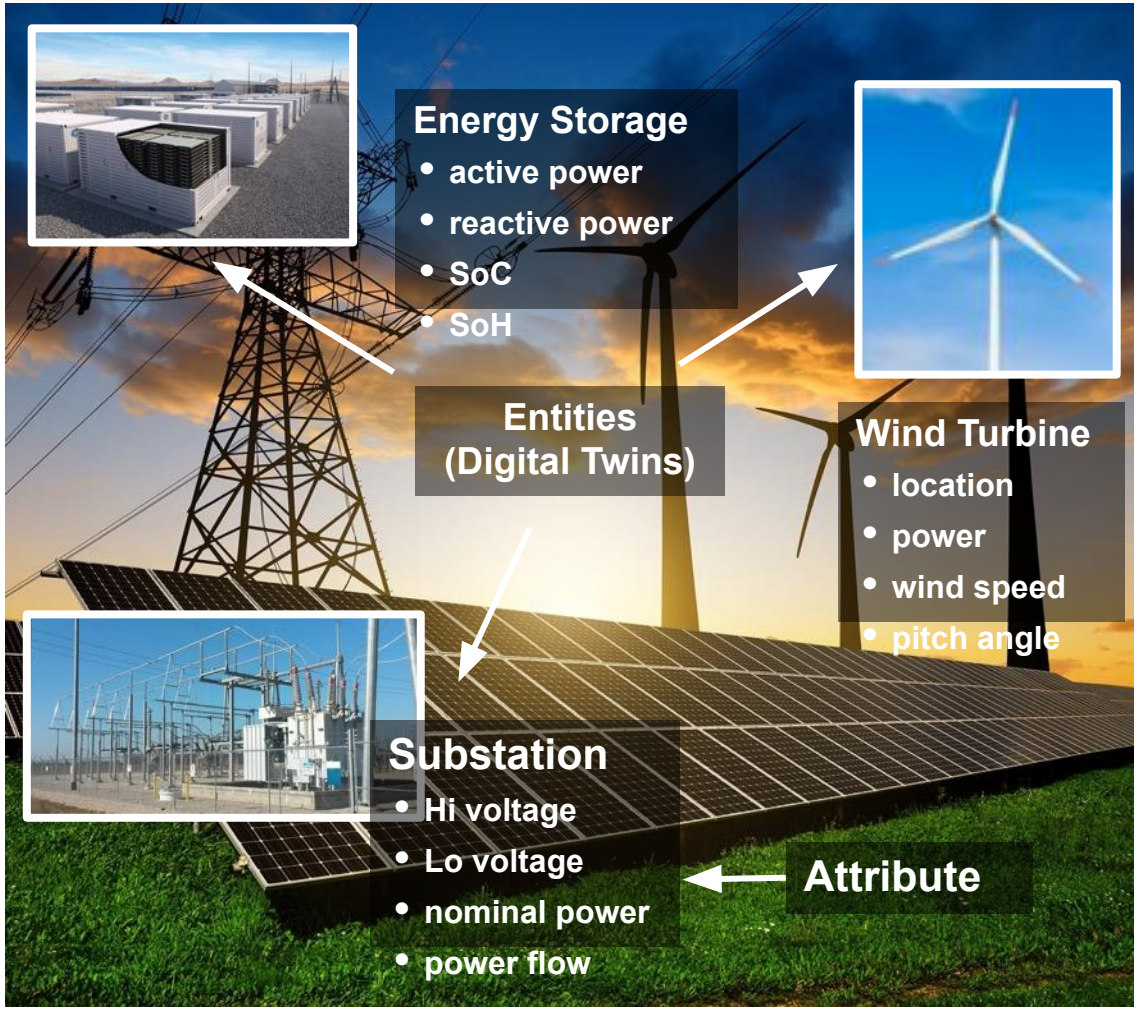
Data Exchange API: ETSI NGSI-LD





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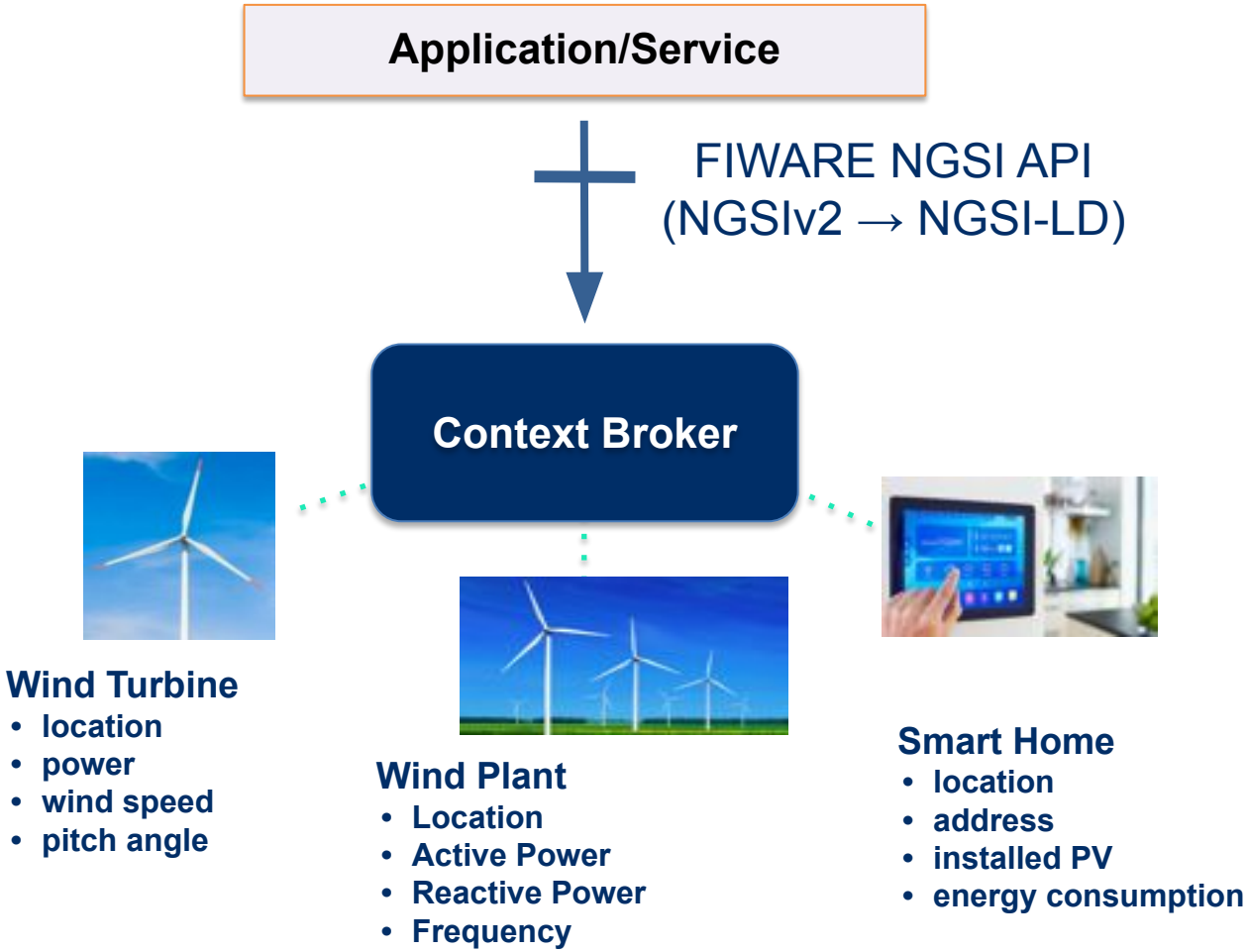
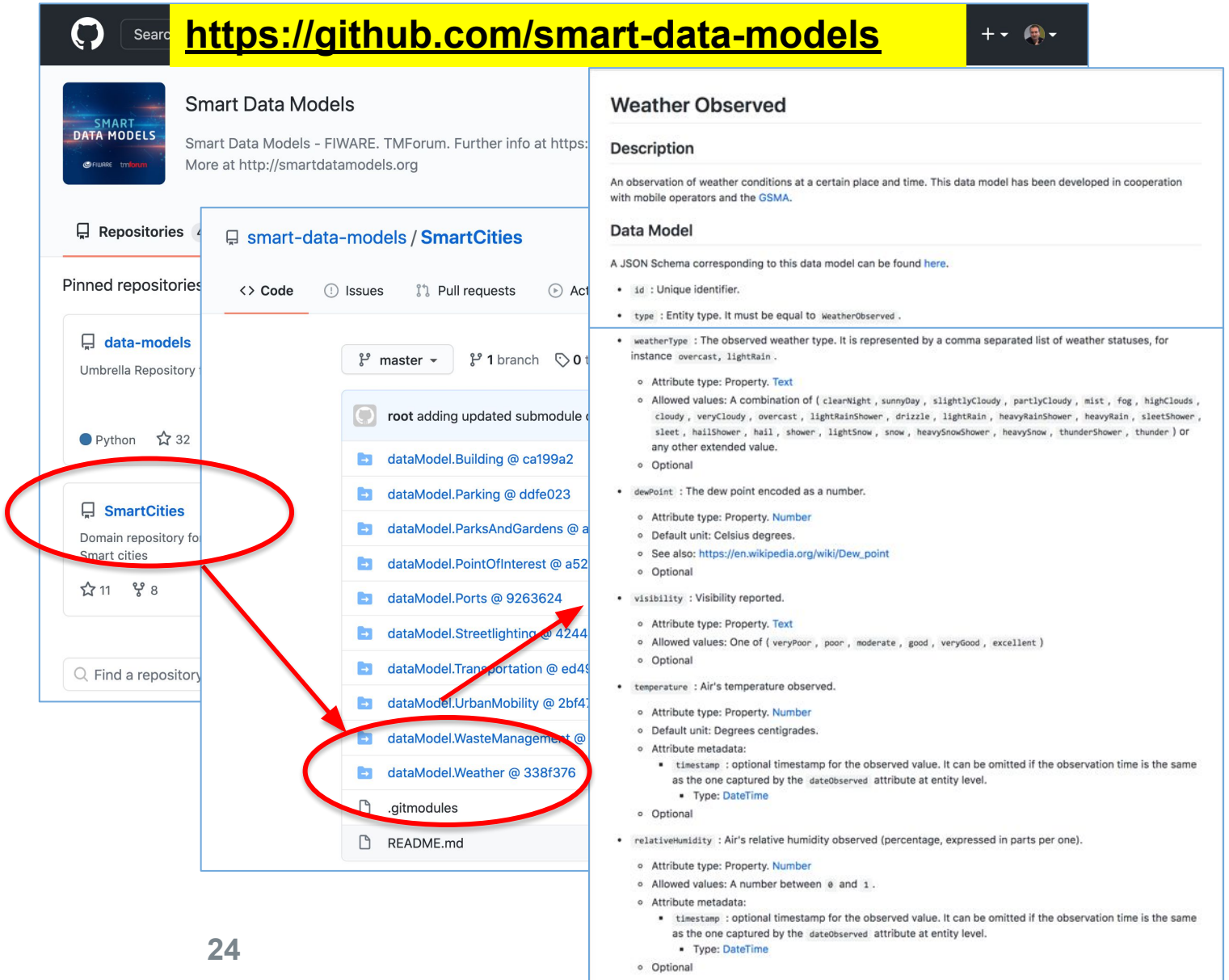
Data Exchange API: ETSI NGSI-LD



- NGSI-LD is a simple yet powerful REST API
- Simple: simple operations are rather simple, what you would expect in a RESTful API
  - Entity types, entities, attributes have a path
  - You perform standard GET, POST, PUT, PATCH, DELETE operations
- Yet powerful: powerful operations supported
  - Geo-queries
  - Subscription / Notification
  - Pull/Push styles for gathering data
  - Multiple data ”renderings” (key value, normalized, GeoJSON)
  - Temporal operations
  - Federation mechanisms

Smart Data Models

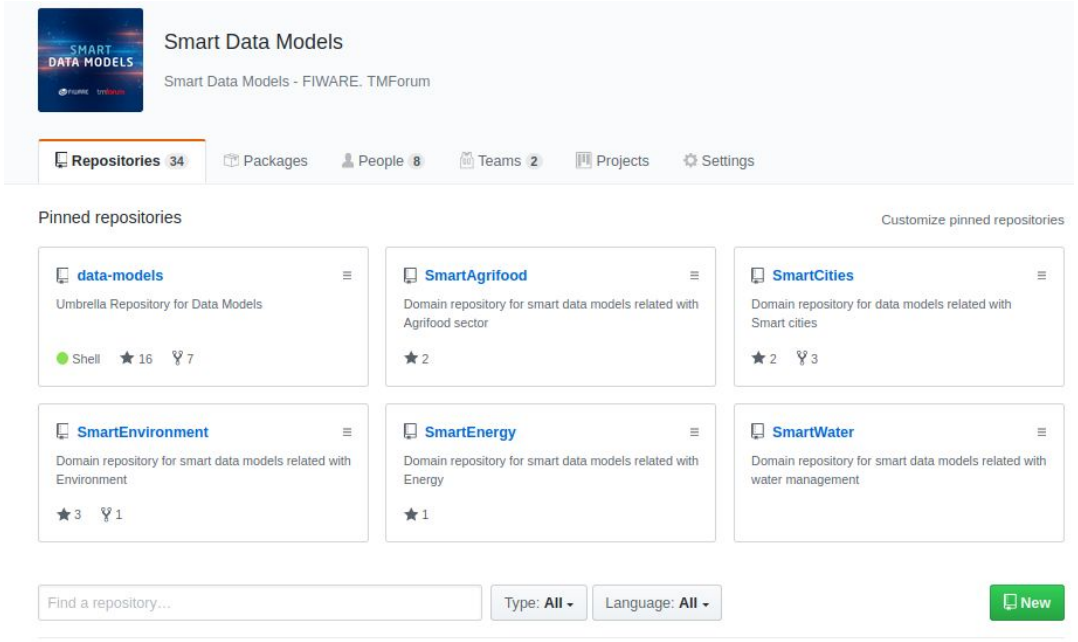
- FIWARE Foundation is collaborating with relevant organizations towards definition of common data models for multiple application domains
  - Smart Cities
  - Smart Health
  - Smart Energy
  - Smart Environment
  - Smart Manufacturing
  - …
- Defined data models rely on well-established ”de-facto” standards (schema.org, SAREF, IEC CIM in Energy, UNE 178503 for Tourism, …)
- Provides JSON/JSON-LD Mappings compatible with NGSIv2/NGSI-LD also useful for other RESTful APIs



Smart Data Models: Webs

GITHUB

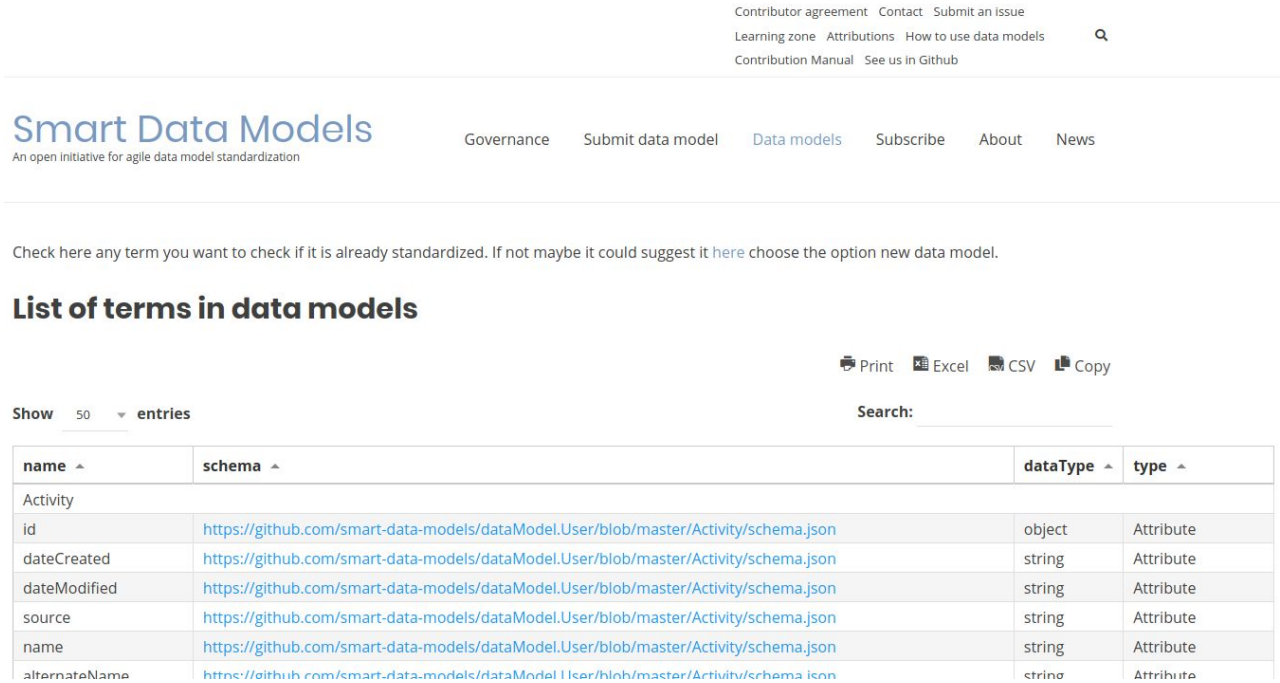
http://github.com/smart-data-models



- Oriented to **developers**
- All resources available
- Contribution by PR
- Issues on data models

WEBSITE (Wordpress)

http://smartdatamodels.org



- Oriented to **end users**
- News on updates (subscription)
- Check attributes and enumerations

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Smart Data Models: domains and subjects

DATA-MODELS

- Guides for coding new data models
- Template for new data models and examples
- Directory for scripting tools to check data models
- Inventory of domains and data models
- Inventory of attributes and terms
- @Context for json-ld

data-models
Umbrella repo

DOMAINS REPOSITORIES

Readme pointing to the list of subjects
General info or shared resources

Smart Water | Smart Cities | Smart Environment | Cross Sector | Smart Destinations | Smart Agrifood | Smart Energy | Smart Manufacturing | Smart Aeronautics | Smart Robotics

Subject 1 (sewage) | Subject 2 (parking) | Subject 3 (weather) | Subject 4 (Power Transformer)

SUBJECTS' REPOSITORIES

Readme pointing to the list of data models for the objects
Contributors.md
subject-schema.json

DATA MODELS

README.md
/doc/spec.md
/examples
schema.json
Adopters
LICENSE

LIFECYCLE MANAGEMENT REPOSITORIES

Incubated | Harmonization

i4Trust

Why FIWARE: endorsement at global level

ETSI created Jan 2017 an Industry Specification Group (ISG CIM) for defining a Context Information Management API

FIWARE NGSIv2 provided the basis for the NGSI-LD specs published by ETSI

FIWARE provides several open source implementations of ETSI NGSI-LD

The GSMA has published a Reference Architecture for IoT Big Data Ecosystem which recommends to mobile operators

NGSI-LD plays the core role for the integration of components and the development of applications in the defined Reference Architecture

TM Forum supports FIWARE NGSI for real-time access to context information in cities

TM Forum and FIWARE collaborate in development of data marketplace platform components

TM Forum and FIWARE also collaborate in definition of common data models (smart data models initiative)

Why FIWARE: endorsement at global level

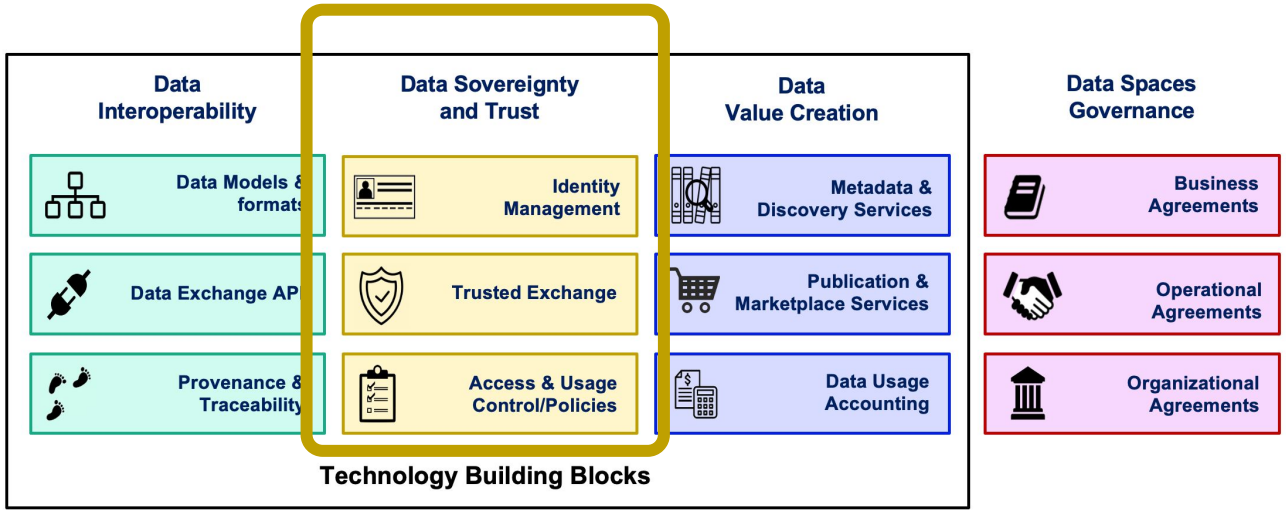
The FIWARE Context Broker Technology (hence, NGSI-LD) is a CEF (Connecting Europe Facility) Building Block recommended by the EC to public and private sector for publication of right-time context data

