D7.6 Report on standardisation activities

Authors: Silvia Castellví (IDSA), Martin Kaltenböck (SWC), Bert Utermark (G1), Martin Kaltenböck (SWC), Olga Galanets (IDSA), Antonia Kuster (IDSA), Julia Jakuzzi (IDSA), Antragama Ewa Abbas (TUD).

Additional Information: **overview on current states and relevant trends on the topic of data marketplaces to ensure that the projects' results are targeting market needs and working with up-to-date requirements.**

December 2022

TRUSTS Trusted Secure Data Sharing Space

D7.6 Report on standardisation activities

Document Summary Information

Grant Agreement No.	871481	**Acronym**	TRUSTS
Full Title	TRUSTS Trusted Secure Data Sharing Space		
Start Date	01/01/2020	**Duration**	36 months
Project URL	https://trusts-data.eu/		
Deliverable	D7.6 Report on standardisation activities		
Work Package	WP7 'Business Model, Exploitation & Innovation Impact Assurance'		
Contractual due date	30-12-2022	**Actual submission date**	23-01-2023
Nature	Report	**Dissemination Level**	Public
Lead Beneficiary	IDSA		
Responsible Author	Silvia Castellví (IDSA), Martin Kaltenböck (SWC)		
Contributions from	Bert Utermark (G1), Olga Galanets (IDSA), Antonia Kuster (IDSA), Julia Jakuzzi (IDSA)		

Revision history (Including peer reviewing & quality control)

Version	Issue Date	% Complete	Changes	Contributor(s)
V0.1	27.05.2022	10 %	Initial deliverable structure	Natalia Simon (IDSA)
V0.2	16.12.2022	40%	Information collected, introduction finalised, several chapters structured and populated	Martin Kaltenboeck (SWC)
V0.3	13.01.2023	80%	Further development of the deliverable	Silvia Castellví (IDSA) Martin Kaltenboeck (SWC)

V0.4	16.01.2023	100%	Finalisation of the deliverable document	Silvia Castellví (IDSA) Martin Kaltenboeck (SWC)
V0.5	20.01.2023	100%	Review done, comments integrated and deliverable finalised.	Antragama Abbas (TUD) Silvia Castellví (IDSA) Martin Kaltenboeck (SWC)
V1.0	23.01.2023	100%	Deliverable submitted	Silvia Castellví (IDSA) Martin Kaltenboeck (SWC)

Disclaimer

Copyright message

Table of Contents

List of Figures

List of Tables

Glossary of terms and abbreviations used.

Abbreviation / Term	Description
AI	Artificial Intelligence
AMDEX	Amsterdam Data Exchange
AML	Anti-Money Laundering
API	Application Programming Interfaces
B2B	Business to Business
BDVA	Big Data Value Association
BMVIT	Bundesministerium für Verkehr, Innovation und Technology (Austrian Ministry for Innovation)
C2B	Consumer to Business
CA	Certificate Authority
CMS	Content Management System
CO2	Carbon Dioxide
CSV	Comma-separated values
DAPS	Dynamic Attribute Provisioning Service
DCAT	Data Catalogue Vocabulary
DIN	Deutsches Institut für Normung
DIO	Data Intelligence Offensive
DMA	Data Market Austria
EC	European Commission
ELG	European Language Grid
EOSC	European Open Science Cloud
ETSI	European Telecommunications Standards Institute
EU	European Union
EU27	27 European Union Countries
EuroVoc	EU Vocabularies
FAIR	Findability, Accessibility, Interoperability, and Reuse (of digital assets)
FCAI	Finnish Center for Artificial Intelligence
FFG	Forschungfsörderungs Gesellschaft (National Funding Agency Austria)
GA	Grant Agreement
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
FpML	Financial products Markup Language
HTML	Hypertext Markup Language
HTTPS	Hypertext Transfer Protocol Secure
ICT	Information and Communication Technology
IDC	International Data Cooperation
IDS	International Data Space
IDSA	International Data Spaces Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
INSPIRE	Infrastructure for Spatial Information in the European Community
IoT	Internet of Things

IOTA	IOTA is funded by the non-profit IOTA Foundation. IOTA focuses on the IoT market with the goal to enable secure data transactions between data sellers and buyers.
IPR	Intellectual Property Rights
ISO	International Organisation for Standardisation
ISST	Institute for Software and Systems Engineering (IIST) of Fraunhofer
IT	Information Technology
ITU	International Telecommunication Union
JS	JavaScript
JSON	JavaScript Object Notation
ITU	International Telecommunication Union
kWh	Kilowatt hour
ML	Machine Learning
MSP(s)	Multisided Platforms
NL AIC	The Netherlands AI Coalition
P2B	Platform to Business
ParIS	Participant Information System
PoC	Proof of Concept
PSD2	Payment Service Directive 2;
RAM	Reference Architecture Model
SDO	Standards Development Organization
SME	Small and Medium-sized Enterprises
SOLID	Social Linked Data
SSHOC	Social Sciences and Humanity Open Cloud
SSO	Single Sign On
STOF model	The STOF model consists of the service domain (S), technology domain (T), organisation domain (O), and finance domain (F). The STOF model is a framework that provides the logic of business and its ecosystem[1].
TFEU	Treaty on the Functioning of the European Union
TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Netherlands Organisation for Applied Scientific Research)
TRUSTS	Trusted Secure Data Sharing Space
UC	Use Case
UI	User Interface
US	United States
USP	Unique Selling Proposition
VM(s)	Virtual Machine(s)
W	Watt
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines
WP(s)	Work Package(s)

[1] *Bouwman et al., 2008*

Executive Summary

The lack of interoperability and the integration costs to access data markets do not allow a proper data economy to thrive yet. Those hurdles can be lowered with standardisation efforts. With more interoperability at the (meta)data level, players could exchange their data in the same trusted data space much easier and more efficiently and with lower costs, which will lower the barrier to accessing the market.

Task T7.4 'Standardisation uptake and recommendations' in the TRUSTS project tackles the state-of-the-art of standardisation in the field and provides information on the standards used by TRUSTS, as well as working on the spotting of gaps and missing areas and activities related to standardisation in the domain of data spaces and data sharing.

This D7.6 'Report on standardisation activities' provides a report on the work carried out in the area of standardisation in data markets and data sharing throughout Work Package 7 of the TRUSTS project.

D7.6 provides a short overview of the current standardisation landscape relevant to the topic of data markets and data spaces, and the topic of secure and trusted data sharing. This section provides insights into two topics: (i) the benefits of standards and (ii) relevant standardisation bodies in the field.

Section 3 gives an overview of standards: the existing ones that are relevant for data spaces and data sharing, in addition to identifying those standards that are relevant for the TRUSTS project and have been used in TRUSTS. One result of standardisation work in TRUSTS is the breakthrough that interoperability needs to be tackled and further developed for the success and sustainability of data spaces and data sharing mechanisms.

Section 4 provides the findings from two workshops organised by the TRUSTS project, namely:

a) **Workshop on Data Spaces and Semantic Interoperability**[2], organised by TRUSTS as a full-day workshop on the 3rd of June 2022 in Vienna at the University of Economics Vienna, co-organised by the World Wide Web Consortium (W3C)[3] and the International Data Space Association (IDSA)[4].

b) **Workshop: Towards Data Spaces Interoperability Workshop on standardisation co-organised by BD4NRG, TRUSTS and IDSA**[5], taking place on the 23rd November 2023 as a one-hour session in the course of the European Big Data Value Forum 2023 (EBDVF2023)[6].