The European Data portal will support the publication of right-time Open Data

IUDX, which provides the trusted data exchange framework recommended to cities by the government of India, has adopted NGSI-LD as API for data exchange

IUDX will join the smart data models initiative and play a leading role in definition of data models for cities

Data Sovereignty and Trust



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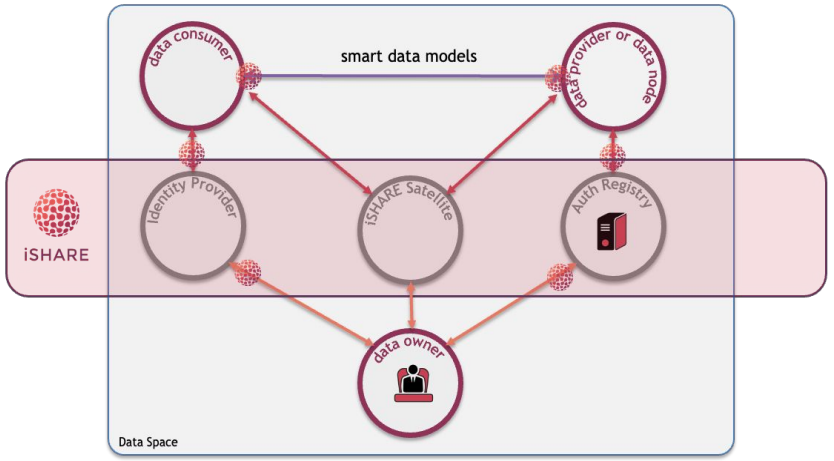
Data sovereignty and trust: principles

- Identity and access/control policies should be handled:
  - At organization level (participants)
  - At the level of users of applications within each organization
- Identity, Authentication and Authorization based on standards:
  - OpenId Connect
  - OAuth2
  - XACML
- There will be a trust authority that certifies what organizations are considered trusted parties in a data space
- Model should work assuming there is no single global Identity Provider and Authorization Registry, each organization may have:
  - A certified Identity Provider of its own choice for managing identity of end users
  - Its own Authorization Registry (XACML PMP/PAP server)
  - Its own XACML PEP proxy and PDP server



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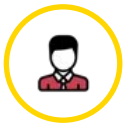
Trustworthy Identification, Authentication and Authorisations

Interaction

Machine-to-Machine (M2M)
Communication between machines, without interference by a human



Human-to-Machine (H2M)
Communication between a human and (a) machine(s). Requires a user interface

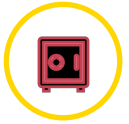
Facilitate

Flexible authorizations
- Coarse-grained: broad authorization
- Fine-grained: specific authorization
- Flexibility on where to store authorizations

Portable identities
Identities can be spread out and recognised, i.e. portable, across multiple, independent systems

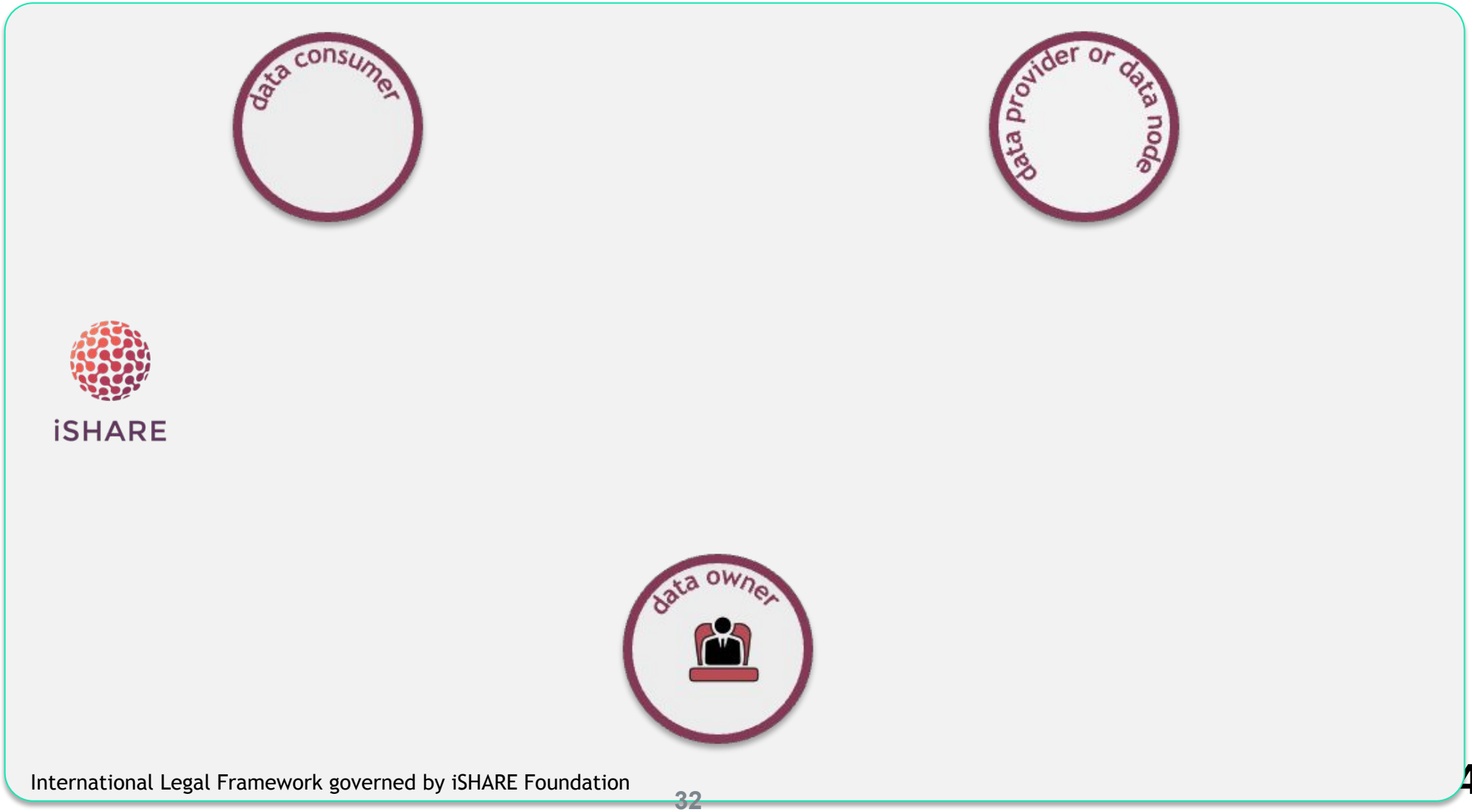
Enable

Delegations
Functions as evidence that a party is directly or indirectly operating on behalf of a known party



Customer in control
parties are allowed to modify or withdraw access rights to their data or services, whenever they wish

iSHARE is a legal framework providing legal assurance….



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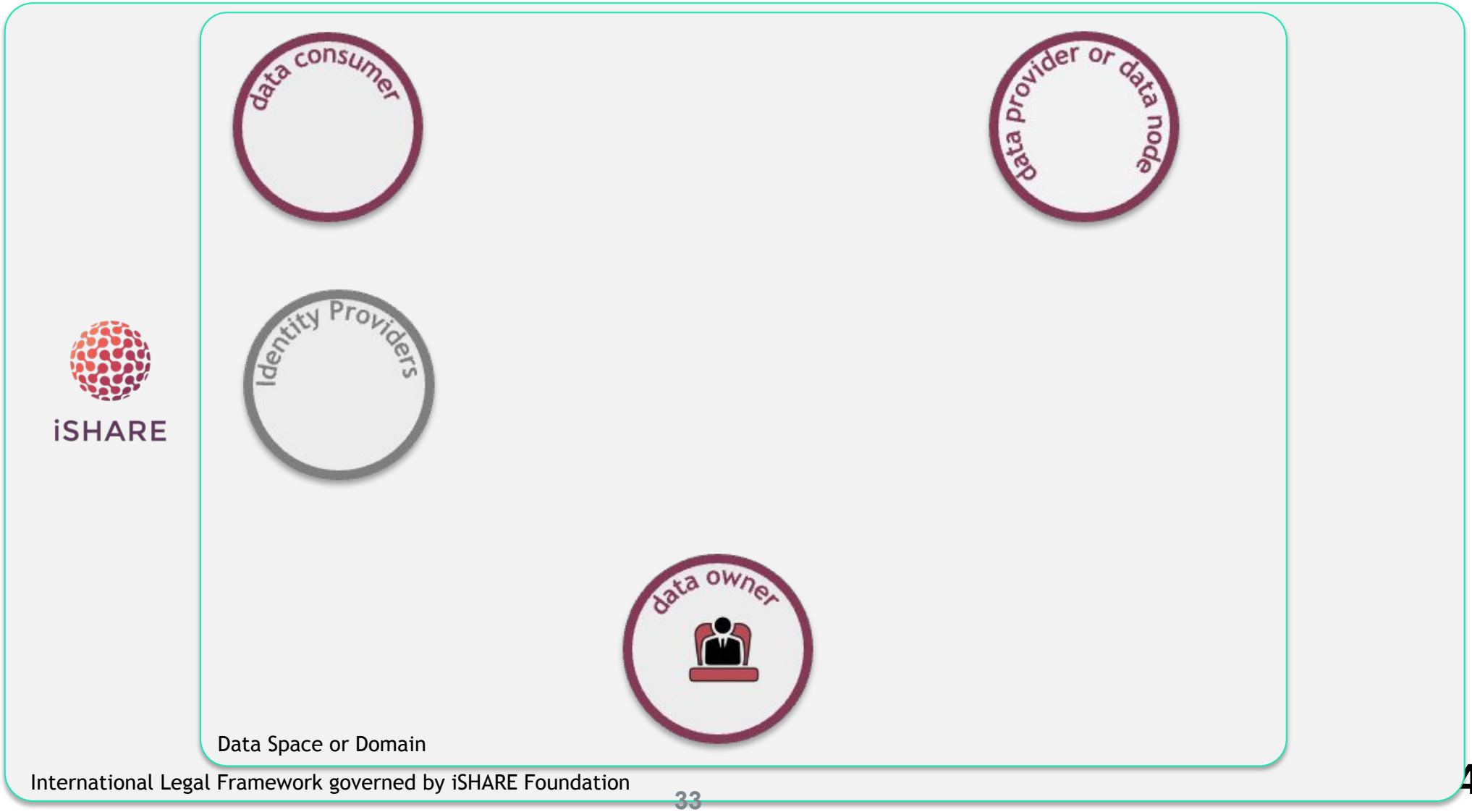
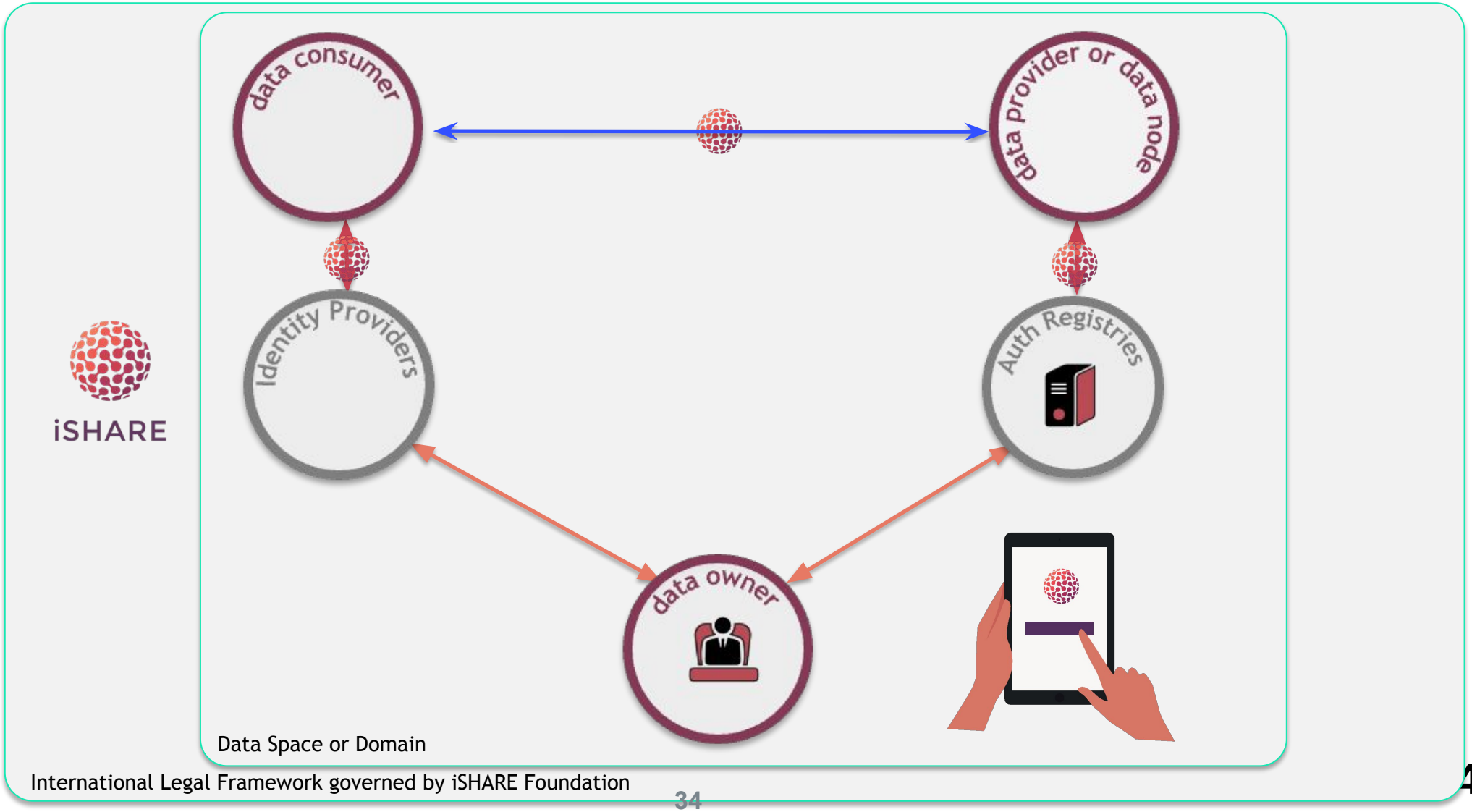
…utilising existing identities that are available in a dataspace…



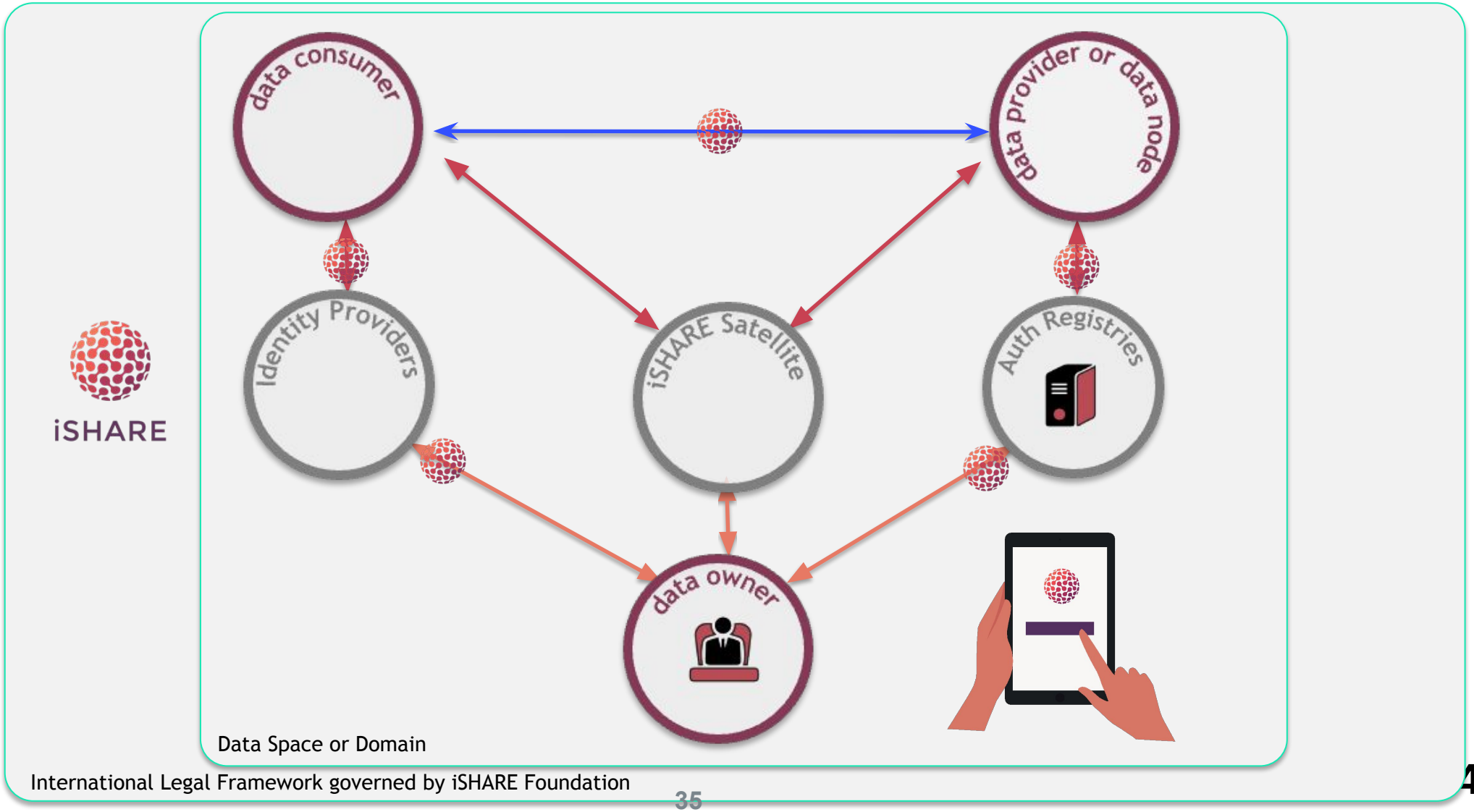
4Trust

..and iSHARE standards allowing data owners to authorise other to access their data fields



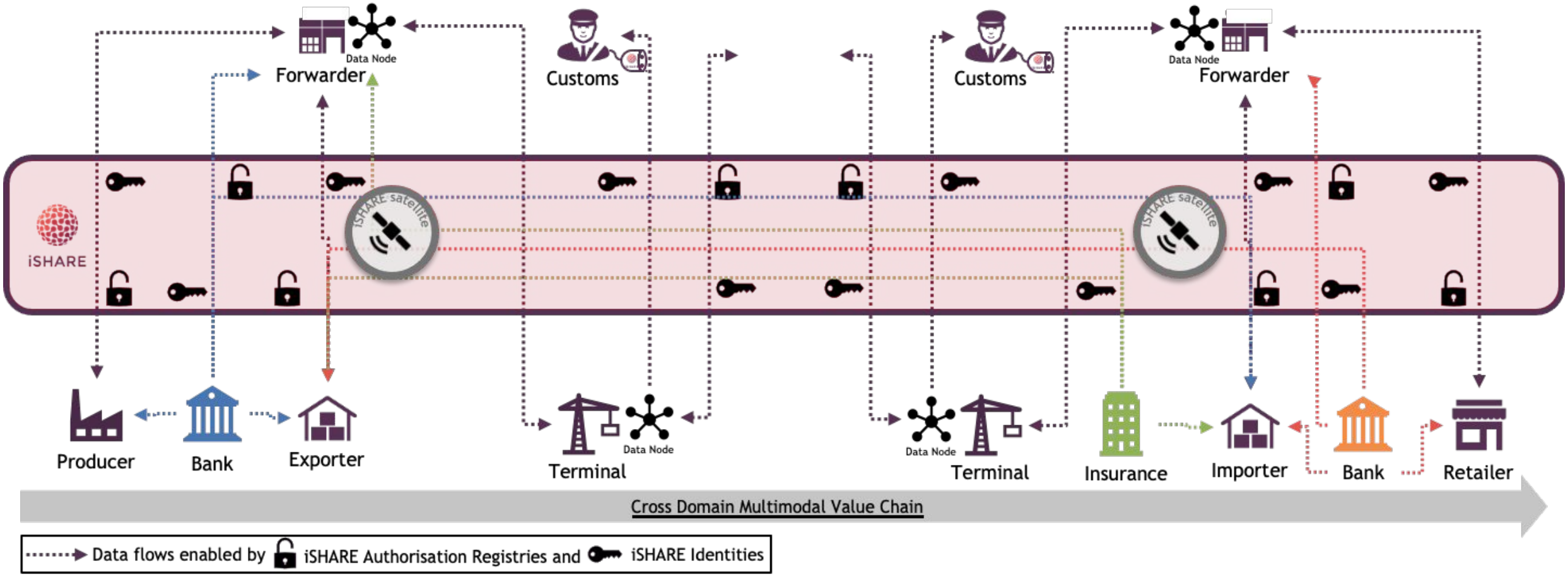
4Trust

.. and iSHARE satellites guarding the trust in the dataspace.



4Trust

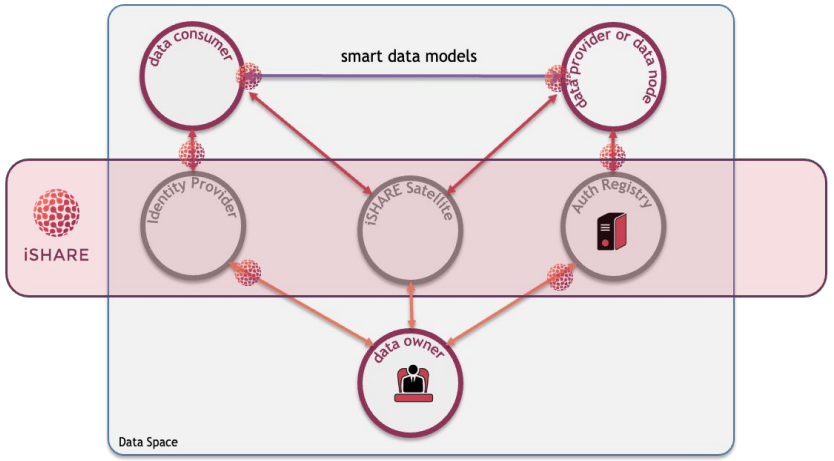
…thus enabling Cross Domain trusted data sharing



i4Trust

Data sovereignty and trust: components

- FIWARE security components comply with standard-based iSHARE specifications and can be hosted locally to each participant for a better performance:
  - FIWARE Keyrock can serve both as Identity Provider and Authorization Registry (XACML PMP/PAP server)
  - FIWARE API umbrella can serve as XACML PEP proxy and PDP server
- Alternatively, participants may rely on any certified iSHARE Identity Provider and Authorization Registry services
- The certified iSHARE Satellite service acts a Trust Authority



i4Trust

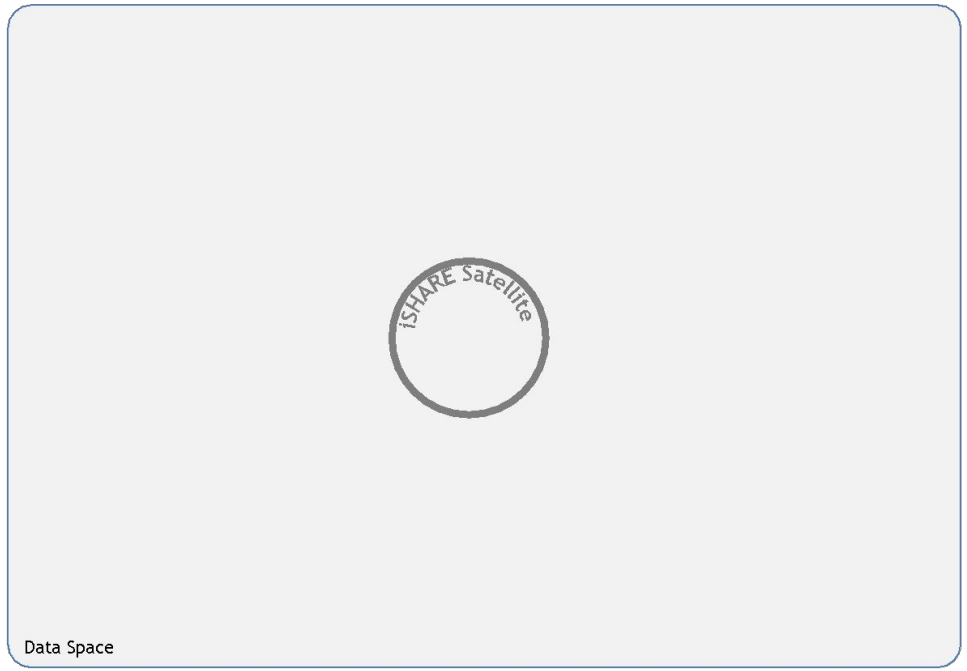
Because iSHARE is an open and federated trust framework and standard ..

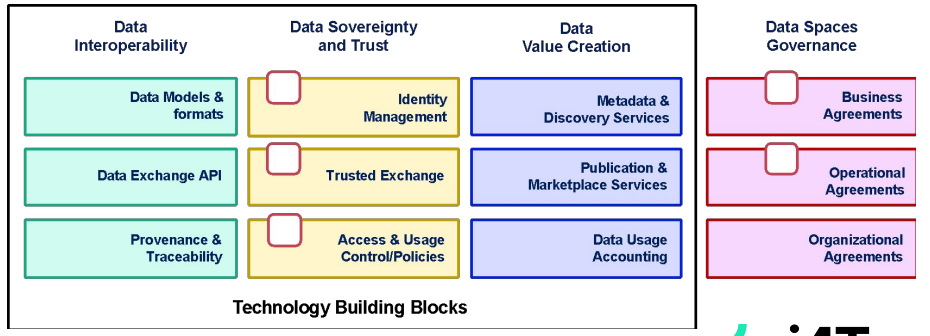
…anyone within the trust requirements can setup an iSHARE Satellite to have Data Sovereignty and Trust covered for a new dataspace and/or domain.

iSHARE satellites allow to to define operational agreements and governance within the dataspace for

- Data Interoperability
- Data Value Creation
- Governance

Hence, great building block for i4Trust participants setting up new dataspaces!





i4Trust

Why iSHARE

- Data Sovereignty and trust start with data ownership and knowing the actors in the data space.
- iSHARE is the standard for b2b data sharing trust frameworks, allowing cross domain data sharing.
- iSHARE is acknowledged by IDSA as the trust framework and Participant registration (PaRIS)
- Identities in the framework are based upon CEF building block eIDAS
- The Data Sharing Coalition acknowledged iSHARE as the trust framework for data sharing.
- iSHARE is totally federated and hence encourages more parties to start a data space on this basis.

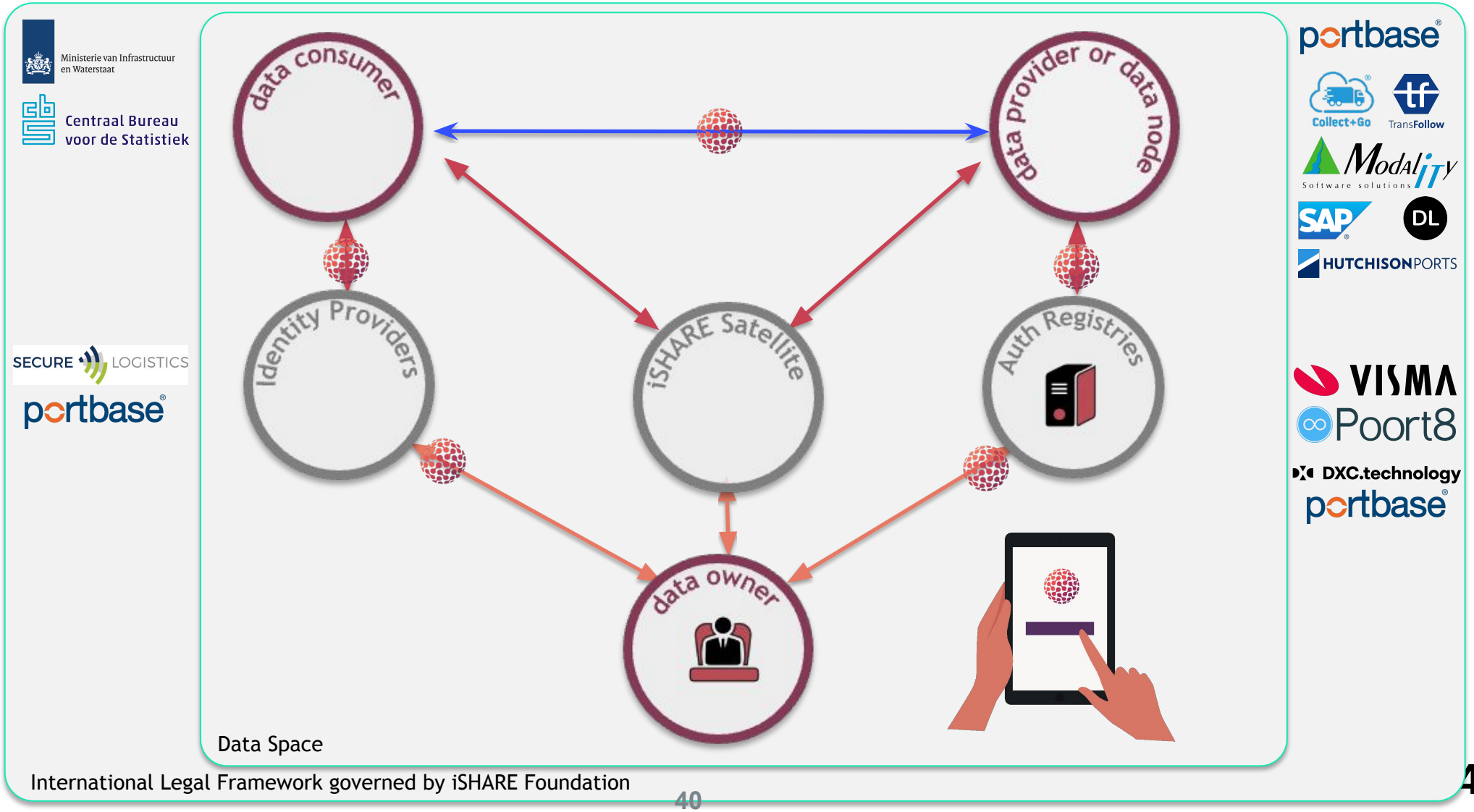
DATA SHARING COALITION

INTERNATIONAL DATA SPACES ASSOCIATION

eIDAS

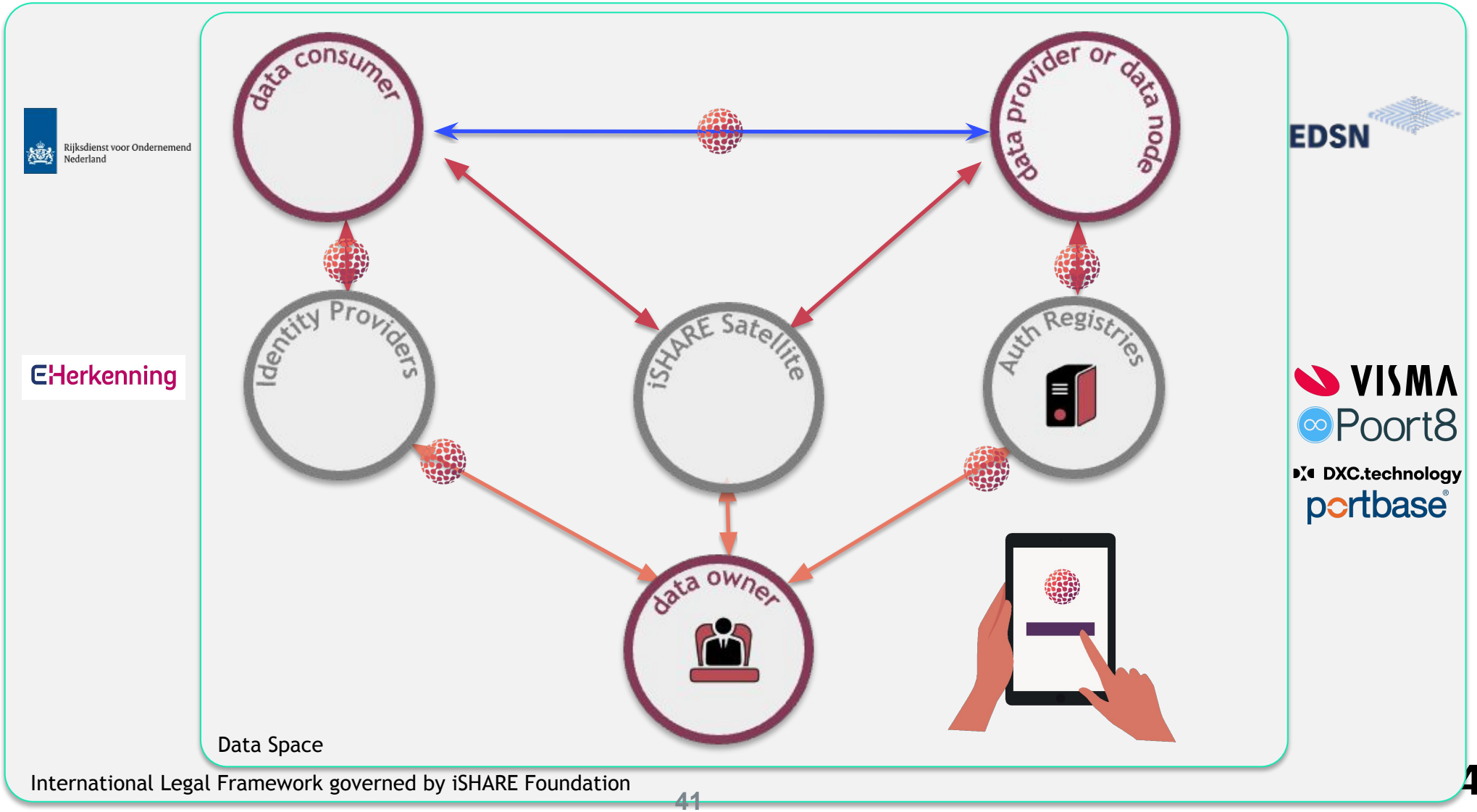
i4Trust

Currently operational in the Dutch Logistics Data space which In 2021 it already covers the data of over 100.000 companies



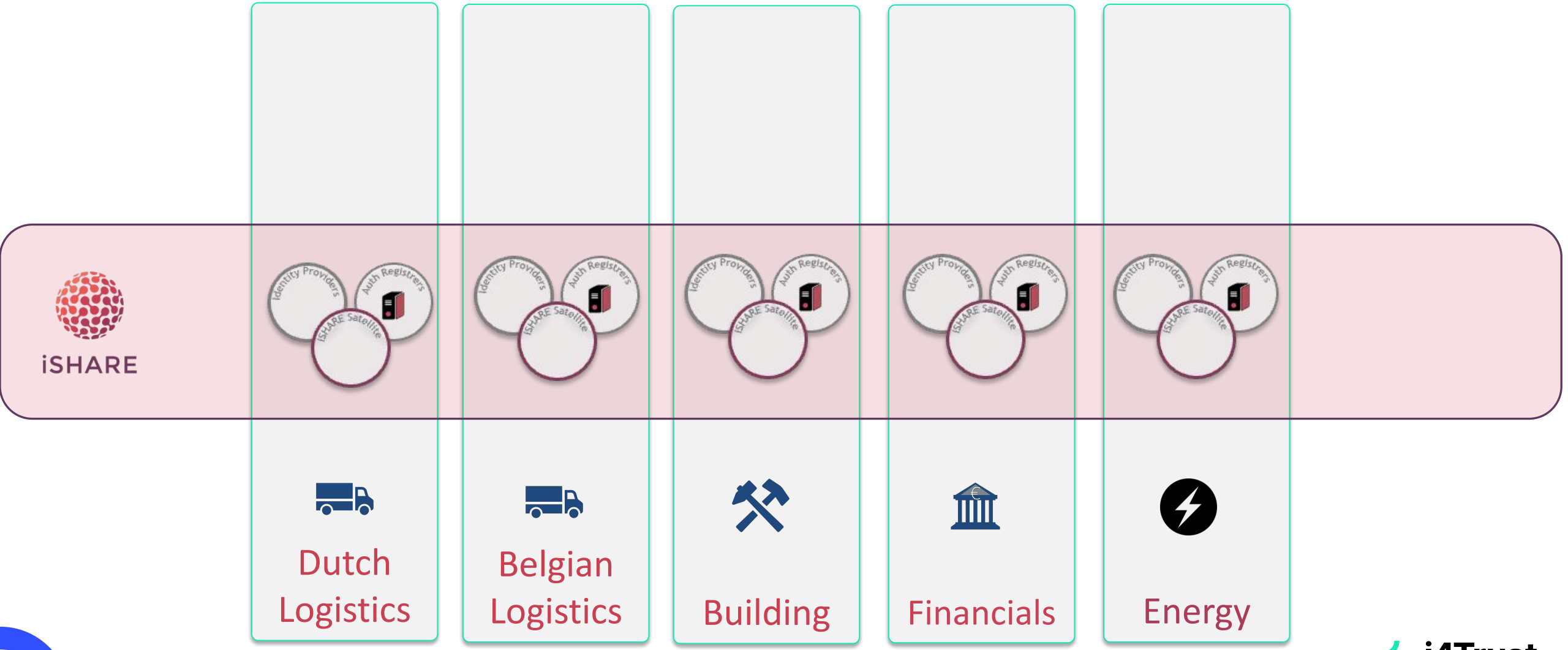
4Trust

In 2022, in the Dutch Energy Data space it is expected to cover the data of over 1.5mn companies