Section 5 closes the document with a short conclusion, taking into account the main findings and providing an outlook on what needs to be done next and where we have identified bottlenecks and gaps that need further attention in the future.

[2] https://www.trusts-data.eu/data-spaces-semantic-interoperability/

[3] https://www.w3.org/

[4] https://internationaldataspaces.org/

[5] https://european-big-data-value-forum.eu/2022-edition/programme/

[6] https://european-big-data-value-forum.eu/

The most significant identified gaps regarding interoperability in Data Spaces are:

- Interoperability is often available on the metadata level only but not on the data level.
- No industry-specific controlled vocabularies & Knowledge Graphs exist.
- Resources are not available in languages other than English.
- Insufficient data usage control mechanisms are in place (right-, value-, purpose modelling)
- The connection between the physical and digital world is still missing.

1 Introduction

The lack of interoperability and the integration costs to access a data market do not allow a proper data economy to thrive yet. Those hurdles will be minimised with a standardisation effort. With more interoperability, players could exchange their data in the same trusted data market, and open-source technologies would lower the barrier to accessing the market.

Task T7.4 'Standardisation uptake and recommendations' in the TRUSTS project interacts with task T3.3 'Data marketplaces interoperability solutions'. TRUSTS uses and implements state-of-the-art technologies and libraries provided by standardisation bodies to tackle those challenges.

The work included elaboration, assessment, and identification of required future development of various concepts and standards (e.g., IDSA Reference Architecture Model, FpML) we identified as required and necessary for developing a state-of-the-art TRUSTS ecosystem. TRUSTS has thereby provided recommendations targeting major standardisation bodies based on its research.

Such recommendations have been shared, presented and discussed with standardisation bodies' representatives during two dedicated workshops along the project. As our main objective was to develop a sustainable data ecosystem, the TRUSTS project team has paid special care to the support requirements and has shared the experience from IDSA, which has, up to now, supported and developed the Architecture Model for any data ecosystem.

This document on hand, Deliverable D7.6 'Report on standardisation activities', provides a report about the carried-out standardisation activities shared in the course of work package 7 in the TRUSTS project.

The outline of D7.6 is as follows:

- **Section 2** provides a short overview of the current standards landscape relevant to the data markets and spaces and the issue of secure and trusted data sharing. The section presents insights into two cases: (i) the benefits of standards and (ii) relevant standardisation bodies in the field.
- **Section 3** gives an overview of standards: existing ones and the ones that are in use relevant for the TRUSTS project, whereby one result of standardisation work in TRUSTS is the finding that mainly interoperability needs to be tackled and further developed.
- **Section 4** provides the findings from two workshops organised by the TRUSTS project, namely:
    - *Workshop on Data Spaces and Semantic Interoperability*[7], organised by TRUSTS as a full-day workshop on the 3rd of June 2022 in Vienna at the University of Economics Vienna, co-organised by the World Wide Web Consortium (W3C)[8] and the International Data Space Association (IDSA)[9] .
    - *Workshop: Towards Data Spaces Interoperability Workshop on standardisation co-organised by BD4NRG, TRUSTS and IDSA*[10], taking place on the 23rd November 2023 as a

[7] https://www.trusts-data.eu/data-spaces-semantic-interoperability/

[8] https://www.w3.org/

[9] https://internationaldataspaces.org/

[10] https://european-big-data-value-forum.eu/2022-edition/programme/

one-hour session in the course of the European Big Data Value Forum 2023 (EBDVF2023).

- **Section 5** closes the document on hand with a short conclusion section taking into account the main findings, as well as providing an outlook on what needs to be done next -mainly in the field of interoperability- and where we have identified bottlenecks and gaps that need further attention in the future.

2 Current Landscape of Standards

This section explains why standardisation is important, identifies the main standardisation bodies related to TRUSTS and how the project can contribute to the different standardisation committees.

2.1 Benefits of standardisation

Standardisation facilitates the exchange of goods, processes, data and services by eliminating technical barriers. Phone communications, credit card payments and goods transport in supply chains are standardised and can be used in different countries worldwide. The products can be sold in foreign markets with lower development and testing costs, so the manufacturers can look for suppliers worldwide that can provide products with more excellent quality assurance whereas customers can benefit from trustworthy products. Concisely, the benefits of standardisation are[11]:

- Dissemination and application of innovations.
- Promotion of worldwide trade.
- Standardising interfaces enhance compatibility.
- Time advantage and knowledge lead.
- Preview of what is happening on the market.
- Lower R&D risks and costs.
- Assurance of quality.
- Environmental protection.

2.3 Standardisation bodies

Apart from the abovementioned, there can be strategic reasons for companies to engage in standardisation, which may also include the ability to design industry-friendly regulations, enforce their content, prevent formal standards from conflicting with their interests, solve industry-specific technical problems, and acquire competitive advantages through advantage in knowledge. This are the motivations for companies and also for research projects to engage with standardisation bodies to set common guidelines, standardised methodologies and specifications.

[11] CEN/CENELEC Guide 23:2020 (https://www.cencenelec.eu/media/Guides/CEN-CLC/cenclcguide23.pdf)

Key standardisation bodies interesting for the TRUSTS projects are detailed below. For example, ISO and IEC offer the international workshop agreement (IWA) at an international level, CEN and CENELEC offer the CEN workshop agreement at European level, and DIN offers the DIN SPEC at national level. Many of the pre-standards or standards elaborated in consortia are taken over by the international standardisation system, in essence, ISO or IEC standards.

International SDOs

ISO - International Organisation for Standardisation

https://www.iso.org/home.html

ISO is an independent, non-governmental international organisation with a membership of 167 national standards bodies. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market-relevant international standards that support innovation and provide solutions to global challenges.

IEC – International Electrotechnical Commission

https://iec.ch/homepage

IEC standards cover a vast range of technologies from power generation, transmission and distribution to home appliances and office equipment, semiconductors, fibre optics, batteries, solar energy, nanotechnology and marine energy, and many others. The IEC also manages four global conformity assessment systems that certify whether equipment, system or components conform to its international standards.

The IEC cooperates closely with the International Organization for Standardisation (ISO) and the International Telecommunication Union (ITU).

ITU - International Telecommunication Union

https://www.itu.int/en/about/Pages/default.aspx

The International Telecommunication Union is a specialised agency of the United Nations responsible for many matters related to information and communication technologies.

The ITU promotes the shared global use of the radio spectrum, facilitates international cooperation in assigning satellite orbits, assists in developing and coordinating worldwide technical standards, and works to improve telecommunication infrastructure in the developing world.

European and regional SDOs

CEN/CENELEC

https://www.cencenelec.eu/

CEN and CENELEC (www.cencenelec.eu) are organisations in charge of developing standards that set specifications and procedures for a wide range of European products and services. The members of CEN and CENELEC are the National SDOs (also called National Standards Bodies in the EU) and National Electrotechnical Committees of all EU member states, plus associated nations (such as Iceland, Norway, Switzerland, and Turkey). European standards approved by CEN and CENELEC are accepted and recognised in all member and associated countries.