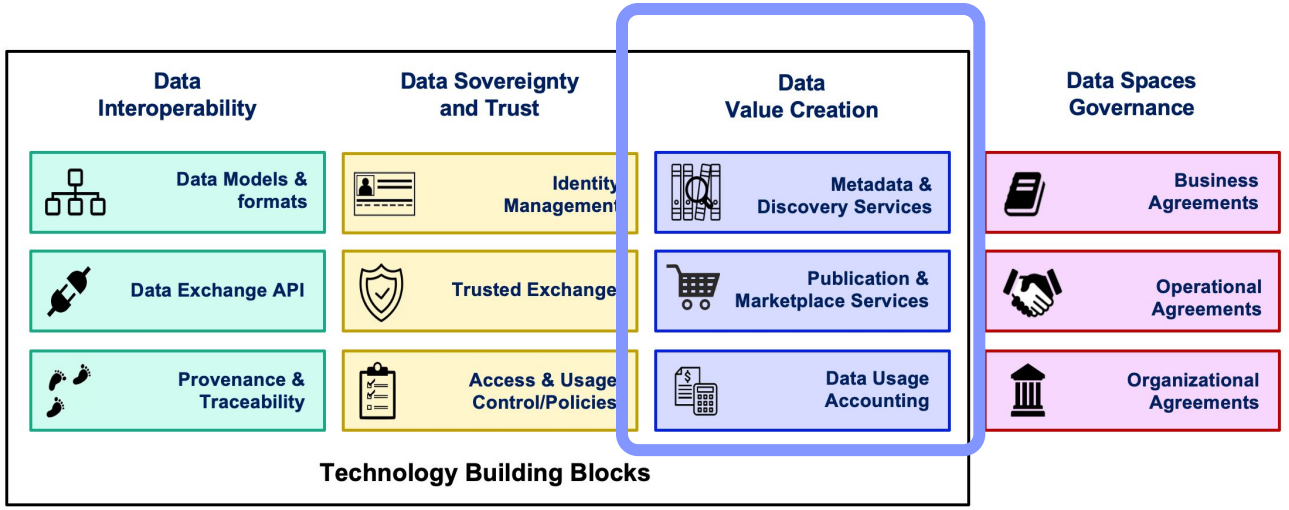
4Trust

Other data spaces are live of being formed, form a good starting point for experiments



i4Trust

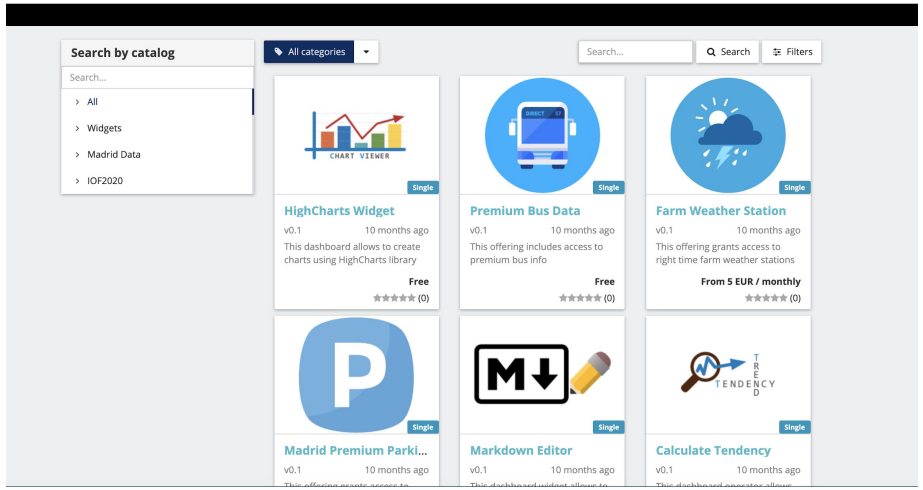
Data Value Creation

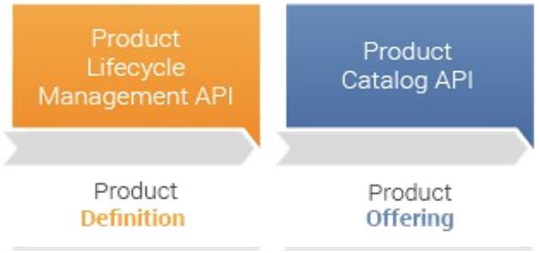


i4Trust

Data Marketplace Services

- Data Marketplace Services:
  - Supports the definition of offerings around digital assets (data files, right-time data access/processing services are handled as such)
  - Integrated with Identity Management and Data Usage Policy Management frameworks
  - Relying on TM Forum Business Ecosystem Open APIs to manage lifecycle of digital assets and monetization
  - Data providers can instantiate their own marketplace or rely on global independent Marketplace services
- Advanced pricing and revenue sharing support:
  - Basic models: free, one-time, recurring, pay-per-use
  - Dynamic pricing: fees, discounts
- Product terms and conditions:
  - Licenses, terms and conditions
  - Service Level Agreements (SLAs) metrics

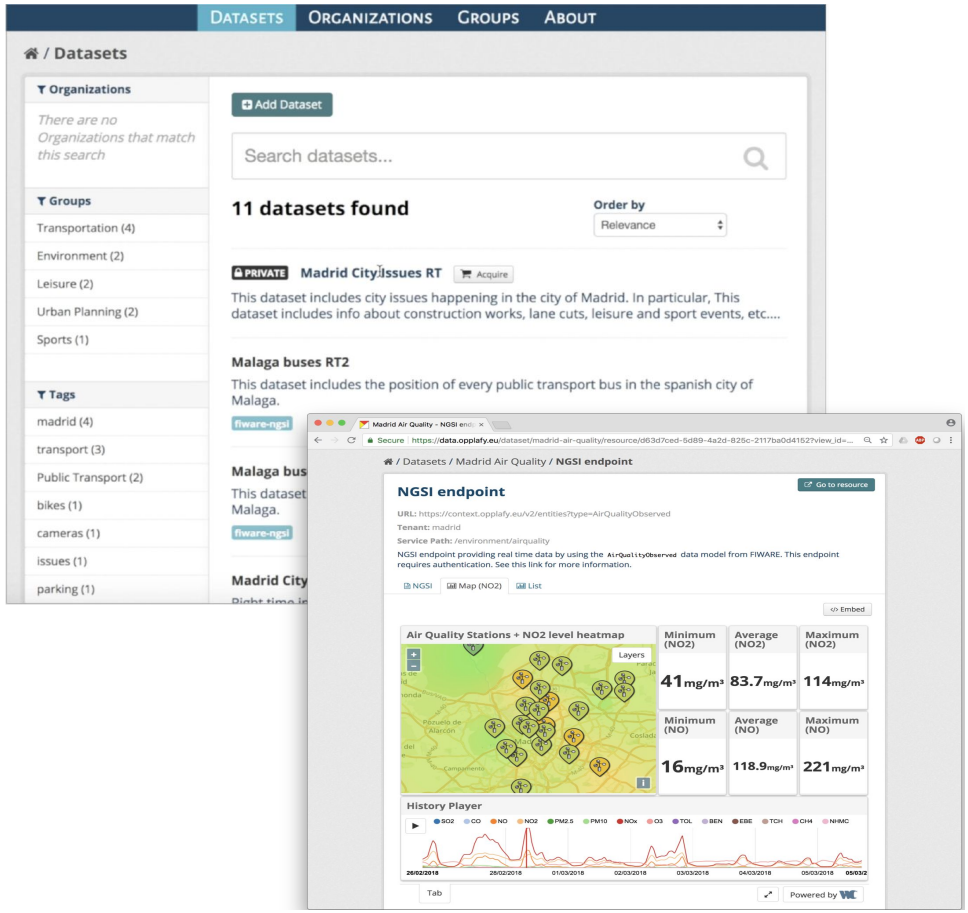




i4Trust

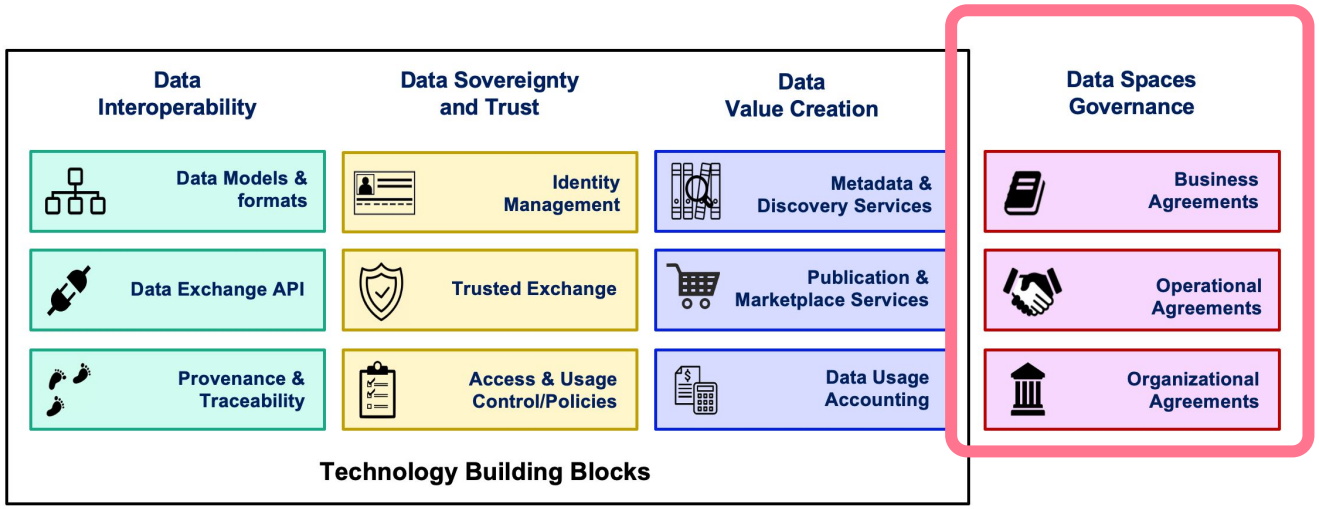
Data Publication and Discovery/Brokering Services

- Data Publication Services:
  - Data portal supporting DCAT-AP and publication of data resources linked to offerings in the Marketplace
  - Harvesting of data from Open Data Portals
- Data Discovery/Brokering services:
  - Metada linked to description of data resources based on DCAT-AP standard
  - NGSI-LD as basis for discovery of data resources (modeled as entities with DCAT-AP properties)



i4Trust

Data Spaces Governance



i4Trust

Data licenses in iSHARE legal framework create trust about who does what with data after it has been shared

Under iSHARE, it is possible to provide explicit instructions about the **conditions** under which data can be exchanged

iSHARE Participants can hold each other to licenses because they have all signed the same agreement with the iSHARE satellite – thus creating a **network of trust**

For example: *you, as the recipient of my data, may only make use of this data for one month and may NOT share it with others*

i4Trust

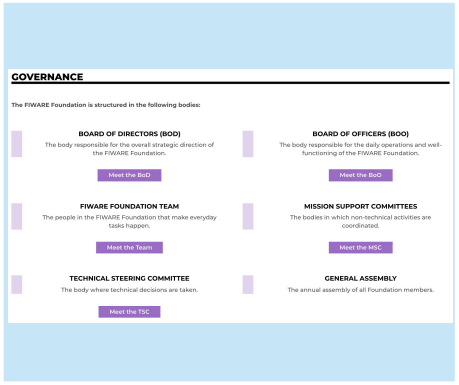
iSHARE provides operational agreements and service levels for all its certified roles as foundation

Operational agreements determine how the data space will be operated and what service levels can be expected. This is necessary for parties to trust the ecosystem to commit and be part of.

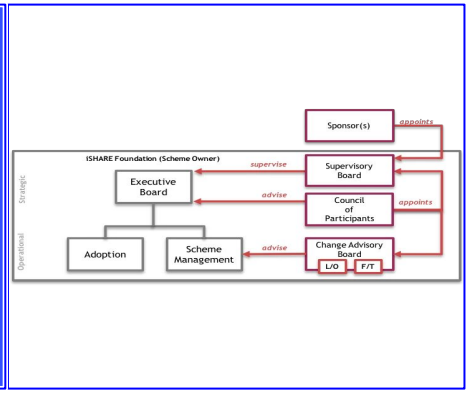
Operational agreements include but are not limited to agreements like which parties are responsible for providing which services and their corresponding levels.

Governance is key for optimum operation and future sustainability of both i4Trust and data spaces it creates

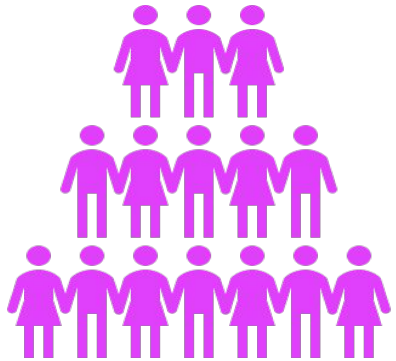
FIWARE governance structure drives strategic and technical direction make sure that the technology evolves to serve their needs



iSHARE has governance structure in place to make sure that it remains operational and trust is preserved in network for its participants

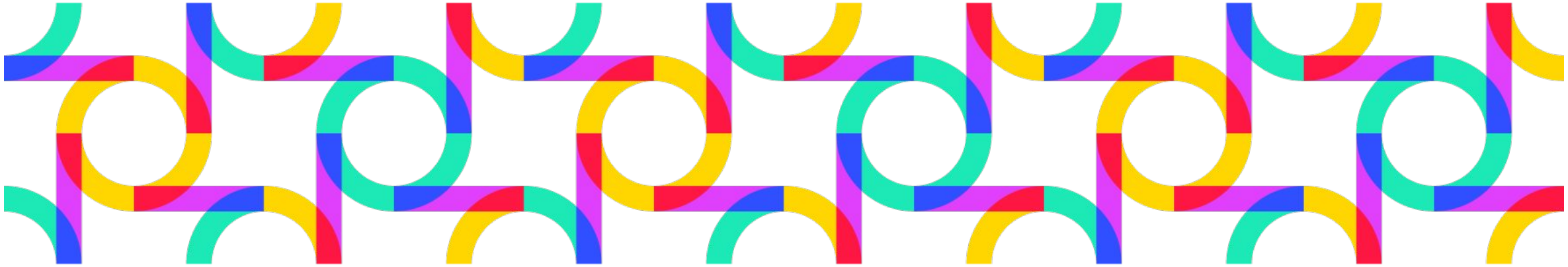


The governance of iSHARE and FIWARE will be key for the i4Trust projects and will be compatible



Governance

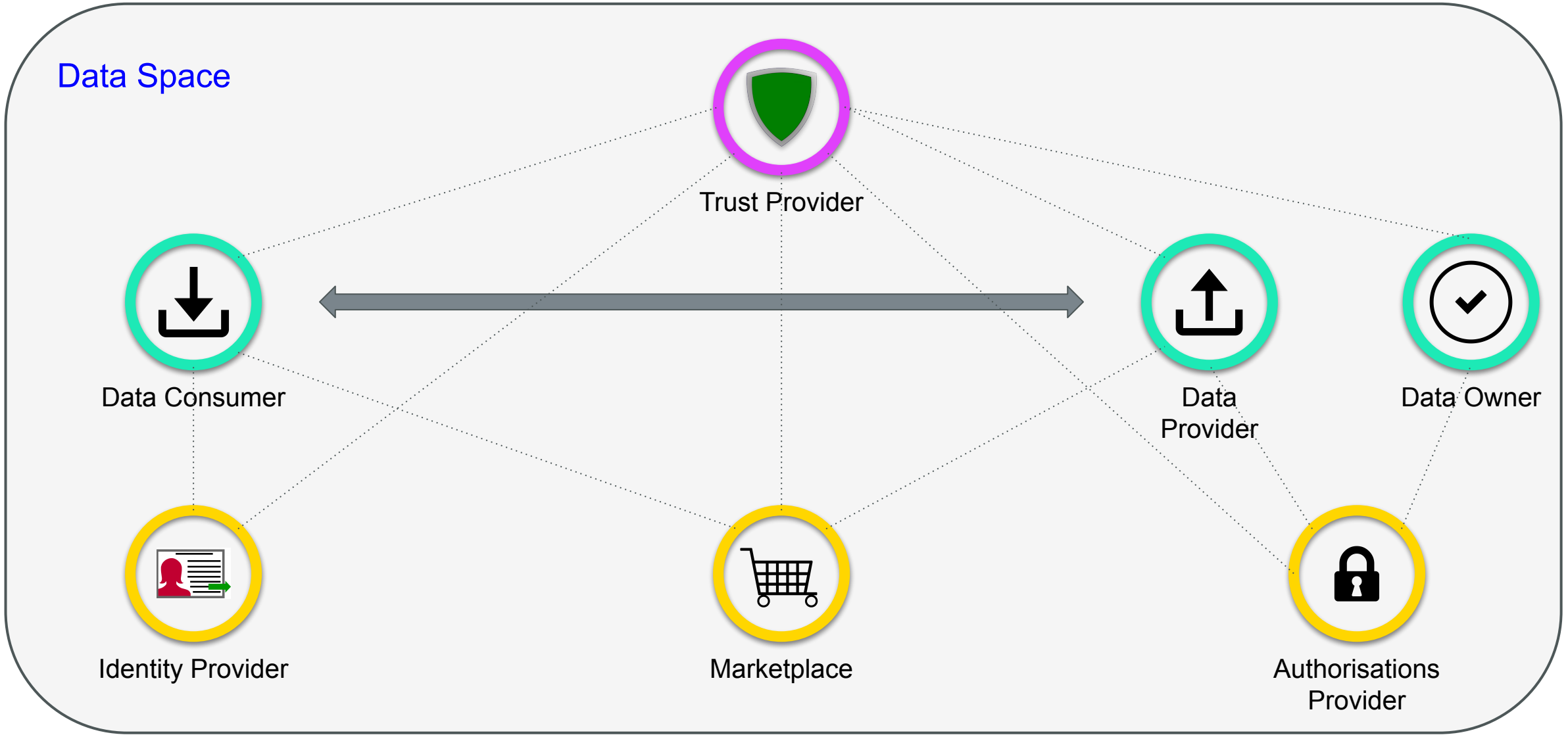
i4Trust



Summary of roles in i4Trust Data Spaces

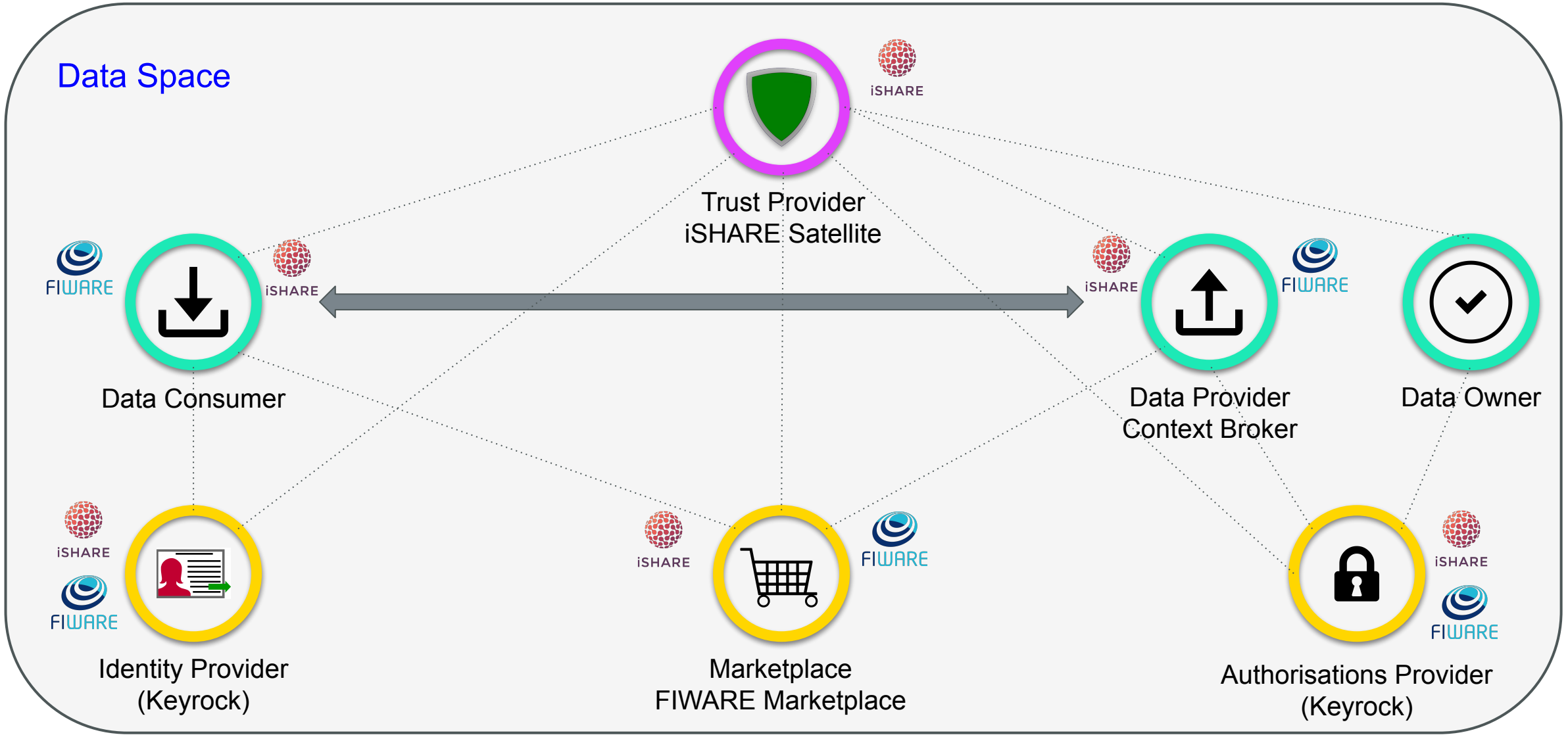
i4Trust

Roles in a Data Space



i4Trust

Roles in i4Trust complies to iSHARE and FIWARE



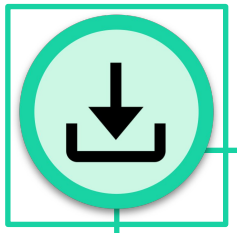
i4Trust

Trust Provider essentially facilitates trust in a data space and acting as a guardian

Trust Provider

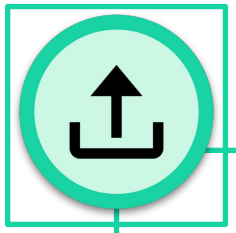
- Every data space needs a trust provider who acts as register of participants of the data space and keeps their status up to date
- They follow predefined and agreed upon procedures to maintain the list of participants
- Since they play important role in a data space it is paramount that trust provider is a neutral party or a party providing this service within the confines of strict agreements on neutrality
- Every data space should have one trust provider at minimum, however, same trust provider organisation can provide service in multiple data spaces
- In a large data space there can be more than one trust provider
- In i4Trust this role will be fulfilled by iSHARE satellite role

i4Trust enables data sharing among parties in an effective, trusted and secure way



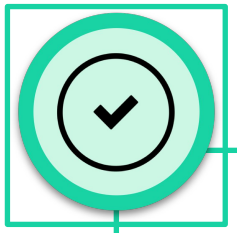
Data Consumer

- Data Consumer is a role played by organisation or a person who is interested in data at other party either for its own use or to provide services to the data owner/data provider
- It needs to handle data it receives in accordance to the conditions set by the data owner



Data Provider

- Data Provider is role played by organisation who provide data via means of service or portal
- Data Provider relies on data owner to provide with authorizations and usage rights for the data it shares with data consumer



Data Owner

Data Owner is the party who has right over the data in given context and time

- It provides with authorizations, so data consumer can get access to data
- In i4Trust, data owner also can specify the conditions under which data is shared, thereby providing it with data sovereignty

Identity Provider role is designed for users to reuse their existing identity provider at various service/data providers

Identity Provider

- The Identity Provider role deals with the human identities with varying level of assurances, as defined in eIDAS framework, to support various use cases
- Depending on the criticality of the data, appropriate level of assurance for an identity can be requested
- iSHARE specifications are designed such that service/data provider does not necessarily need to pre-register an identity provider as it can verify if it is an iSHARE certified provider from iSHARE satellite
- Keyrock Identity Provider software from FIWARE already complies with iSHARE specifications and is available as open source

Authorisations Provider is a role which can be played by any organization as defined in iSHARE

Authorisations Provider

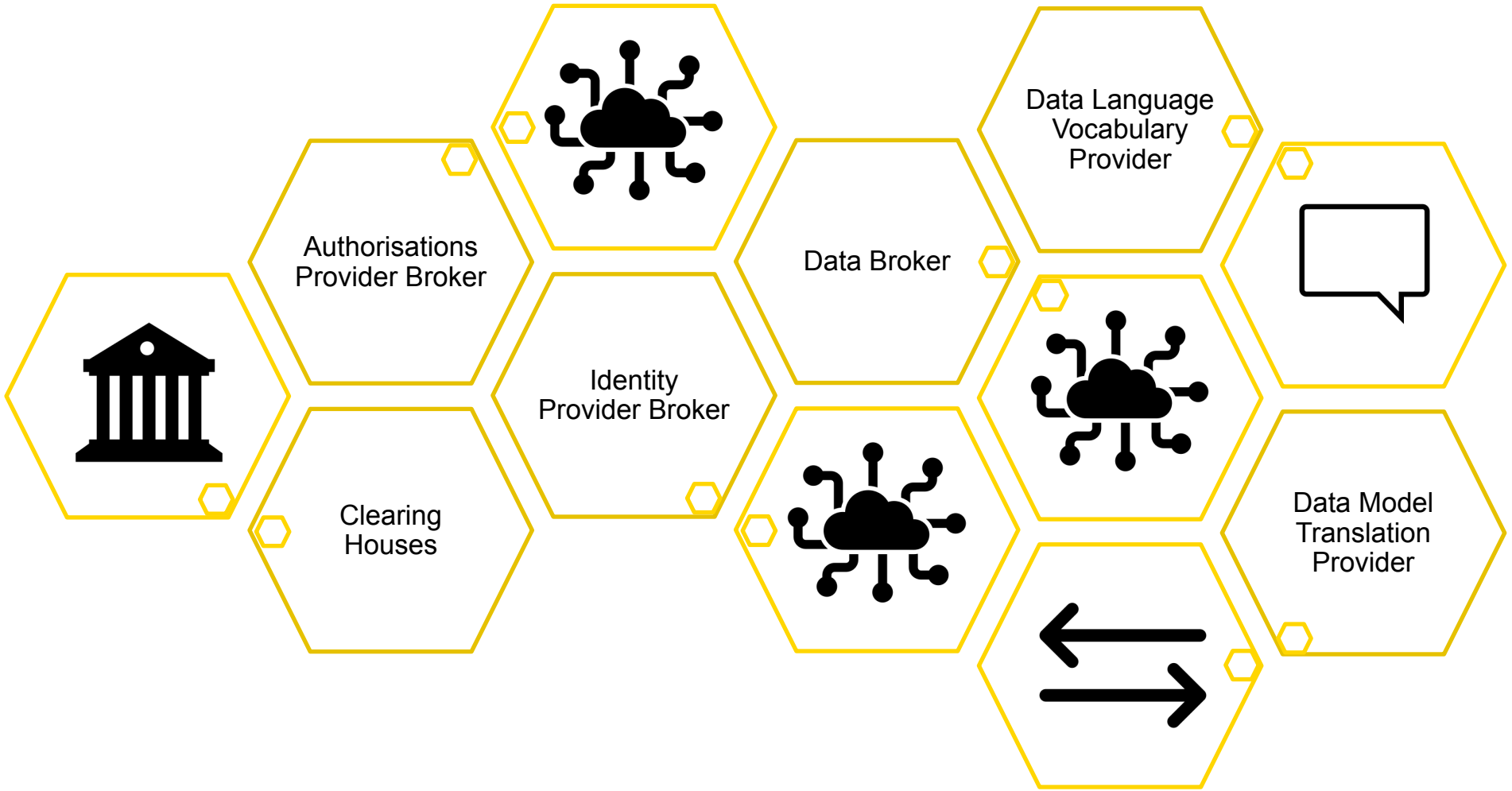
- The role only defines the interface for asking about authorizations and how the response should look like.
- The authorizations can be determined by using a policy database and/or transactional data from backend systems and/or existing authorizations from LDAP/AD or a combination thereof.
- Keyrock in FIWARE will provide a policy database to define policies for authorizations which can be combined with other sources to determine authorization during runtime.

Marketplace allows discovery and monetization of data and services in a data space

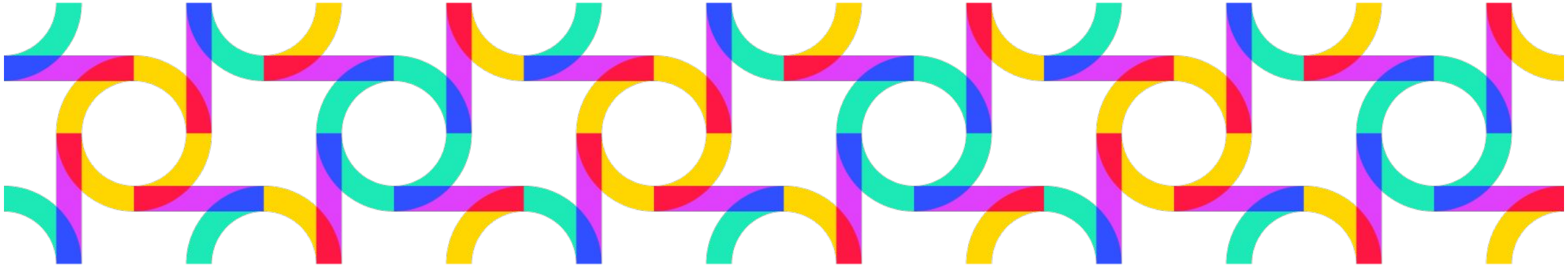
Marketplace

- The Marketplace provided by FIWARE technology allows data providers and data owners to list data and/or services to offer which data consumers can buy/subscribe to.
- On the other hand, data consumers can find offerings of relevant data from multiple data providers/owners.
- Besides, marketplace can act as clearing house and broker when required between the parties exchanging data so that data sharing transactions can be logged at 3rd party for auditing and billing purposes.

Additionally, other service providers can provide specific services within a data space



i4Trust



i4Trust: Going beyond technology

i4Trust

Going beyond the technology: a vibrant Community

Training
Technical Support

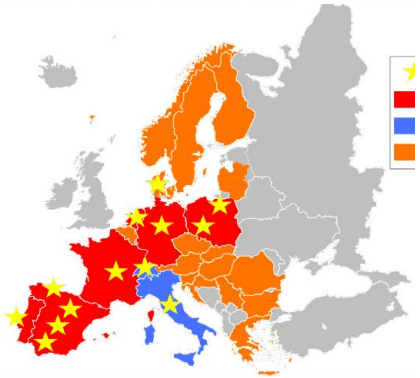
FIWARE iSHARE

Digital Innovation Hubs
(DIHs)

i4Trust Community

32 BuE – 150+ SMEs
(Bottom-up Experiments

Future experiments
Market solutions



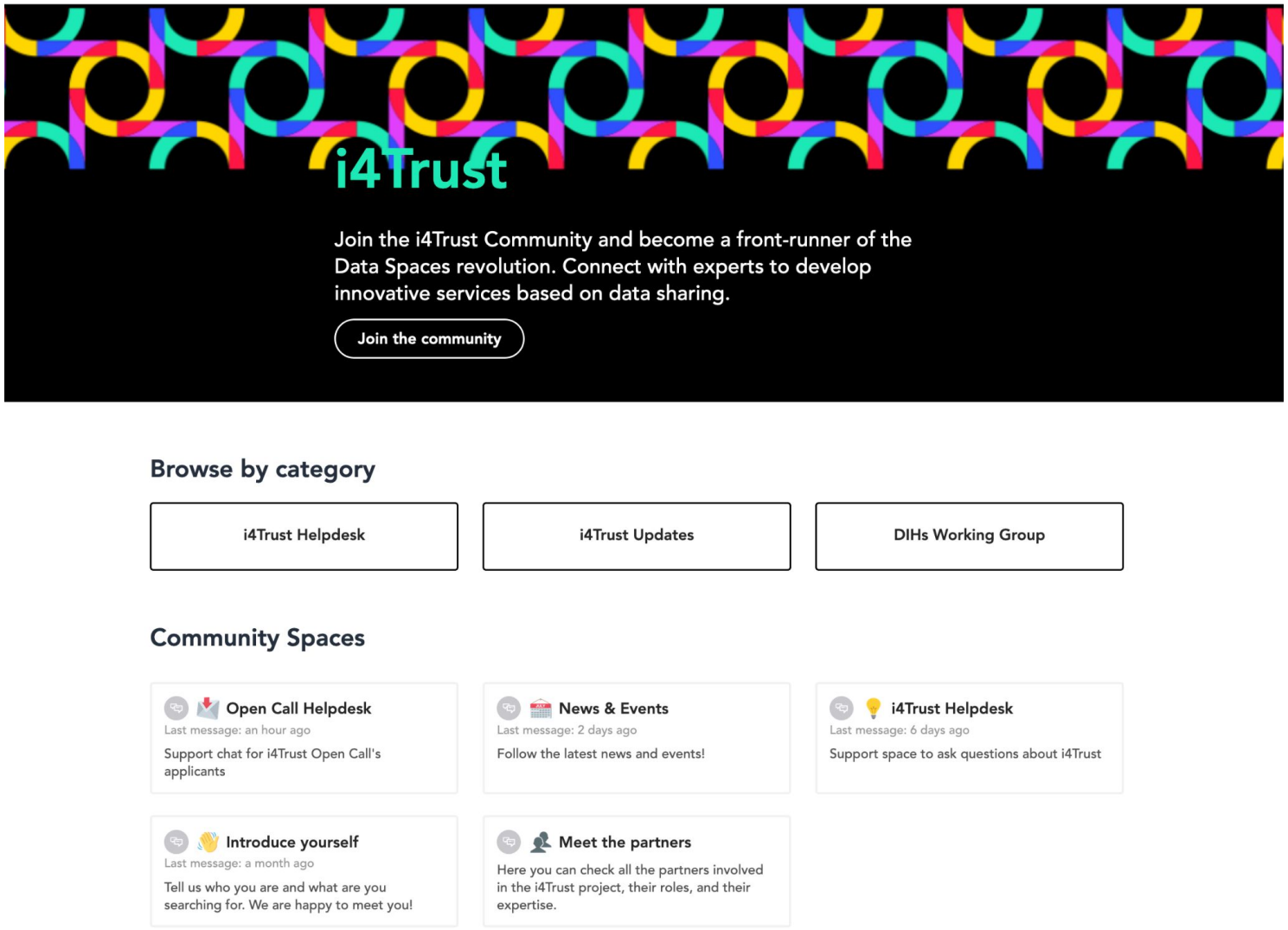
Community Platform
Community Mgmt

FundingBox

FIWARE iSHARE

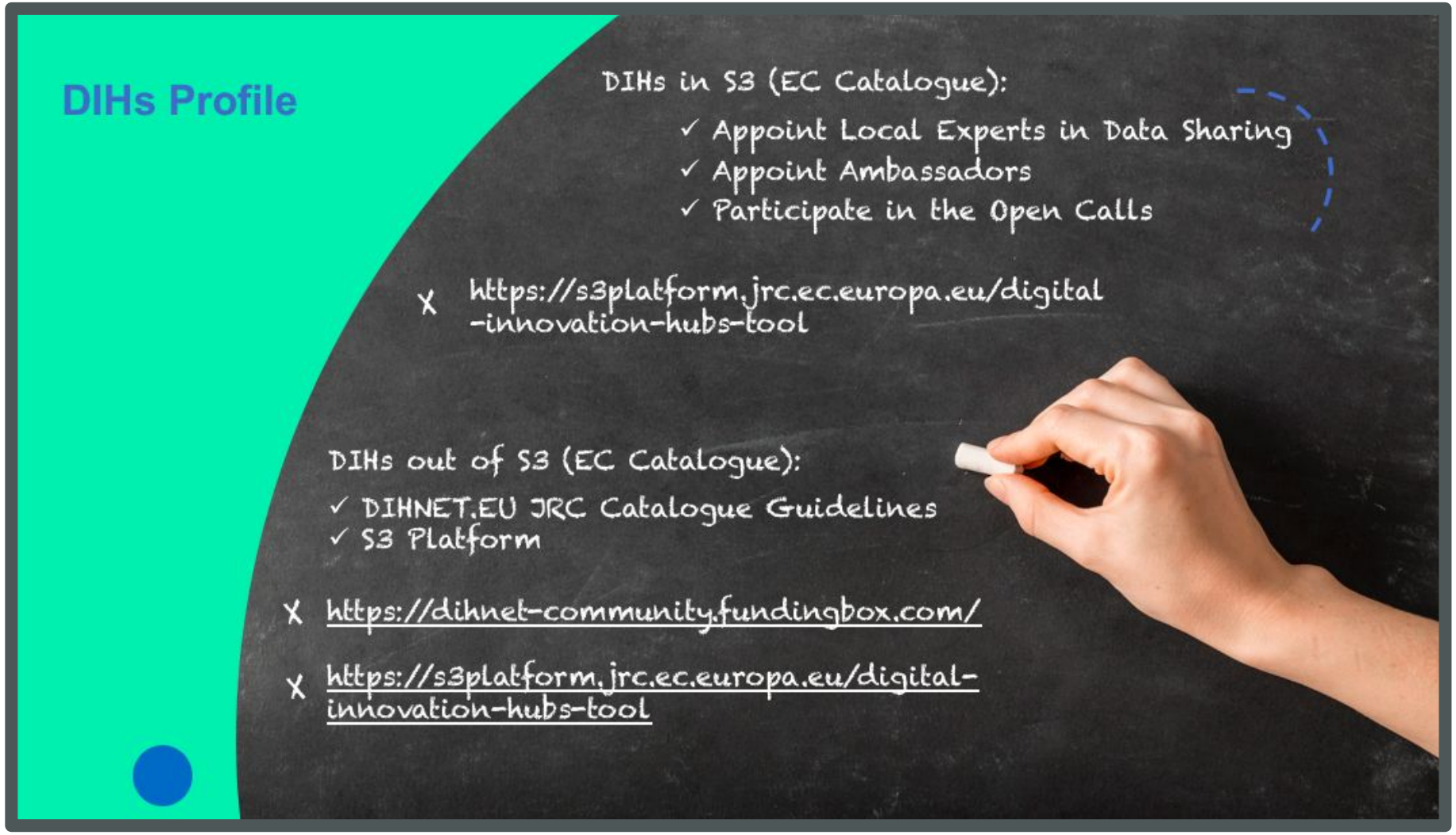
i4Trust

Join the i4Trust Community! - https://spaces.fundingbox.com/c/i4trust



i4Trust Community: DIHs Working Group

Profile of the DIHs joining i4Trust



i4Trust

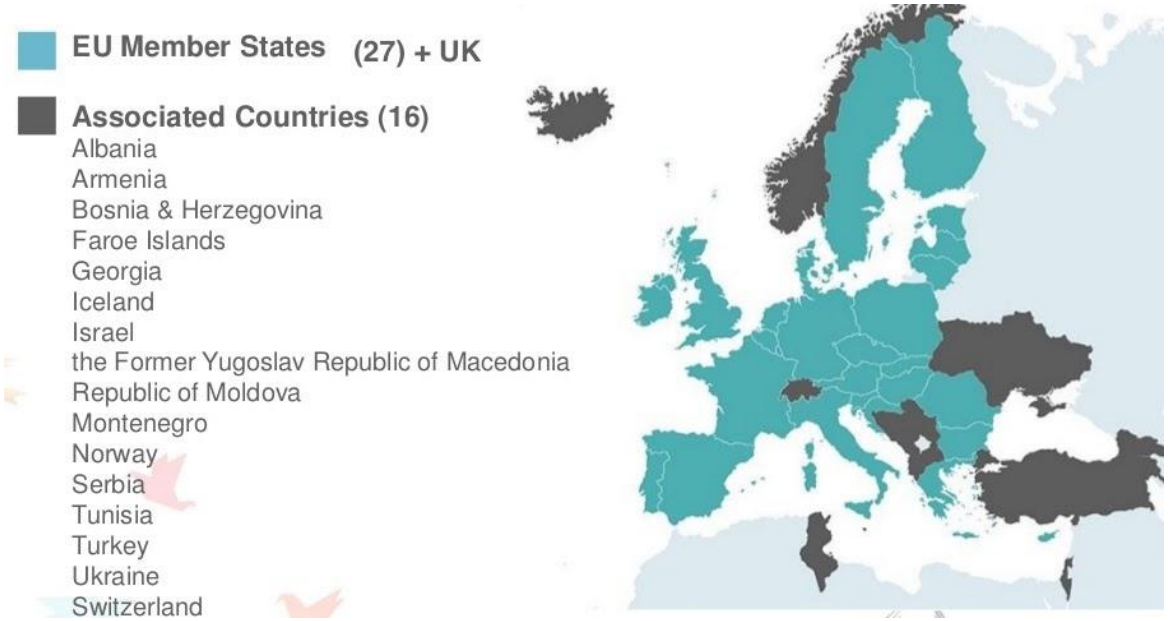
What benefits will DIHs joining i4Trust gain?

- i4Trust allows to materialize the concept of Data Spaces: **DIHs joining will stay at the forefront of the Data Spaces revolution**!
- Since the i4Trust local expert of a DIH will get certified as a FIWARE expert, that will bring quite a number of advantages beyond participation in the i4Trust Community:
  - The DIH would be automatically validated if it wish to be validated as an entity able to provide FIWARE Training and Coaching Services as well as FIWARE Technical Consultancy and Support Services in the FIWARE Marketplace.
  - If the DIH decides to join the network of FIWARE iHubs, it will be entitled to validate products to be listed in the FIWARE Marketplace. Note that becoming a FIWARE iHub will bring notable benefits in terms of revenue streams (check out the FIWARE iHub brochure)
- DIHs trained on iSHARE will also be eligible to become iSHARE implementation partners. Additionally, DIHs could also play one of the iSHARE roles like, iSHARE satellite or iSHARE Authorisation Registry, if they like to.

i4Trust Open Calls

Who are we looking for?

- Consortia composed by **SMEs**/slightly bigger companies and **DIHs** registered in any of the following countries:
  - Member States of the European Union
  - Associated Countries to H2020
  - The United Kingdom
- Minimum of 4 entities per proposal are compulsory: 3 SMEs/slightly bigger companies + 1 DIH.