CEN/CENELEC aim to produce high-quality standards for products and services that incorporate quality, safety, environmental, interoperability and accessibility requirements.

ETSI – European Telecommunications Standards Institute

https://www.etsi.org/

ETSI is a European Standards Organization (ESO). We are the recognised regional standards body dealing with telecommunications, broadcasting and other electronic communications networks and services. ETSI has a significant role in Europe. This includes supporting European regulations and legislation by creating harmonised european standards. Only standards developed by the three ESOs (CEN, CENELEC and ETSI) are recognised as European Standards (ENs).

IEEE-SA

www.standards.ieee.org

IEEE is a primary SDO with a large number of active technical standards, ranging from wireless communications and digital health to cloud computing, power and energy, 3D video, electrical vehicle standards, and the Internet of Things. It was created by the Institute of Electrical and Electronics Engineers (IEEE), the American Association of Electrical and Electronics Engineers. It brings together and organises members from all over the world.

Standard Initiatives & Professional organisations

W3C - World Wide Web Consortium

https://www.w3.org/

The World Wide Web Consortium (W3C) is an international community where Member organisations, full-time staff, and the public work together to develop Web standards. Led by Web inventor and

Director Tim Berners-Lee and CEO Jeffrey Jaffe, W3C's mission is to lead the Web to its full potential. Contact W3C for more information.

ECMA – INTERNATIONAL (European Computer Manufacturers' Association) was founded in 1961 by major multinational computer hardware manufacturers present in Europe. Whilst the brand name has been kept, nowadays, ECMA's membership has grown; it includes companies and academics from around the world. ECMA focuses on standardisation topics such as hardware, software, communications, consumer electronics, media, storage, and environmental subjects. ECMA actively contributes to the work of others by submitting its standards to ISO, IEC and ETSI for approval and publication. https://www.ecma-international.org/

Ecma International is an industry association dedicated to standardising information and communication systems. ECMA covers a broad scope of standardisation topics, including hardware, software, communications, consumer electronics, IoT, programming languages, media storage, environmental subjects, etc.

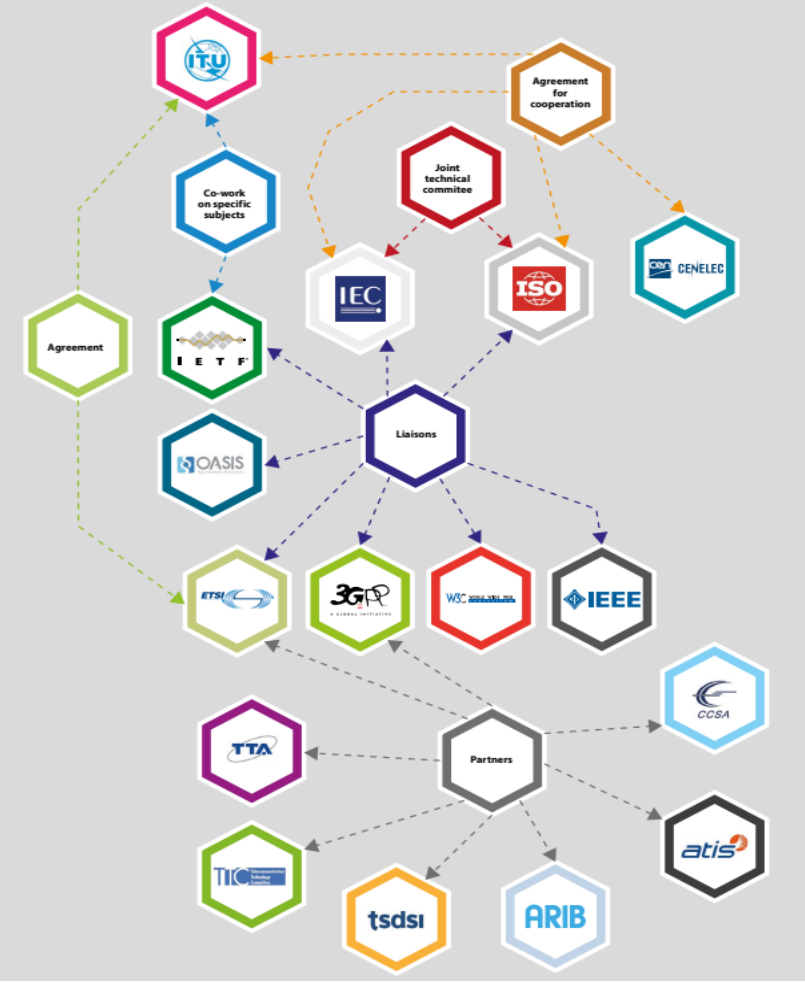

Figure 1. An overview of the ICT standardisation ecosystem. *Source: ETSI*

With this standardisation organisations review we want to provide and understand the different standardisation bodies (SDO) types; there are recognised SDO and non-recognised SDO, one example of a recognised SDO is ISO, and another example of not recognised one but relevant is the IEEE. Regulation 1025/2012 of the European Parliament and Council establishes rules about the cooperation between European standardisation organisations, national standardisation bodies, Member States and the Commission. The previous picture provides additional information about relationships between the different standardisation bodies to better understand how to approach them.

Additionally, TRUSTS research in the field standards regarding interoperability makes standardisation bodies to a target group relevant for the TRUSTS community. The results of the TRUSTS standardisation efforts have been promoted and presented to W3C that it is a crucial standardisation body regarding interoperability.

2.3 How to impact standards.

We have seen in chapter 2.1 the benefits of standardisations; the most important is that standards generate trust and facilitate coherence while assuring interoperability. They facilitate the innovation path to the industry easing market access and scalability. So, the companies that contribute to the standards creation will take advantage of the technology implementation.

The standardisation is a co-creation process that embraces universities, research centres and industries from different sectors participating in new technologies development. The co-creation process is based on open innovations that are fully supported by the European Commission in research projects.

The EC has published the standardisation strategy to strengthen the EU's global competitiveness in new technologies applications.

There are different methods to influence standardisation. We identify these methods that have been presented and evaluated in a TRUSTS project:

1. **Standardisation roadmap deliverable**: during the project's lifecycle, we analyse the status of the standardisation area covered by the project. This activity includes investigating existing standards at the national, European and international level, accessing superior knowledge, resources and industry best practices in the working field so that you can avoid reinventing the wheel and be aware of the standardisation existing context, and ensure interoperability. Based on this analysis, the project can identify gaps for future fields of activities and concrete recommendations.
2. **Standardisation strategy deliverable**: the project develops a standardisation proposal in a specific area. This activity is similar to the standardisation roadmap but with a reduced scope.
3. **Contributing to existing or initiating new standards** based on a depth gap analysis during the project.

The projects financed by European Research and innovation initiatives such as Horizon 2020 and Horizon Europe can participate in relevant Technical Committees through the **project liaison** concept; the project will be represented and fully contribute without voting rights.

The project can participate in the technical committees, providing high-quality and added-value expertise in the field relevant to the technical committee. The interaction with the technical body typically is:

- The provision of written contributions.
- Participation of representatives of the project in a meeting to get more information and discuss the topic.
- Participation in events or workshops organised by the project.