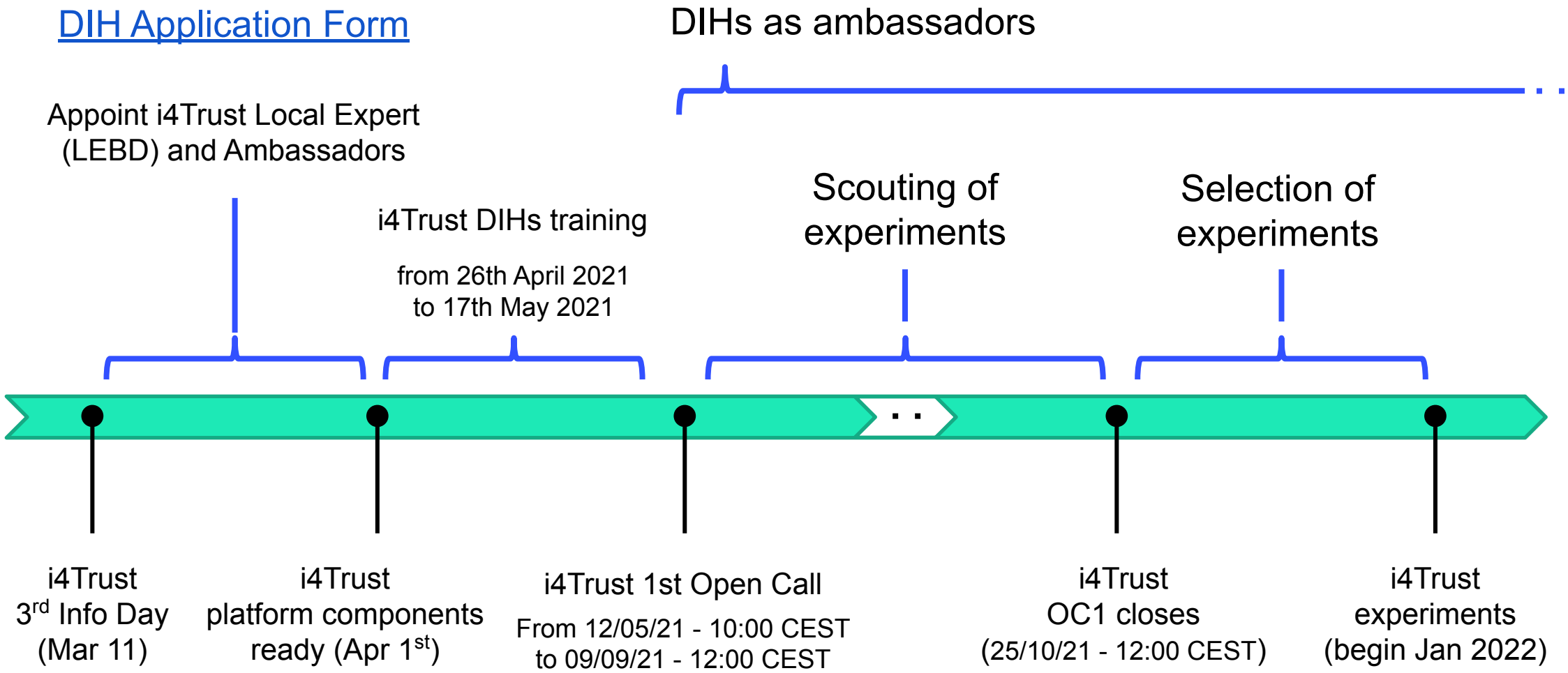
i4Trust

i4Trust Open Calls

Which kind of experiments are we looking for?

- Those implementing effective data sharing among companies in one or more cross-value chains
- Real-life challenges solved through data sharing with business and/or societal impact
- Implementing FIWARE+iSHARE technology framework to solve specific challenges
- All requirements are listed in the Open Call and evaluation criteria in the Guide for Applicants
- DIHs joining i4Trust Community and engaged with a certified local expert will be listed as DIHs that interested parties may contact to get support and, eventually, incorporate in their consortium
- DIHs can use i4Trust channels to promote concrete local challenges and application domains

Timeline of the 1st Open Call



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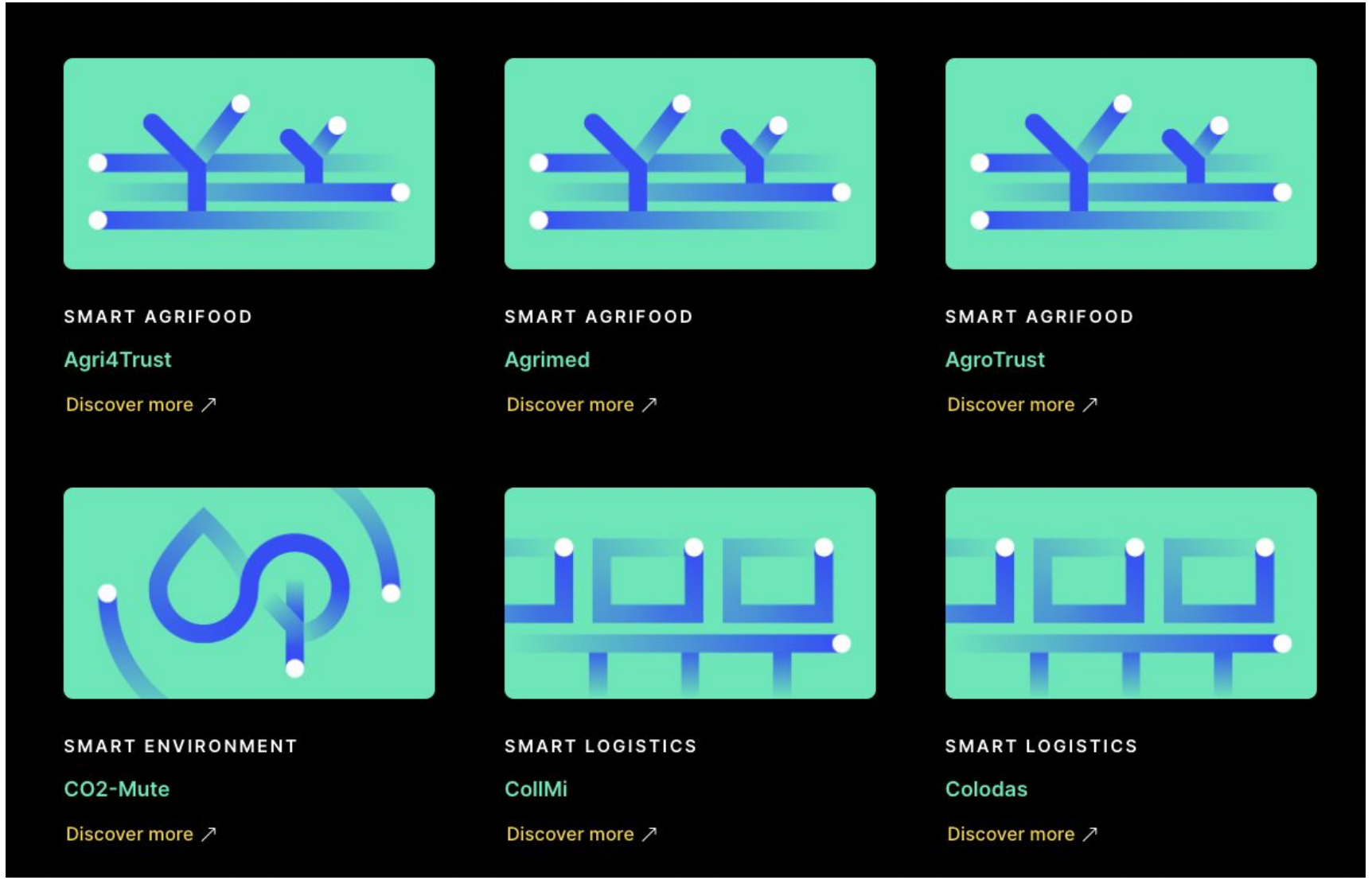
1st Open Call results



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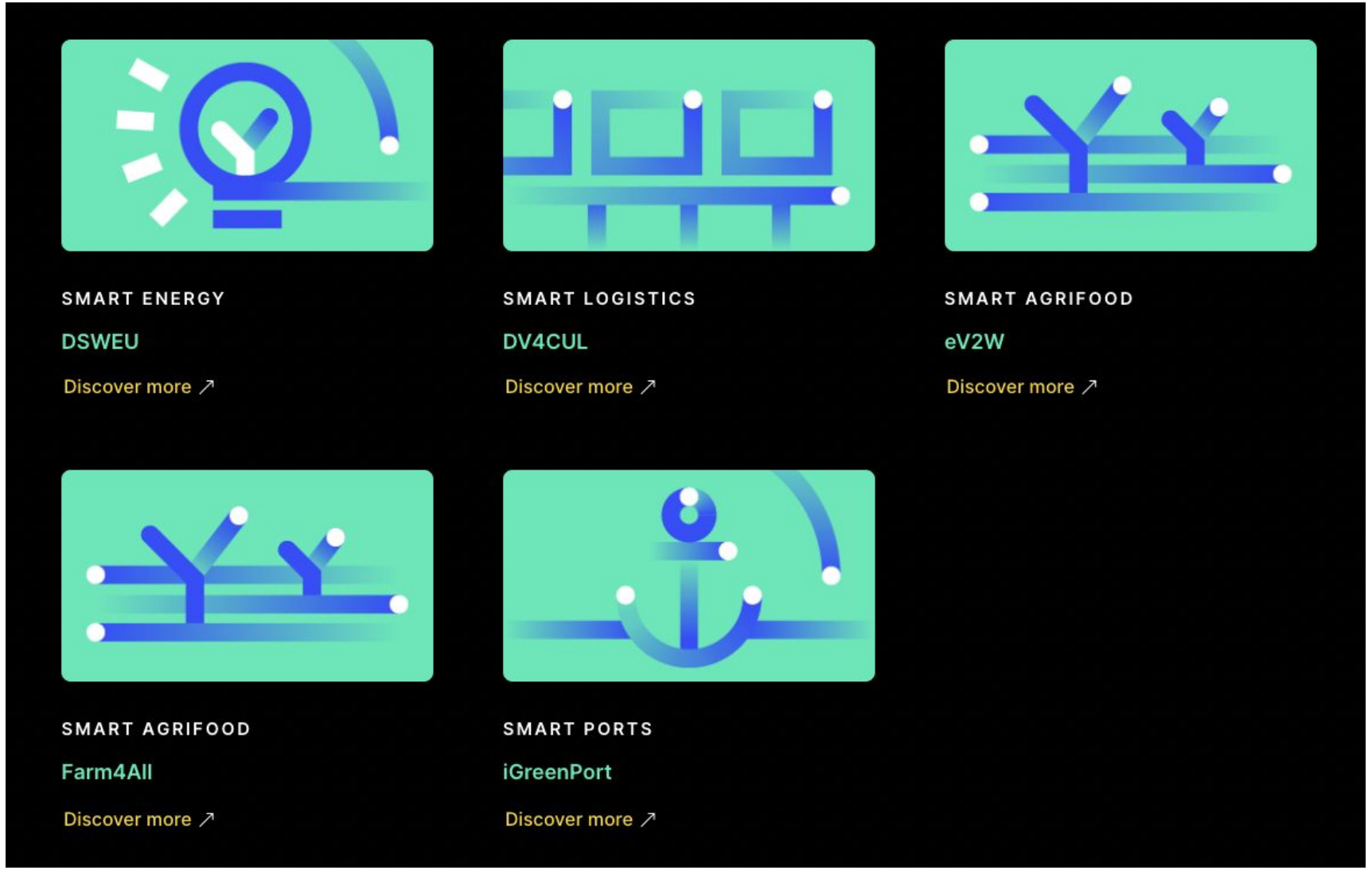
1st Open Call results



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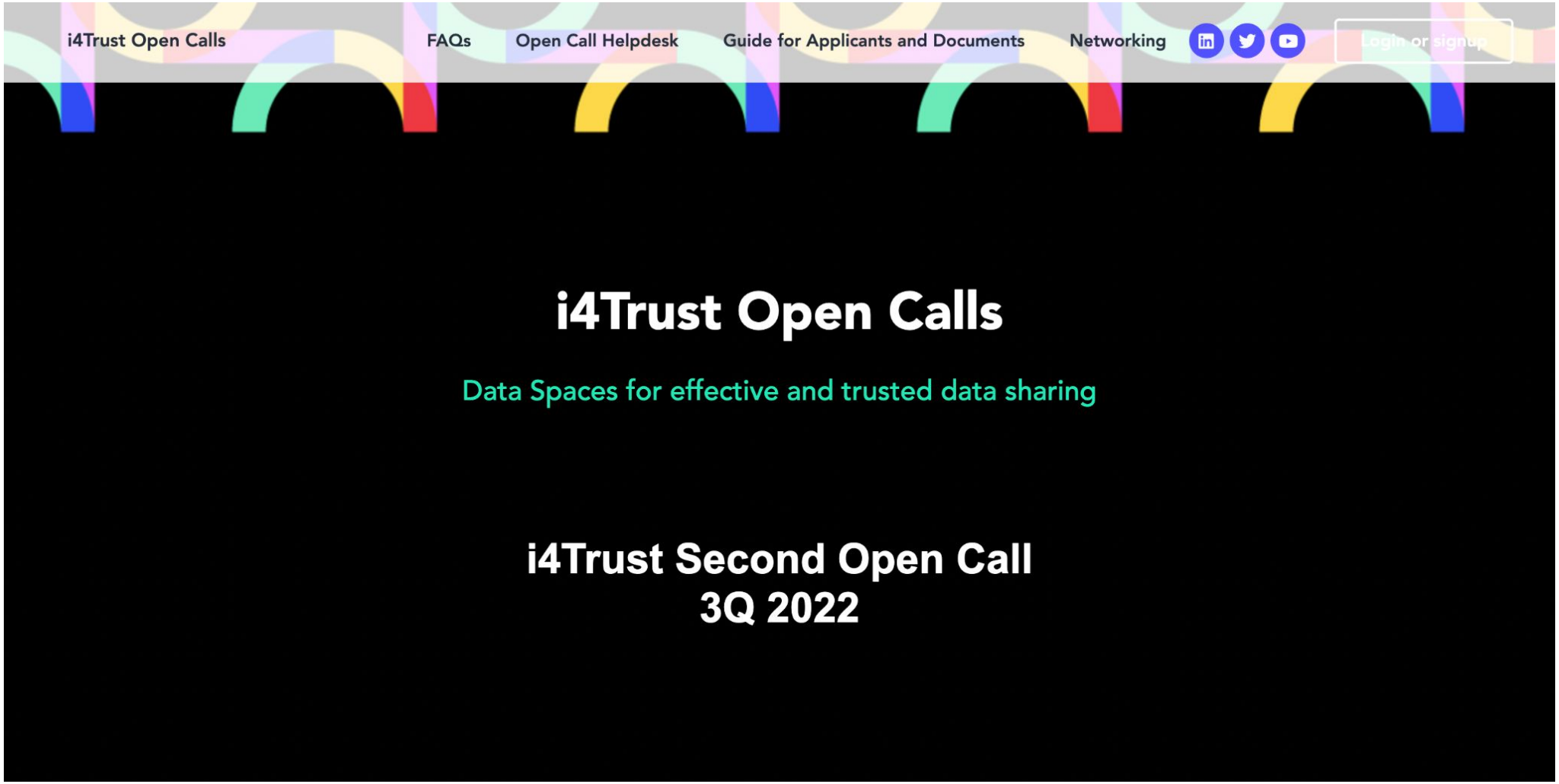
i4Trust 2nd Open Call: How to apply?

https://i4trust-open-call.fundingbox.com/



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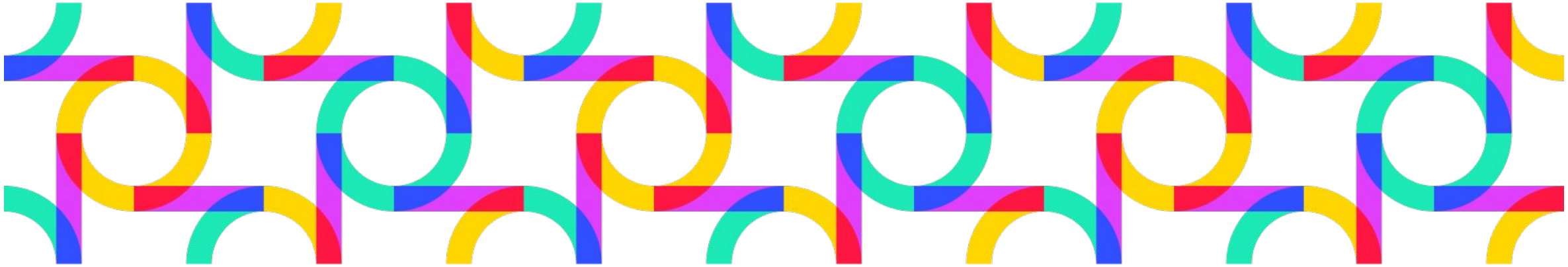


Closing remarks

i4Trust

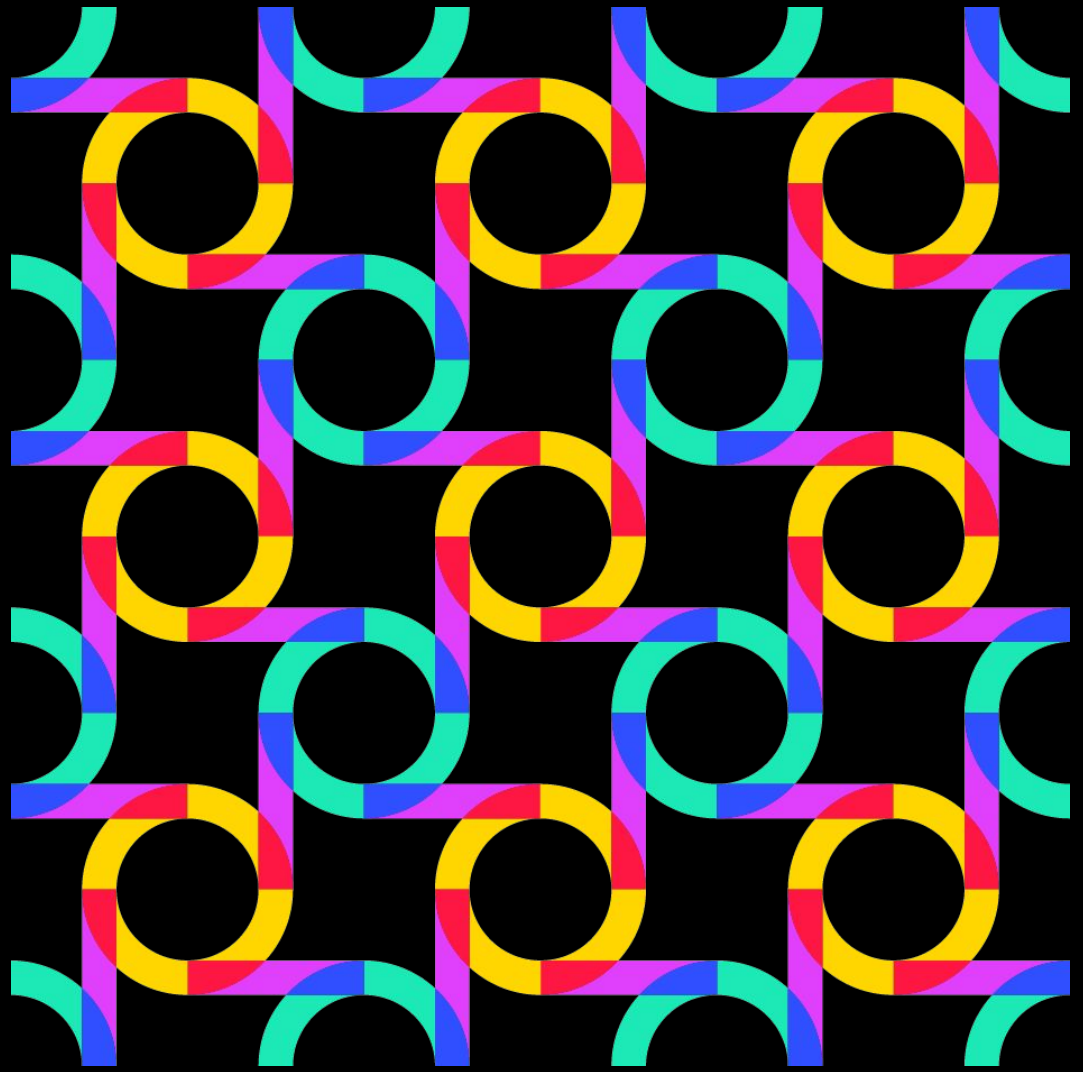
i4Trust – why to join

- Level of maturity of iSHARE and FIWARE building blocks
- Existing ecosystems around iSHARE and FIWARE
  - iSHARE:
    - 5 K+ participants managing data
    - 45 K+ identities sharing that data
  - FIWARE:
    - 100+ organization members, 350+ individual members
    - 150+ product offerings, 150+ cities adopting FIWARE
    - growing market successes in other sectors
- Strategic alignment with EC CEF Digital program
- Opportunity to join a vibrant Community where to share knowledge and best-practices
- Opportunity to become FIWARE iHub and iSHARE partner
- Be recognized as a front-runner !!

Thank you!