The contribution to the standardisation of the TRUSTS project is based on the interaction with the relevant standardisation Technical Committees (TC) and with standardisation initiatives that contribute to standardisation bodies. The strategy follows a process of three steps:

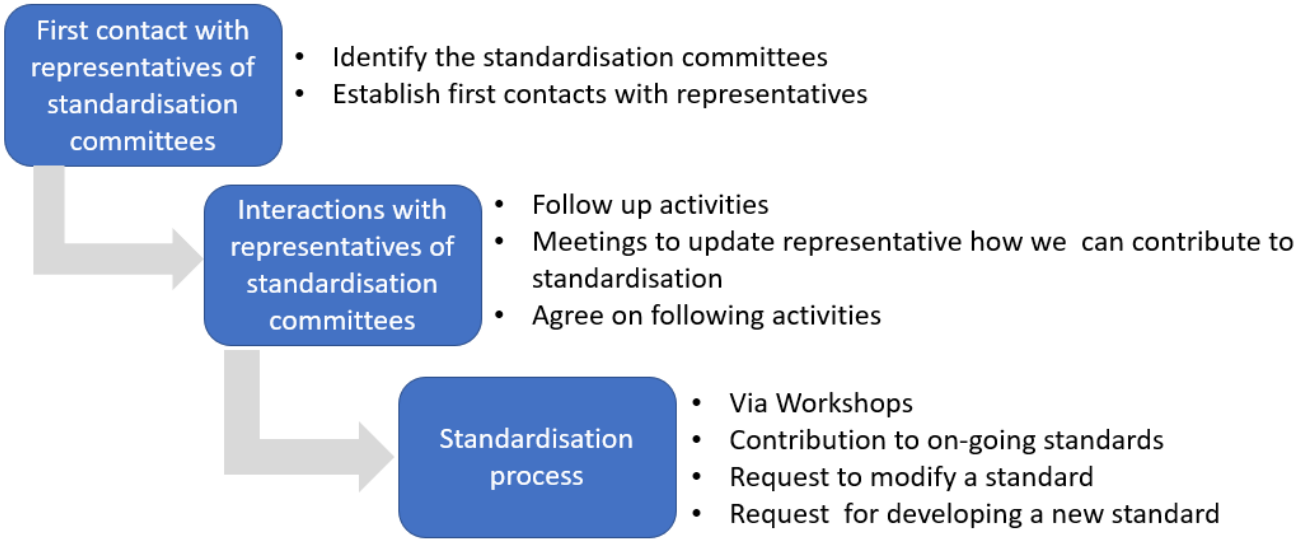

Figure 2. TRUSTS standardisation strategic actions.

TRUSTS project decided to collaborate with W3C on the interoperability topic, organising a TRUSTS-W3C workshop to promote involvement in the development of W3C activities; the workshop promotes early involvement in developing W3C activities from members and the public. The agenda and description of the workshops are detailed in chapter 4.1.

3 Relevant standards for TRUSTS

3.1 Data Standards in the topic: "Interoperability: data markets and schemata"

Before diving into the topic of interoperability and data spaces, some definitions of different types of interoperability are provided to ensure a common understanding of the topic.

Interoperability is a characteristic of a product or system whose interfaces are completely understood to work with other products or systems, at present or in the future, in either implementation or access, without any restrictions[12].

Data interoperability addresses the ability of systems and services that create, exchange and consume data to have clear, shared expectations for that data's contents, context and meaning[13].

Semantic interoperability is the ability of computer systems to exchange data with unambiguous, shared meaning. Semantic interoperability is a requirement to enable computable machine logic, inferencing, knowledge discovery, and data federation between information systems.

Semantic interoperability is therefore concerned not just with the packaging of data (syntax) but the simultaneous transmission of the meaning with the data (semantics). This is accomplished by adding data about the data (metadata) and linking each data element to a controlled, shared vocabulary. The meaning of the data is transmitted with the data itself, in one self-describing "information package" that is independent of any information system. This shared vocabulary and its associated links to a model like an ontology which provide the foundation and capability of machine interpretation, inference, and logic[14].

As already stated in the introduction of this document, interoperability is one of the most crucial areas for success regarding data sharing. In both: (i) inside a data market or data space, as well as (ii) between different data spaces, interoperability is the key to enabling important mechanisms and services for successful data spaces.

Valuable data space services and features based on interoperability are:

- Harmonised metadata: for datasets provided by a broad range of stakeholders that themselves use a heterogeneous landscape of metadata models and schemas.
- Data brokerage: search, recommendation, retrieval, and discovery of valuable data in a data space that includes vast amounts of data.

[12] Wikipedia, accessed: 01/2023, https://en.wikipedia.org/wiki/Interoperability
[13] https://datainteroperability.org/, accessed: 01/01/2023
[14] https://en.wikipedia.org/wiki/Semantic_interoperability.

- Data monetisation: data interoperability enables the identification of useful data for specific use cases and thereby lowers the costs of long data identification processes.
- Easier data integration, higher quality of data and thereby lower costs of integration as well as reuse of data for different purposes or use cases.
- Enablement of working data usage control mechanisms: right-, value-, purpose information and control mechanisms

Therefore, as an additional type of interoperability, we can find **natural language interoperability** (interoperability between languages), which is as important as metadata and data. Different languages can converge in the same data space; thereby, interoperability needs an additional attribute regarding context and meaning natural language (understanding).

Furthermore**, the FAIR Principles**, which are an essential concept in data sharing and, consequently in data spaces, include interoperability as one of the four main concepts: **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets.

The data usually needs to be integrated with other data. In addition, the data needs to interoperate with applications or workflows for analysis, storage, and processing.

- (Meta)data use a formal, accessible, shared and broadly applicable language for knowledge representation.
- (Meta)data use vocabularies that follow FAIR principles.
- (Meta)data include qualified references to other (meta)data[15].

The following image reflects the situation in TRUSTS regarding used standards and its use and regarding interoperability:

[15] Source: https://www.go-fair.org/fair-principles/, accessed: 01/2023

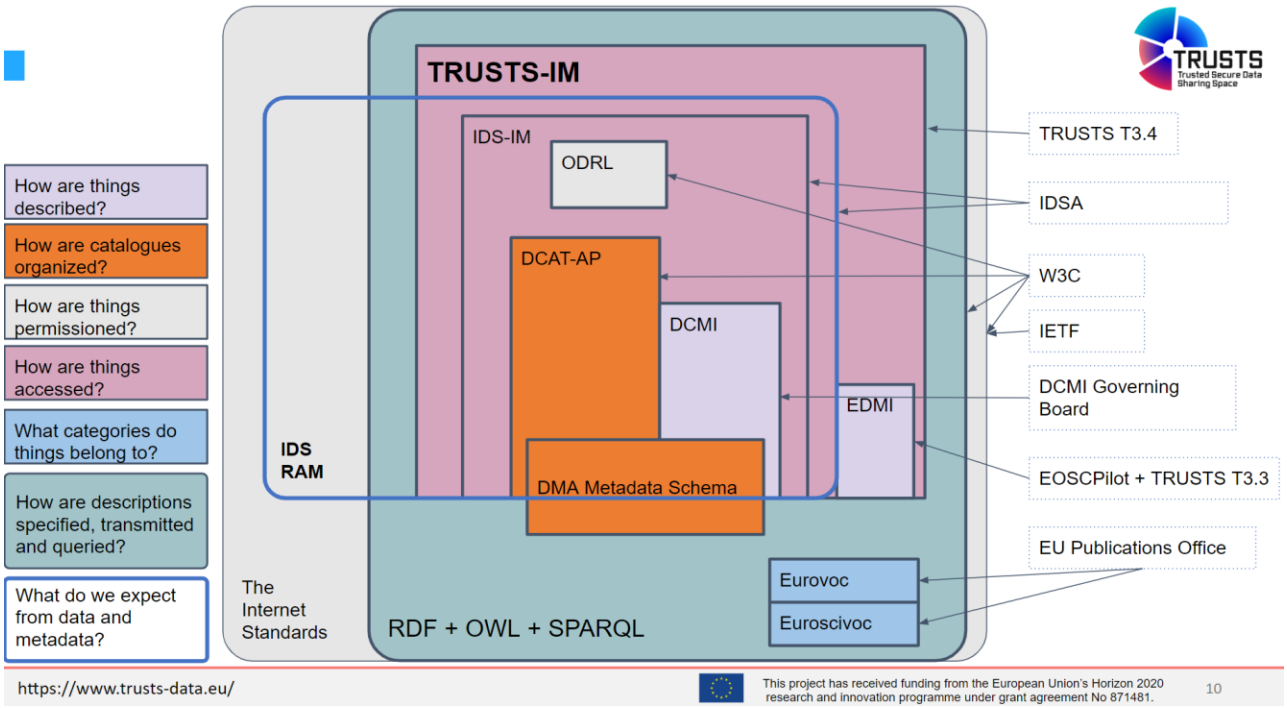

Figure 3. Standards (for interoperability) used in TRUSTS. Source: Slides for EBDVF2021 presentation by SWC

3.1.1 Standards used in Interoperability: data markets and schemata.

The TRUSTS project has carried out desk research, and the standardisation working team in TRUSTS (WP7 and T7.4) has furthermore involved the whole project consortium in identifying, collecting and classifying standards in the field of interoperability that is relevant to the work done in TRUSTS. In addition, a continuous discourse has taken place with several standardisation bodies and organisations working on standardisation, mainly with: IDSA[16], BDVA[17], and W3C[18].

The following areas have been specified for the standards collection in TRUSTS:

Information Security
Data interoperability*
Data architecture*
Data platforms*
Privacy and anonymisation
Use case standards
Data Management*
Metadata*

*relevant areas for this section

[16] https://internationaldataspaces.org/

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

[18] https://www.w3.org/

The results of the TRUSTS collection for interoperability and interoperability-relevant standards are as follows:

Area	SDOs Body	Standard	Description	Important for TRUSTS	Used in TRUSTS	TRUSTS Technology	Geographical scope	Link to the standard
Data Management	DIN	DIN SPEC 27070	Requirements and reference architecture of a security gateway for the exchange of industry data and services	It allows secure data sharing	Yes	IDS Connector	Germany	https://www.din.de/de/forschung-und-innovation/din-spec/alle-geschaeftsplaene/wdc-beuth:din21:271182058
Metadata	W3C	DCAT	Data Catalogue Vocabulary (DCAT) - Version 2	Describe catalogues and also datasets in a proven metadata schema	Yes	Metadata Layer	Worldwide	https://www.w3.org/TR/vocab-dcat-2/
Data platforms	W3C	HTTP	Hypertext Transfer Protocol -- HTTP/1.1. HTTP is an application layer protocol in the Internet protocol suite model for distributed, collaborative, hypermedia information systems	It is a widely used protocol for communication between applications in the TRUSTS infrastructure	Yes		Worldwide	https://www.w3.org/Protocols/
Data platforms	W3C	TLC	Transport Layer Security -- TLS1.2/1.3. TLS is a cryptographic protocol designed to provide communications security over a computer network.	It needs for secured communication in the TRUSTS platform	Yes		Worldwide	https://www.w3.org/2005/Incubator/webid/spec/tls/
Data platforms	W3C	X.509	An X.509 certificate is a digital certificate that uses the widely accepted international X.509 public	It needs for authentication and security in the	Yes		Worldwide	https://www.w3.org/PICS/DSig/X509_1_0.html

			key infrastructure (PKI) standard to verify that a public key belongs to the user, computer or service identity contained within the certificate.	TRUSTS platform				
Metadata	W3C	RDF	Resource Description Framework -- The basic standard for describing resources using explicit, machine-readable semantics	Metadata in the IDS-IM is stored in RDF, and it is exchanged using its serialisations	Yes	Metadata Layer	Worldwide	https://www.w3.org/TR/2014/REC-rdf11-concepts-20140225/
Metadata	W3C	OWL	Ontology Web Language -- Specifies how ontologies are described in a machine and human-readable way, forming the basis of Knowledge Graphs	The IDS-IM and the TRUSTS-IM are specified in OWL	Yes	Metadata Layer	Worldwide	https://www.w3.org/TR/owl2-overview/
Metadata	W3C	ODRL	Policy description language -- Allows for specifying collections of permissions and prohibitions	The IDS-IM and the TRUSTS-IM describe access policies using ODRL	Yes	Metadata Layer	Worldwide	https://www.w3.org/TR/odrl-model/
Metadata	W3C	SKOS	Simple Knowledge Organization System -- An ontology for describing concepts and their relations, allowing for the creation of hierarchically organised controlled vocabularies	Vocabularies used in TRUSTS, such as those for Themes, business models, etc., are specified in TRUSTS	Yes	Metadata Layer	Worldwide	https://www.w3.org/TR/2014/REC-rdf11-concepts-20140225/

Data architecture	W3C (draft standard)	REST	Representational state transfer (REST) is a software architectural style that was created to guide the design and development of the architecture for the World Wide Web. The REST architectural style emphasises the scalability of interactions between components, uniform interfaces, and the independent deployment of components.	Used in TRUSTS, e.g., for accessing the recommender system developed in T3.6	Yes		Worldwide	https://www.w3.org/2001/sw/wiki/REST
Data interoperability	ECMA	JSON	JSON (JavaScript Object Notation) is a lightweight data interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language Standard ECMA-262 3rd Edition.	The output of the recommender system developed in T3.6. is in JSON format	Yes		Worldwide	https://www.json.org/json-en.html
Data interoperability	ISO	ISO/TR 23455:2019	Provides an overview of smart contracts in BC/DLT systems, describing what smart contracts are and how they work. It also discusses methods of interaction between multiple smart contracts. Focuses on technical aspects of smart contracts and for legally binding use and applications will only be briefly mentioned.	Used in TRUSTS in the blockchain and smart contract demonstrator		Smart Contract Demonstrator	Worldwide	https://www.iso.org/standard/75624.html?browse=tc

Table 1. TRUSTS interoperability-relevant standards.

3.2 Standards in the topic: Privacy-preserving technologies

Another core area of data spaces, and more specific in TRUSTS, was secure (and trustful) data sharing, privacy preservation and data sovereignty.