Follow @i4Trust on Twitter
Visit https://i4Trust.org

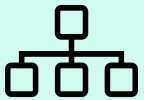
Contact of coordinator: juanjose.hierro@fiware.org



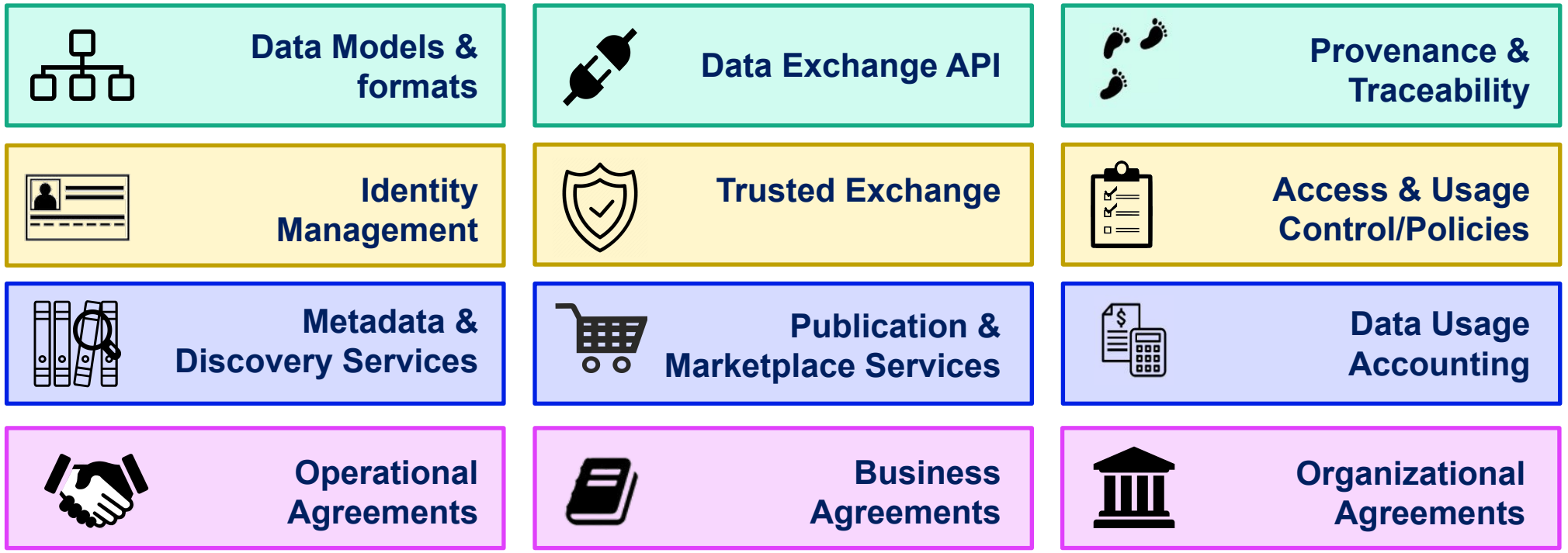
i4Trust

i4Trust has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement no 951975.

Data Spaces building blocks (horizontal layout)

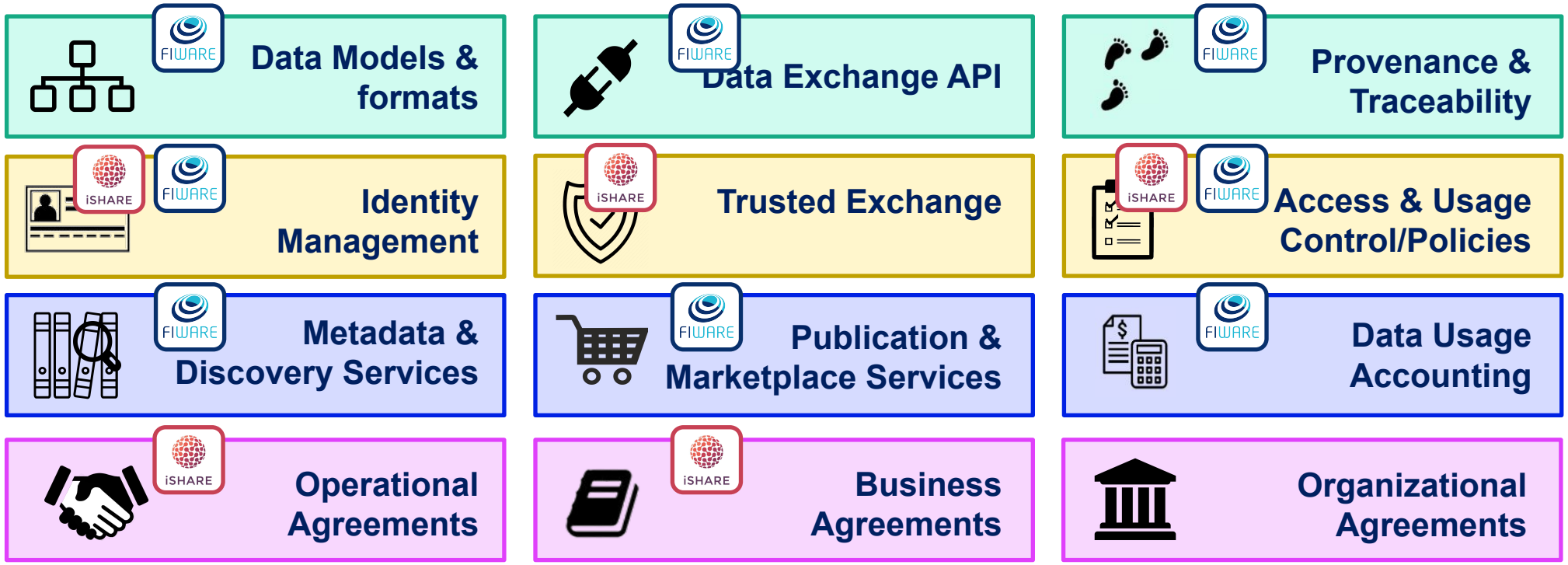
Level Playing Field	 **Data Models & formats**	 **Data Exchange API**	 **Provenance & Traceability**
Data Sovereignty	 **Identity Management**	 **Trusted Exchange**	 **Access & Usage Control/Policies**
Data as Economic Asset	 **Metadata & Discovery Services**	 **Publication & Marketplace Services**	 **Data Usage Accounting**
Public-Private Governance	 **Operation Agreements**	 **Business Agreements**	 **Organizational Agreements**

Data Spaces building blocks (horizontal layout)



i4Trust

Data Spaces building blocks (horizontal layout)



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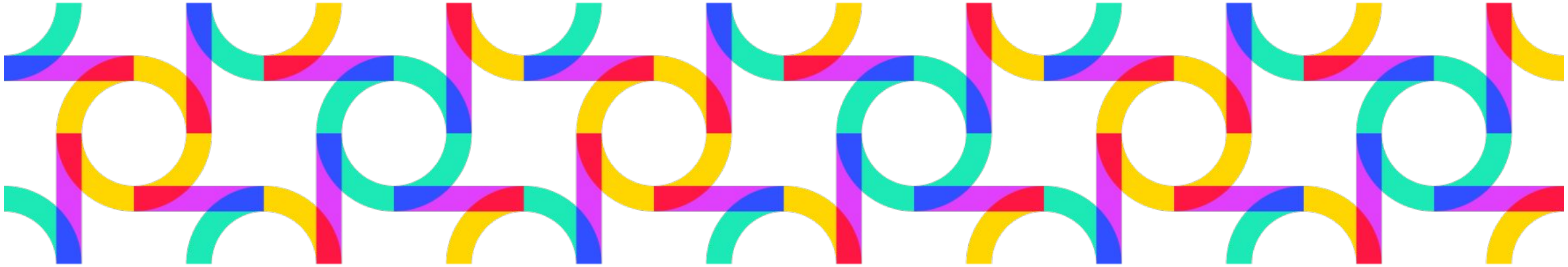

Annex: NGSI-LD main features

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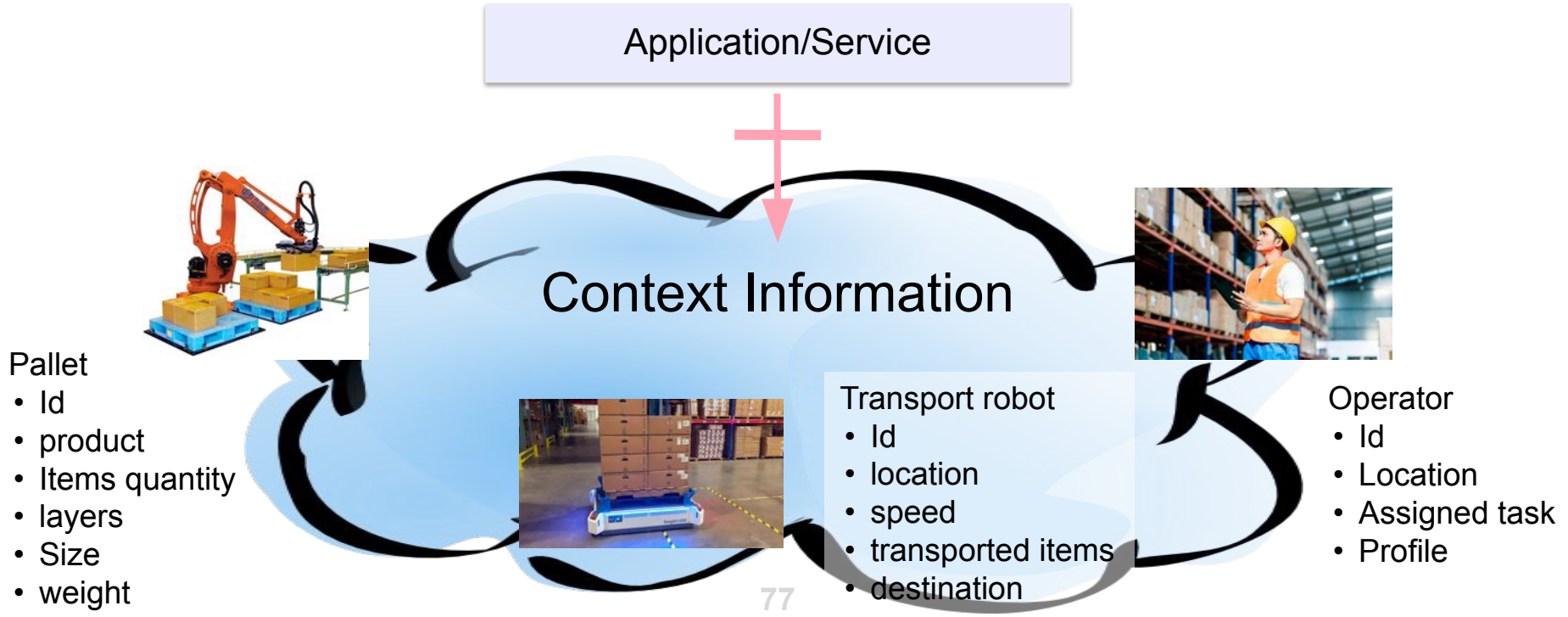
ETSI NGSI-LD: A standard API for Context Information Management

- The ETSI NGSI-LD API is a simple yet powerful public, royalty-free standard API for Context Information Management
- Simple: A RESTful API which any web programmer learns how to use in one day
- Yet powerful: It supports geo-queries, Linked Data (JSON-LD), subscription/notification, ...



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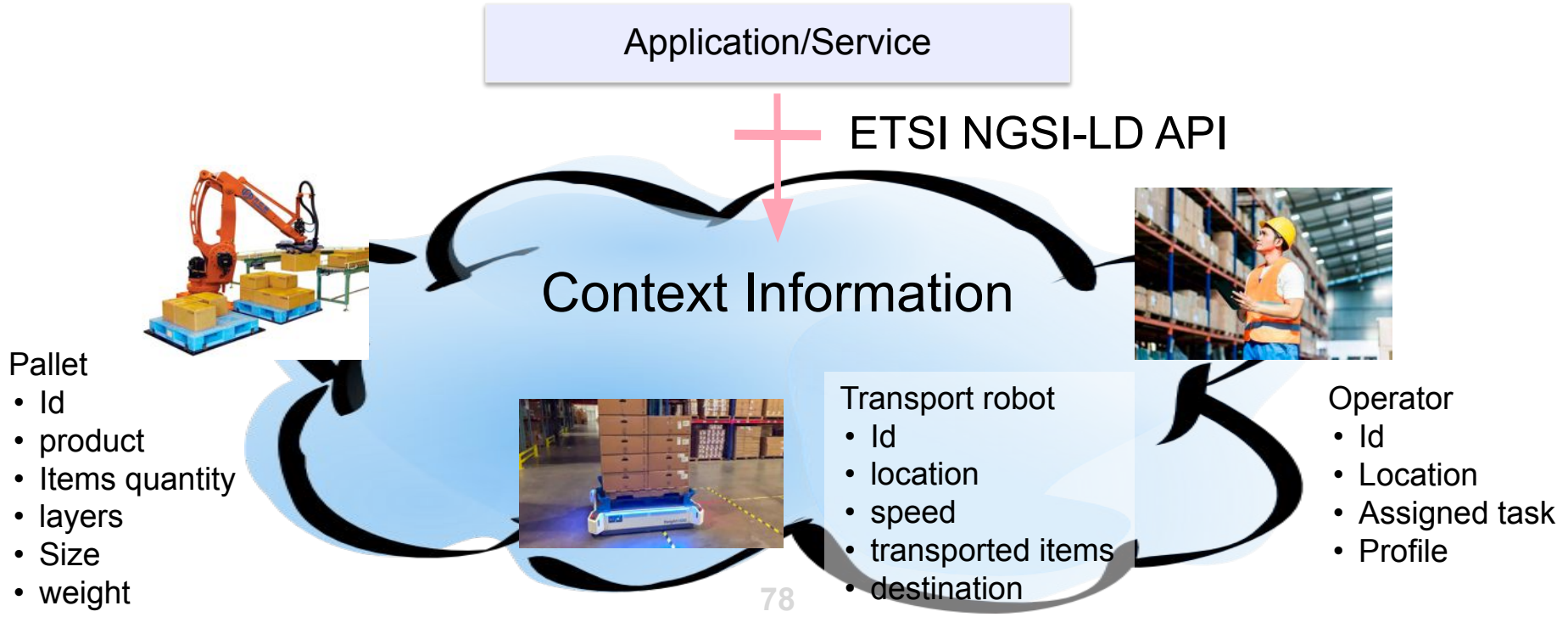
Context Broker

- NGSI-LD API servers are usually referred as Context Brokers
- A Context Broker is associated to a transport end point
- A Context Broker does not necessarily hold the data you are looking for but “knows” how that data can be obtained. Strictly speaking, they provide access to data (using the NGSI-LD API)



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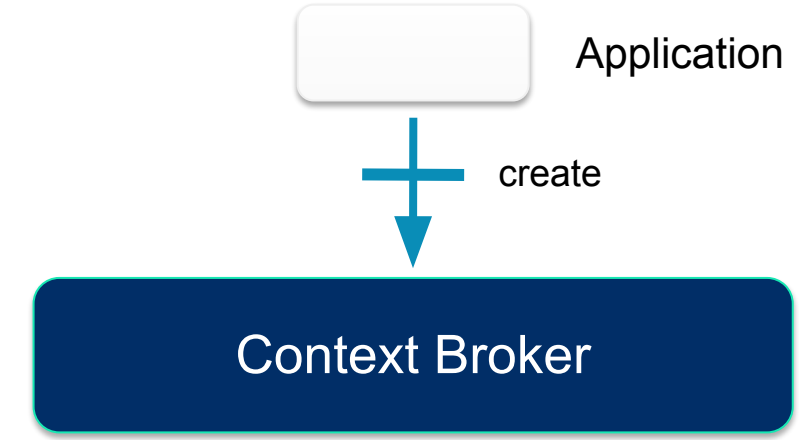
Creation of entities

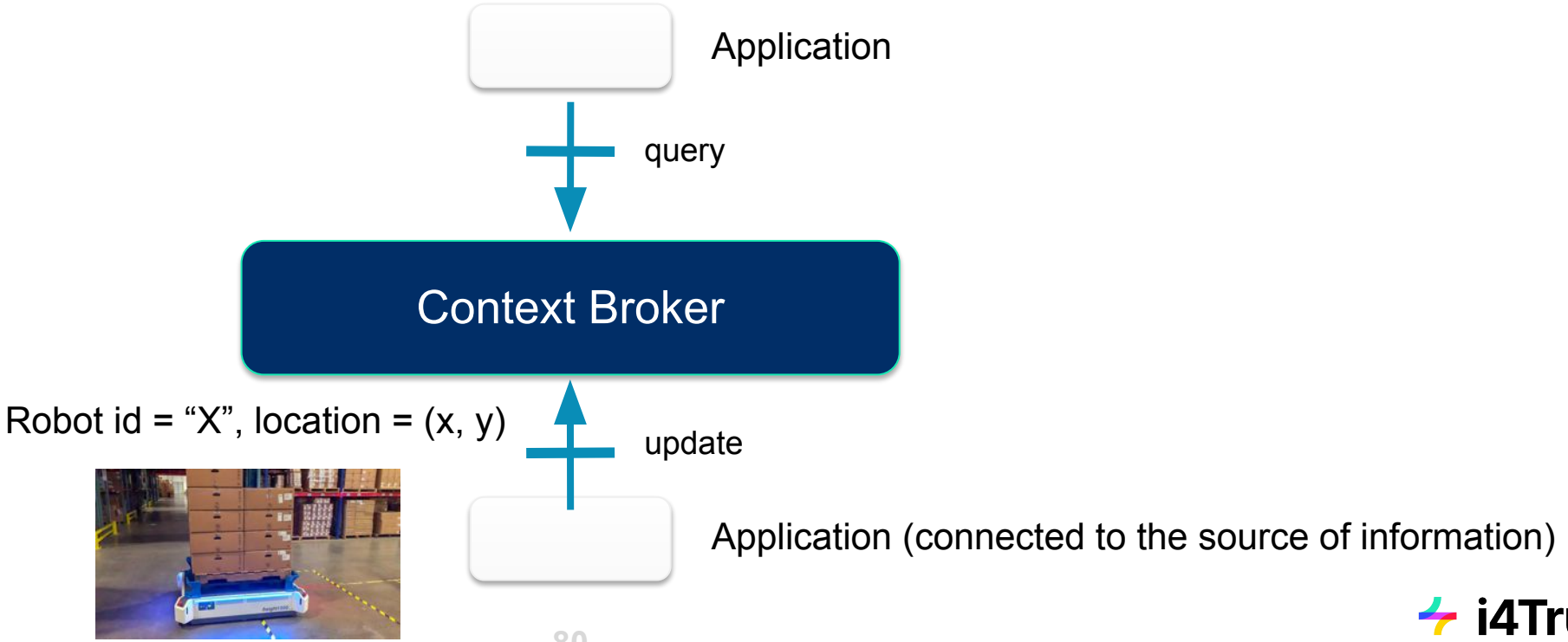
- Application can create entities and give initial values to their attributes (properties/relationships)
- Multiple entities can be created in a single request



Transport robot
- Id
- location
- speed
- transported items
- destination

Updates on entities

- You can update an attribute of a given entity with a request (simplest case)
- You can update a set of attributes on one or more entities in a single request
- Attributes can be added to a given entity type (effectively extending the underlying data model) at any time without the need to re-initiate