Data sovereignty is defined as the idea that data are subject to the laws and governance structures of the nation where they are collected. The concept of data sovereignty is closely linked with data security, cloud computing, network sovereignty and technological sovereignty. Unlike technological sovereignty, which is vaguely defined and can be used as an umbrella term in policymaking, data sovereignty is specifically concerned with questions surrounding the data itself. Data sovereignty, as the idea that data is subject to the laws and governance structures within one nation is usually discussed in two ways: in relation to Indigenous groups and Indigenous autonomy from post-colonial states or in relation to the transnational data flow. With the rise of cloud computing, many countries have passed various laws around the control and storage of data, which all reflect measures of data sovereignty. More than 100 countries have some sort of data sovereignty laws in place. With self-sovereign identity (SSI), the individual identity holders can fully create and control their credentials, although a nation can still issue a digital identity in that paradigm[19].

The TRUSTS project has carried out desk research, and the standardisation working team in TRUSTS (WP7 and T7.4) has also involved the whole project consortium in identifying, collecting and classifying standards in the field of interoperability that is relevant to the work done in TRUSTS. In addition, a continuous discourse has taken place with several standardisation bodies and organisations working on standardisation, mainly with: IDSA, BDVA, and W3C.

The following areas have been specified for the standards collection in TRUSTS:

Information Security*
Data interoperability*
Data architecture*
Data platforms*
Privacy and anonymisation*
Use case standards
Data Management*
Metadata

* relevant areas for this section

[19] https://en.wikipedia.org/wiki/Data_sovereignty,

3.2.1 Standards used in a topic: Privacy-preserving technologies.

The results for privacy-preserving relevant standards are as follows:

Area	SDOs Body	Standard	Description	Important for TRUSTS	Is it used in TRUSTS?	TRUSTS Technology	Geographical scope	Link to the standard
Data Management	DIN	DIN SPEC 27070	Requirements and reference architecture of a security gateway for the exchange of industry data and services	It allows secure data sharing	Yes	IDS Connector	Germany	https://www.din.de/de/forschung-und-innovation/din-spec/alle-geschaeftsplaene/wdc-beuth:din21:271182058
Data platforms	W3C	TLS	Transport Layer Security -- TLS1.2/1.3. TLS is a cryptographic protocol designed to provide communications security over a computer network.	It needs for secured communication in the TRUSTS platform	Yes		Worldwide	https://www.w3.org/2005/Incubator/webid/spec/tls/
Privacy and anonymisation	ISO	ISO/TR 23244:2020	Provides an overview of privacy and personally identifiable information (PII) protection as applied to blockchain and	Used in TRUSTS in the blockchain and smart		Smart Contract Demonstrator	Worldwide	https://www.iso.org/standard/75061.html?browse=tc

			distributed ledger technologies (DLT) systems.	contract demonstrator				
Information Security	ISO	ISO/TR 23576:2020	Discusses the threats, risks, and controls related to 1) systems that provide digital asset custodian services and/or exchange services to their customers (consumers and businesses) and management of security when an incident occurs; 2) asset information (including the signature key of the digital asset) that a custodian of digital assets manages. This document is addressed to digital asset custodians that manage signature keys associated with digital asset accounts. In such a case, certain specific recommendations apply.	Used in TRUSTS in the blockchain and smart contract demonstrator		Smart Contract Demonstrator	Worldwide	https://www.iso.org/standard/76072.html?browse=tc
Data interoperability	ISO	ISO/TR 23455:2019	Provides an overview of smart contracts in BC/DLT systems; describing what smart contracts are and	Used in TRUSTS in the blockchain		Smart Contract Demonstrator	Worldwide	https://www.iso.org/standard/75624.html?browse=tc

			how they work. It also discusses methods of interaction between multiple smart contracts. Focuses on technical aspects of smart contracts. Smart contracts for legally binding use and applications will only be briefly mentioned.	and smart contract demonstrator				
Metadata	ISO	ISO 22739:2020	Provides fundamental terminology for blockchain and distributed ledger technologies.	Used in TRUSTS in the blockchain and smart contract demonstrator		Smart Contract Demonstrator	Worldwide	https://www.iso.org/standard/73771.html?browse=tc

Table 2. TRUSTS privacy-preserving standards.

3.3 Standards relevant to the use cases (industry)

TRUSTS aims to create a data market capable of integrating and adopting future platforms using interoperability. And the TRUSTS platform will act independently and as a platform federation, applied to the entire data valorisation chain, from data providers to consumers. At the end of the TRUSTS projects, it will:

1. set up a fully operational and GDPR-compliant European Data Marketplace for personal and non-personal related data

2. demonstrate and conduct the potential of the TRUSTS Platform in 3 use cases:

- Use case 1 “The Anti-Money Laundering compliance use case”.
- Use case 2 “The agile marketing through data correlation use case”.
- Use case 3 “The data acquisition to improve customer support services use case”.

The innovation and developments of TRUSTS projects came earlier; they are based on standards in the field of (1) Information Security, (2) Data interoperability, (3) Data architecture, (4) Data Platforms, (5) Privacy and anonymisation, (6) Use case standards (7) Data Management and (8) Metadata.

The use case minimum standards followed for the development of the use case applications and the marketplace platform are based on the regulations.

The use case standards, together with the legal and regulatory framework, provide requirements to:

- develop a platform and the respective operational procedures compliant with all corresponding data privacy and free flow regulations aiming at commercial exploitation of the service.
- design trials safeguarding that all involved stakeholders.

3.3.1 Regulations used in the TRUSTS use cases.

TRUSTS solutions and business aspects will be efficiently tested via various use cases (UCs) involving actors representing all targeted sectors (industry sectors of corporate business data in the financial and operator industries).

The three UCs are:

1. The ‘**Smart big-data sharing and analytics for Anti-Money Laundering compliance**’ UC aims to demonstrate the capabilities of the TRUSTS platform in providing faster and more accurate detection of financial crime and showcase how enriched data can be securely brokered via the platform to interested customers who need to perform AML checks.

2. The '**Agile marketing activities through correlation of anonymised banking and operators'** data' UC, whose intention is to validate how big data analytics techniques applied on data shared via the TRUSTS Platform can provide timely and meaningful information towards targeting profitable customers at a local level.

3. The '**Buying data from a data marketplace to improve Natural Interaction'** UC objective is to create an out-of-the-box analytics solution to anonymise and visualise Big Financial Data.

Regulations and requirements to be applied to the use cases are identified in deliverable D2.2, 'Industry specific requirements analysis, the definition of the vertical E2E data marketplace functionality and use cases definition I"' and deliverable D2.3 entitled 'Industry specific requirements analysis, the definition of the vertical E2E data marketplace functionality and use cases definition.

3.3.1.1 AML Regulations.

Directive (EU) 2015/849 of the European Parliament of 20th May 2015 on the prevention of the use of the financial system for the purposes of money laundering or terrorist financing. This Directive aims, inter alia, to bring European Union legislation in line with the International Standards on Combating Money Laundering and the Financing of Terrorism and Proliferation that the Financial Action Task Force (FATF), an international anti-money laundering and counter-terrorist financing standard setter, adopted in 2012.

Directive (EU) 2015/849 requires obliged entities to put in place anti-money laundering and countering the financing of terrorism (AML/CFT) policies and procedures to mitigate and manage effectively the money laundering and terrorist financing (ML/TF) risks to which they are exposed.