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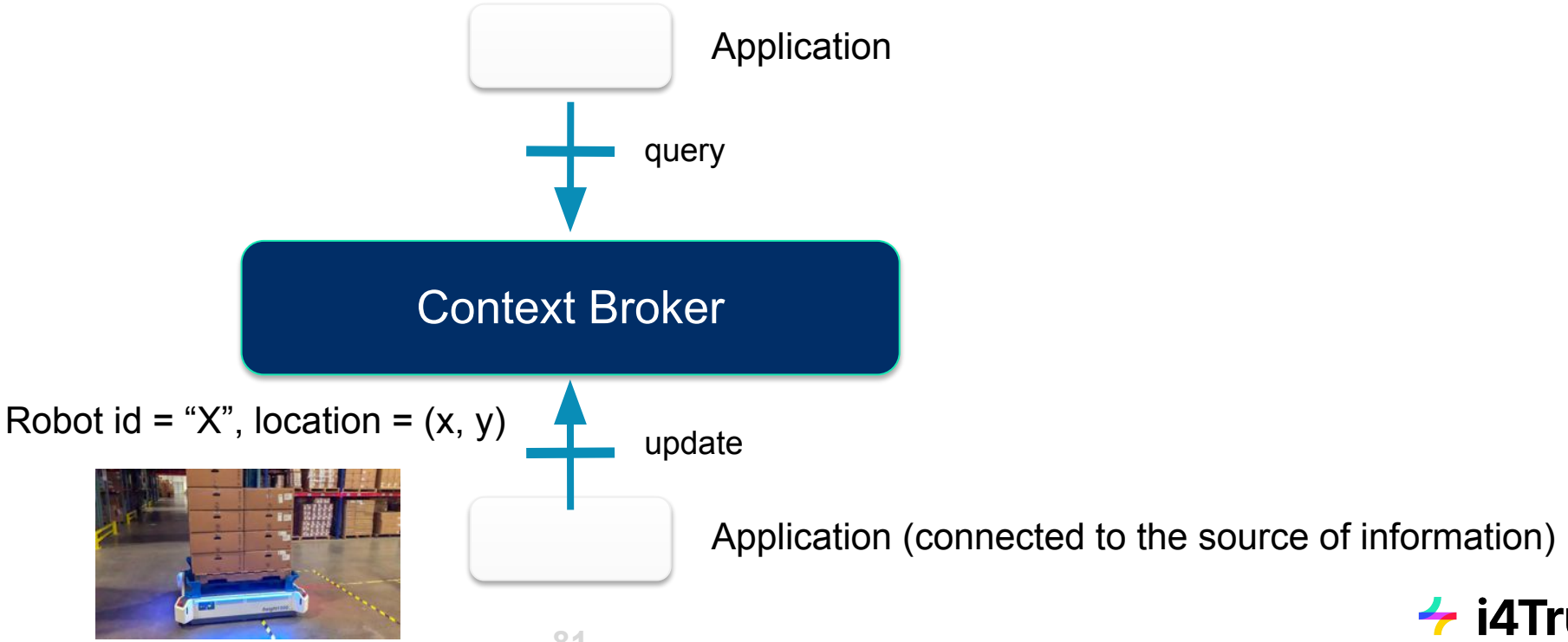
Queries on entities

- You can query for the value of an attribute of a given entity with a request (simplest case)
- You can query for a set of attributes on one or more entities in a single request
- You can specify filters/conditions on your query to refine what entities you are querying information about



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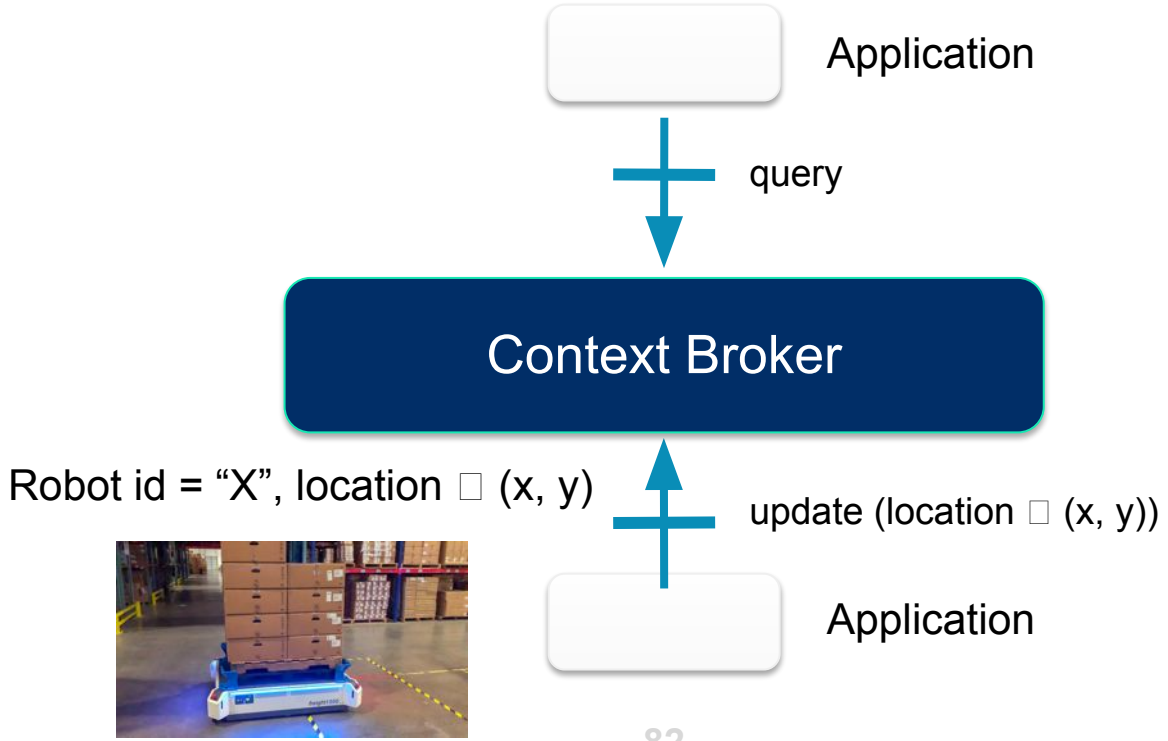
GeoQueries

- Enties may have attributes whose value are of type ”GeoProperty” specifying a location described as { longitude, latitude } pair
- You can query for a set of attributes of those entities located in a given area/zone (more generally, of entities with an attribute whose value refers to a location within a given zone)



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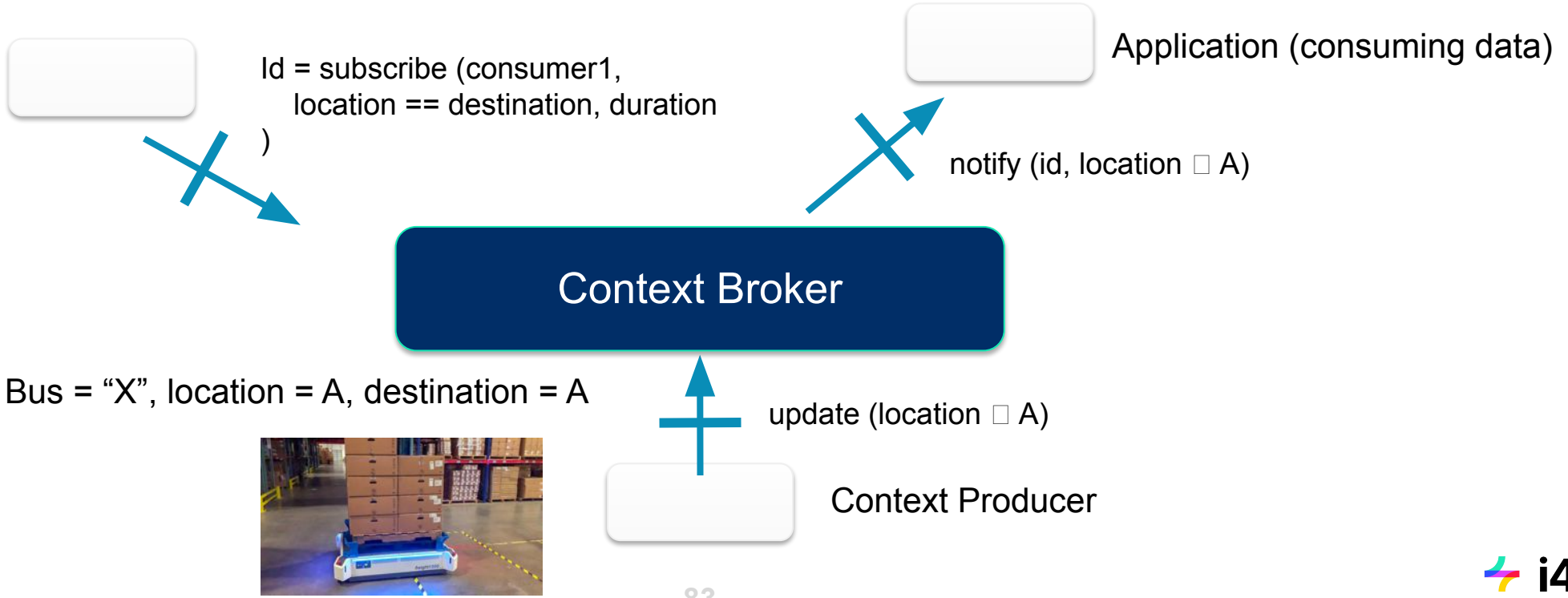
Subscription/Notification

- You can subscribe to get notified about the values of certain attributes of a number of entities when certain conditions occur



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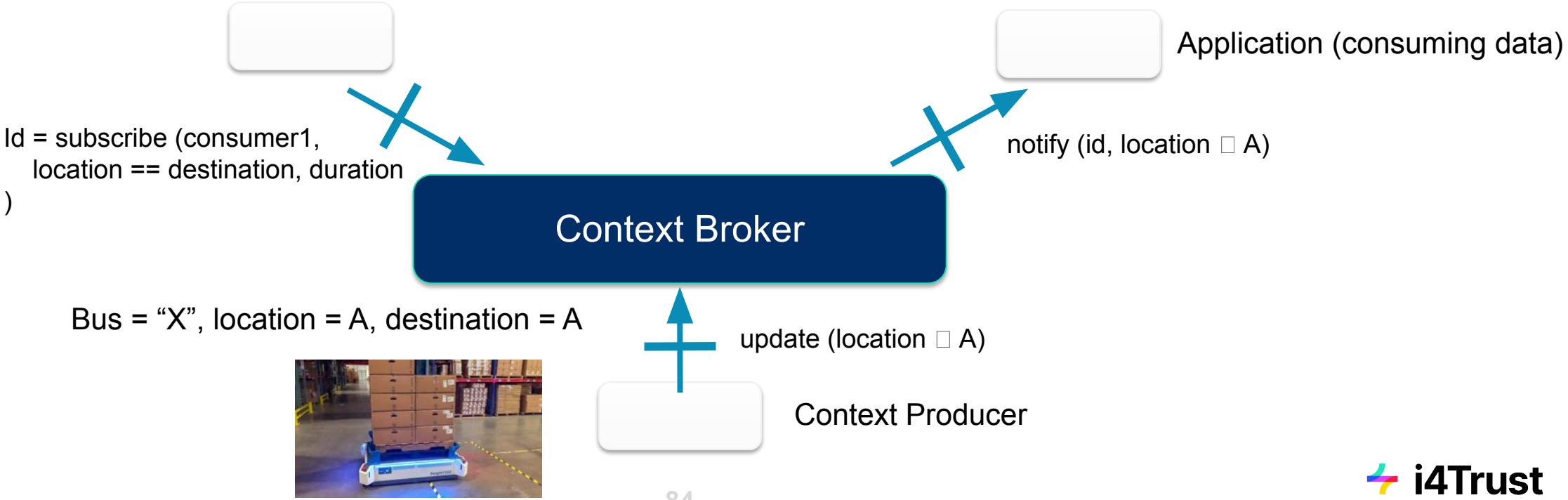
Subscription/Notification (examples)

- Notify url "x" on any change of the attribute ”status" in robot with id=7601CZN
- Notify url "Y" when attribute "speed (Km/h)" of robots located in a given polygon area gets higher than 10 (note that in this case, you will obtain info of several robots)
- Notify url "Z" when the value of attribute ”status" changes in any robot
- …



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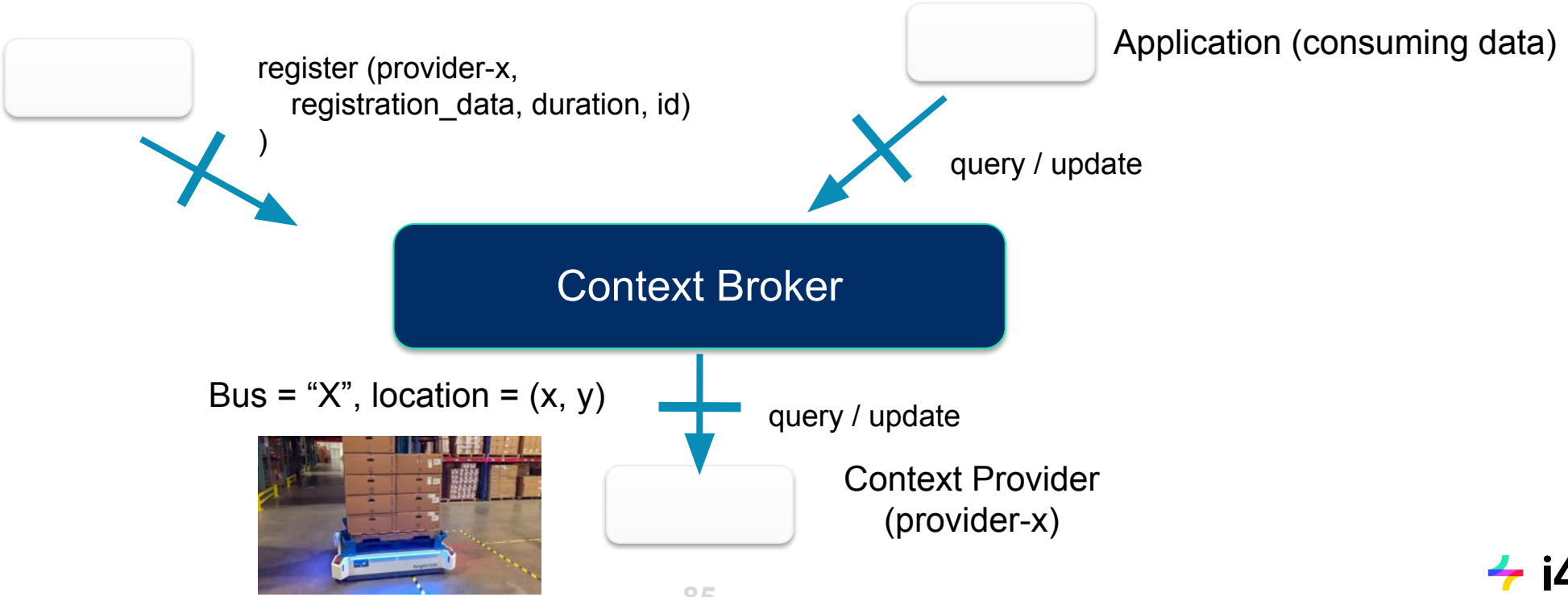
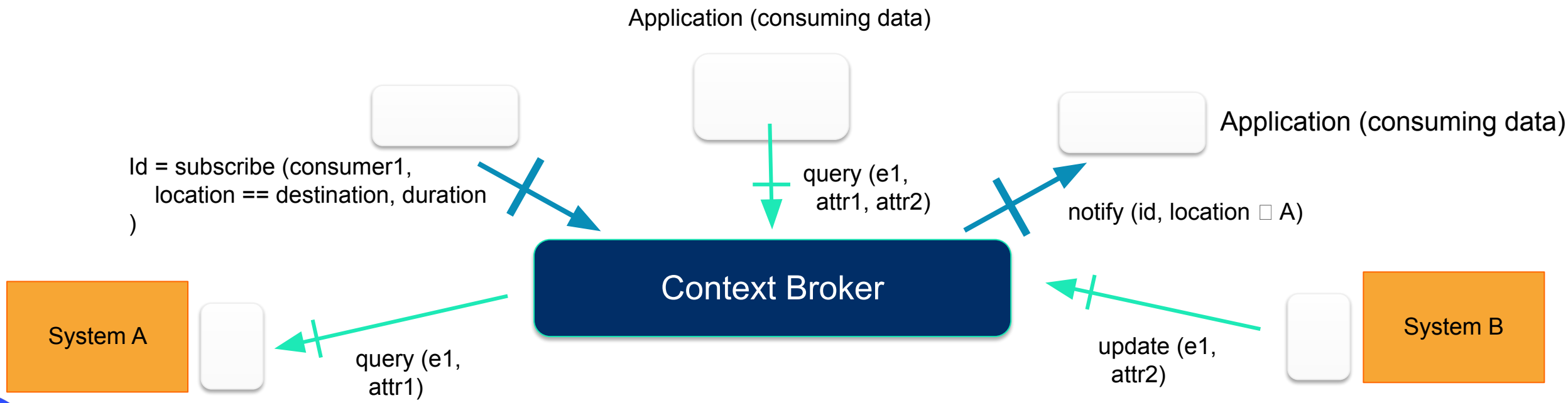
Context Providers

- You may register so-called “context providers” in a Context Broker so that it knows what end point (typically another context broker or a system supporting query and update operations) it has to rely on for serving queries/updates on given entities/attributes



Decoupling producers and consumers of information

- Whether values of certain attributes are pushed into or pulled from a Context Broker is totally transparent to applications that query for information
- Similarly, whether values of certain attributes are consumed via queries or notifications by applications is totally transparent to that part of the application that provides the data



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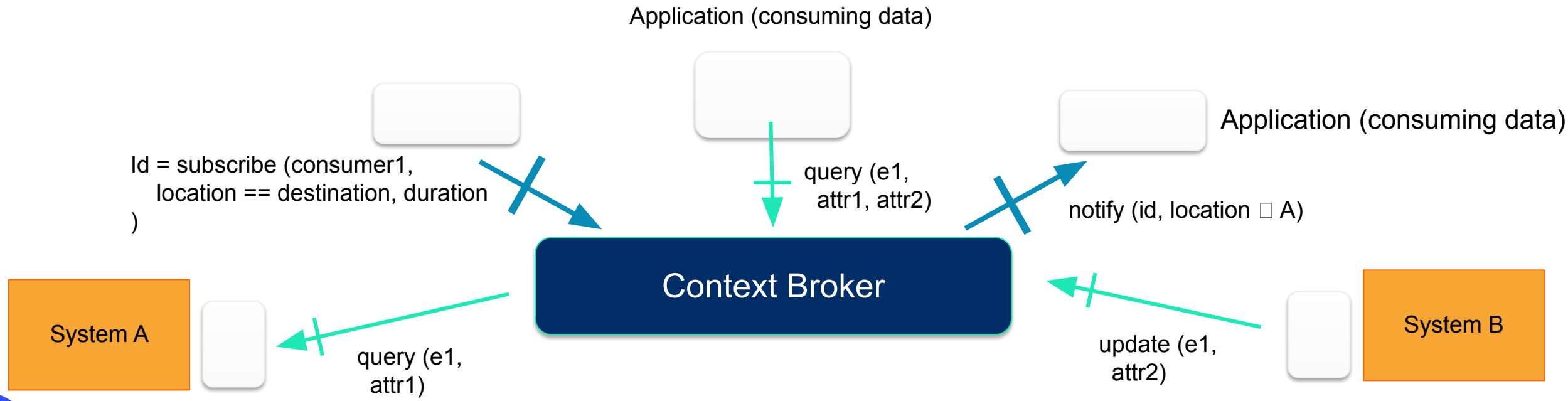
Attribute “domains” (equivalent to submodels)

- An attribute domain represents the grouping of multiple attributes. Attribute domains allow requestors to specify a set of attributes of interest using a single string as attribute domain name.
- Attribute domains are not yet considered in NGSI-LD but subject of current discussion since they were part of the original OMA NGSI-9/10 specifications



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Exploiting the advantages of JSON-LD vs JSON

- Creating linked data using fully qualified names throughout would be painful, as each attribute would need to be a URI, so JSON-LD introduces the idea of an @context attribute which can hold pointers to context definitions

```
{
    "@context": "https://uri.etsi.org/ngsi-ld/v1/ngsi-ld-core-context.jsonld",
    "id": "urn:ngsi-ld:Building:store001",
    "type": "https://uri.fiware.org/ns/data-models#Building",
    "https://schema.org/address": {
        "type": "Property",
        "value": {
            "streetAddress": "Bornholmer Straße 65",
            "addressRegion": "Berlin",
            "addressLocality": "Prenzlauer Berg",
            "postalCode": "10439"
        },
        "verified": {
            "type": "Property",
            "value": true
        }
    },
    "https://uri.etsi.org/ngsi-ld/name": {
        "type": "Property",
        "value": "Bösebrücke Einkauf"
    },
    "https://uri.fiware.org/ns/data-models#category": {
        "type": "Property",
        "value": ["https://uri.fiware.org/ns/data-models#commercial"]
    },
    "location": {
        "type": "GeoProperty",
        "value": {
            "type": "Point",
            "coordinates": [13.3986, 52.5547]
        }
    }
}
```

```
{
    "@context": "https://schema.lab.fiware.org/ld/context",
    "id": "urn:ngsi-ld:Building:store001",
    "type": "Building",
    "address": {
        "streetAddress": "Bornholmer Straße 65",
        "addressRegion": "Berlin",
        "addressLocality": "Prenzlauer Berg",
        "postalCode": "10439"
    },
    "name": "Bösebrücke Einkauf",
    "category": ["commercial"],
    "location": {
        "type": "Point",
        "coordinates": [13.3986, 52.5547]
    }
},
```