Regulatory technical standards in financial services should ensure consistent harmonisation and adequate protection of depositors, investors and consumers across the Union. As bodies with highly specialised expertise, it would be efficient and appropriate to entrust the ESAs with the elaboration, for submission to the Commission, of draft regulatory technical standards which do not involve policy choices. (62) The Commission should adopt the draft regulatory technical standards developed by the ESAs pursuant to this Directive by means of delegated acts pursuant to Article 290 TFEU and in accordance with Articles 10 to 14 of Regulations (EU) No 1093/2010, (EU) No 1094/2010 and (EU) No 1095/2010[20].

[20] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L0849&from=EN,

Regulatory Technical Standards on the implementation of group wide AML/CFT policies in third countries.

With these regulatory technical standards (RTS), the ESAs aim to foster a consistent and more harmonised approach to identifying and managing the ML/TF risk to which credit and financial institutions are exposed as a result of their operations in a third country, should the implementation of the third country's law not permit the application of group-wide policies and procedures. These RTS set out minimum actions that should be taken by credit and financial institutions in such circumstances and will contribute to creating a level playing field across the Union's financial sector.

Draft Joint Regulatory Technical Standards on the measures credit institutions and financial institutions shall take to mitigate the risk of money laundering and terrorist financing where a third country's law does not permit the application of group-wide policies and procedures[21].

3.3.1.2 General Data Protection Regulation.

Regulation 2016/679 (General Data Protection Regulation - **GDPR**) entered into force on the 25th May 2018. The GDPR, whose legal basis has been identified in Art 16 (2) of the Lisbon Treaty (TFEU), regulates the protection of individuals in personal data processing and the free movement of such data. The GDPR represents the cornerstone of the new Data Protection Framework; it sets a higher standard concerning the protection of individuals; the aims of the regulation are:

- The general data protection regulation (GDPR) protects individuals when their data is processed by the private sector and most of the public sector. Data processing by the relevant authorities for law-enforcement purposes is subject to the data protection law enforcement directive (LED) instead (see summary).
- It allows individuals to control their personal data better. It also modernises and unifies rules, allowing businesses to reduce red tape and benefit from greater consumer trust.
- It establishes a system of completely independent supervisory authorities in charge of monitoring and enforcing compliance.
- It is part of the European Union (EU) data protection reform, along with the data protection law enforcement directive and Regulation (EU) 2018/1725 on the protection of natural persons with regard to the processing of personal data by the EU institutions, bodies, offices and agencies

In the context of the TRUSTS project, the initial question stemming from the privacy and data protection framework is whether the data collected and/or processed by relevant stakeholders in the project can be qualified as personal data and if they do, which rules should be applied[22].

3.3.1.3 e-Privacy regulation for electronic communications.

The ePrivacy Directive ensures the protection of fundamental rights and freedoms, in particular, the respect for private life, the confidentiality of communications and the protection of personal data in the electronic communications sector. It also guarantees the free movement of electronic

[21] https://www.eba.europa.eu/regulation-and-policy/anti-money-laundering-and-e-money/rts-on-the-implementation-of-group-wide-aml/cft-policies-in-third-countries

[22] https://eur-lex.europa.eu/EN/legal-content/summary/general-data-protection-regulation-gdpr.html,

communications data, equipment and services in the Union. It implements in the Union's secondary law the fundamental right to the respect for private life, with regard to communications, as enshrined in Article 7 of the Charter of Fundamental Rights of the European Union ("Charter"). Considering the development in this field, the ePrivacy Directive should be considered complementary to the GDPR. Indeed, contrary to the ePrivacy Directive, and similarly to the GDPR, the proposed ePrivacy Directive is directly applicable within the EU[23].

e-Privacy Regulation compliance is required for electronic communications; the classification of data gathered and generated by the TRUSTS Consortium falls under the following categories:

1. Electronic communication data that fall under Art 4(3)(a) EPR but are not personal data (Art 4(1) GDPR). In this case, EPR applies to ensure the confidentiality of electronic communication data that otherwise would not be covered.
2. Personal data that fall under the definition of Art 4(1) GDPR but cannot be qualified as electronic communication data. When this situation occurs, the GDPR provisions apply.
3. Electronic communications data fall into the definition of personal data. When this situation occurs, the EPR will prevail over the GDPR. This implies that the legal basis for the processing of data has to be found in Art 6 EPR (and not in Art 6 GDPR)[24].

3.3.1.4 Free flow of non-personal data regulation for data exchange between the TRUSTS platform and subscribers.

In the Free Flow of Non-Personal Data Regulation (FFNPR), the Council defines the EC proposal as a '*balanced compromise that gives Member States flexibility to address core public responsibilities while respecting the principles of the free flow of data*.' The European Parliament on its side also welcomed the initiative. The Committee for the Internal Market and Consumer Protection has defined the free flow of non-personal data as the fifth freedom of the EU Single Market after goods, people, services and capital. After a negotiation phase between the European Parliament and the Council (under EC supervision), an overall agreement was reached, and final approval occurred at the beginning of November 2018. The FFNPDR was signed on the 14th November 2018, entered into force at the end of December 2018 and is applicable from May 2019.

This regulation applies to the processing of electronic data other than personal data in the Union, which is provided as a service to users residing or having an establishment in the Union, in the case of a data set composed of both personal and non-personal data, this regulation applies to the non-personal data part of the data set[25].

3.3.1.5 Platform-to-business regulation for safeguarding TRUSTS' operational transparency and fairness.

Regulation (EU) 2019/1150 of the European Parliament and of the Council of 20th June 2019 on promoting fairness and transparency for business users of online intermediation services. The EU Regulation on platform-to-business relations (P2B Regulation) is the first ever set of rules for creating a fair,

[23] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017PC0010&from=EN

[24] TRUSTS D2.2 entitled 'Industry specific requirements analysis, the definition of the vertical E2E data marketplace functionality and use cases definition.

[25] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1807&from=EN

transparent and predictable business environment for smaller businesses and traders on online platforms. The Commission created the Observatory on the online platform economy along with the new rules in order to monitor the latest trends in this sector. Platforms had to ensure they complied with the P2B Regulation before it started to apply on 12th July 2020.

The P2BR is part of the legislative measures promoted by the EC for the Digital Single Market strategy. The proposal is the first legislative initiative in the field of platforms. It focuses only on a specific type of platform, namely, those offering services or products to the same users of their business clients. The P2BR foresees for them a list of measures ensuring transparency and fairness. In doing so, the EC aims to temper the natural asymmetries that characterise the relationship between platforms and their suppliers, establishing a fair and trustworthy innovation-driven ecosystem.

The EU Platform to Business Regulation (P2BR or P2B Regulation) is **a crucially important law covering B2C (business to consumer) platforms and search engines**. The P2BR requires platforms to **overhaul their Terms and Conditions**, provide a statement of reasons whenever they **restrict, suspend, or terminate a business user's account**, and set up **internal complaint-handling and mediation processes**. Search engines must **provide transparent information** about how they rank corporate website users in search results.

The results for use case - relevant standards are as follows:

Area	SDOs Body	Standard	Description	Important for TRUSTS	Is it used in TRUSTS?	TRUSTS Technology	Geographical scope	Link to the standard
AML Regulations	AML	4th EU DIRECTIVE	AML EU Directive: the regulation contains directly applicable rules that financial institutions have to apply, for example, on customer due diligence to make sure that the rules against money laundering across the EU are consistent. Up until now, there have been five AML directives.	For the output and trials of UC1	YES	UC1 AML APPS	EU	https://eur-lex.europa.eu/eli/dir/2015/849/oj https://www.eba.europa.eu/regulation-and-policy/anti-money-laundering-and-e-money/rts-on-the-implementation-of-group-wide-aml/cft-policies-in-third-countries
Privacy and anonymisation	EU	Regulation (EU) 2016/679	Protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)	Provides requirements for privacy and data protection framework	YES	Data Marketplace	EU	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679

Privacy and anonymisation	EC	Directive 2002/58/EC "ePrivacy Directive"	Regulation of the European Parliament and the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC (Regulation on Privacy and Electronic Communications)	Provides requirements for privacy and data protection framework	YES	Data Marketplace	EU	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017PC0010&from=EN
Information management	EU	Regulation (EU) 2018/1807	Framework for the free flow of non-personal data in the European Union. This regulation aims to ensure the free flow of data other than personal data within the Union by laying down rules relating to data localisation requirements, the availability of data to competent authorities and the porting of data for professional users.	Provides requirements for privacy and data protection framework	YES	Data Marketplace	EU	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1807&from=EN
	EU	REGULATION (EU) 2019/1150	The purpose of this regulation is to contribute to the proper functioning of the internal market by	Provides requirements for privacy and data protection	YES	Data Marketplace	EU	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019

			laying down rules to ensure that business users of online intermediation services and corporate website users in relation to online search engines are granted appropriate transparency, fairness and effective redress possibilities.	framework				R1150&from=EN

Table 3. TRUSTS use case regulations.

4 Recommendations and Findings

This section provides information about the two workshops organised by TRUSTS, with standardisation bodies and organisations active in standardisation in the respective field. It explains the workshop planning and implementation process, describes the workshop outcomes and provides an overview of workshop findings and recommendations for further standardisation activities in the field.

4.1 Workshop 1

Workshop on Data Spaces and Semantic Interoperability[26], organised by TRUSTS as a full-day workshop on the 3rd of June 2022 in Vienna at the University of Economics Vienna, co-organised by the World Wide Web Consortium (W3C) and the International Data Space Association (IDSA).

4.1.1 Workshop planning and implementation

The planning of the workshop started in late 2021 and was intensified in Q1/2022 by the TRUSTS standardisation team. The workshop has been set up and planned in the form of a "usual W3C standardisation and recommendation event" together with the World Wide Web Consortium (W3C). This means that the workshop information has been promoted 3-4 months before the event in a broad way by all workshop organisers and committee members, that a public call for participation and position papers has been published, promoted and organised and that the Programme Committee (for information please see further below in this document) has discussed and selected relevant position papers for publishing and presentation, that the workshop was open and public for participation, and that W3C accessibility standards applied to the event.

As follows, we summarise the workshop information.

- All public workshop information can be accessed online at: https://www.trusts-data.eu/data-spaces-semantic-interoperability/.
- All position papers, presentations, and results can be accessed online at: https://www.trusts-data.eu/data-spaces-semantic-interoperability/workshop-report-pictures-slides/.

In addition to the invitation, a call for participation and promotion of cooperation has been organised and carried out with the Vienna Business Agency[27]. Two Vienna-based organisations have been invited to present and participate in the workshop thereby.

[26] https://www.trusts-data.eu/data-spaces-semantic-interoperability/

[27] https://viennabusinessagency.at/

Workshop Description and Announcement

Workshop: Data Spaces & Semantic Interoperability
Requirements, standards, certifications, tools, licenses and more

When: 03rd of June 2022, 09.00 – 4.30 pm CEST
Where: Vienna, Austria
Location: *University of Economics Vienna*

Workshop Description
The continuously increasing number of data spaces and data markets in Europe, as well as the related funding lines and regulations by the European Commission (for instance, the Data Governance Act and several programme lines in Horizon Europe and Digital Europe) regarding the topics of (secure) data sharing of industrial and personal related data as well as research data clearly shows the increasing need to discuss, specify and realise (semantic) data interoperability between such data spaces and beyond.

A discussion about (semantic data) interoperability for data spaces includes (i) data space use cases, (ii) requirements for interoperability, (iii) existing and new standards in the field and (iv) technical solutions in place and development, (v) working and proven tools & technologies, as well as (vi) legal issues and licenses, besides other topics.

The assumption is that the concept of a data space defined in IDSA and W3C's work on Linked data is complementary. IDSA is a big user of Linked data specifications and complements them with "connectors" to legacy systems. While W3C provides vocabularies like ODRL for constraints and provenance for data quality, an IDSA data space has a concrete instance of those vocabularies specifying what can be done in a data space, how data is shared, and which limitations and obligations apply.

This one-day workshop brings together researchers, decision-makers and practitioners in the field of the development and operation of European data spaces, data markets and other web-based data management systems that allow data sharing, trading and data collaboration to discuss requirements, standards, tools, licenses and more regarding (semantic data) interoperability in data spaces.

Targeted workshop participants are researchers, decision-makers, and practitioners working on the specification and implementation of data spaces in the field of industry, personal-related data, as well as research data, and open data.

The output document will summarise all the inputs and discussions about mainly (a) requirements for interoperability as well as (b) solution approaches for interoperability in data spaces, and thereby it will

identify existing gaps in the field and will be published freely available under an open license / under open access.

Programme Chair: Sebastian Steinbuß, CTO of the International Data Space Association

Workshop Organisers

- **TRUSTS** project, Trusted Secure Data Sharing Space, https://www.trusts-data.eu/
- **ERCIM** - the European Research Consortium for Informatics and Mathematics, https://www.ercim.eu/
- **IDSA** - International Data Space Association, https://internationaldataspaces.org/
- **Fraunhofer FIT**, https://www.fit.fraunhofer.de/
- **Semantic Web Company**, https://www.semantic-web.com
- **DIO**, https://www.dataintelligence.at/
- **W3C**, World Wide Web Consortium, https://www.w3.org/
- **BDVA**, Big Data Value Association, https://www.bdva.eu/

Agenda, Workshop: Interoperability in Data Spaces, 3rd June 2022, Vienna

Time	Session	Notes
09.00 - 09.15am CEST	**Welcome and Introduction**	Programme Chair, Organisers
09.15 - 10.15am CEST	**Panel Discussion introducing the topic** 1. IDSA & Gaia-X (Christoph Lange) - 10' 2. Overview of W3C activities (Pierre-Antoine) - 10' 3. 3rd speaker on (semantic) interoperability - 10' 4. Panel with all speakers - 30'	Moderation: Sebastian Steinbuss
10.15 - 11.15am CEST	**Lightning Talks I - Position Papers - 10' each** **Use Cases & Solutions: Interoperability in Data Spaces** 1. Wouter v d Berg: The Vocabulary Hub to configure data space connectors - 10' 2. Natascha Totzler, Nexyo: local community talk - 10' 3. Martin Huschka: The AluTrace Use Case: Harnessing Lightweight Design Potentials via the Materials Data Space® - 10' 4. Anna Fensel: Data sharing in smashHit: Making consent and contracts interpretable with knowledge graphs - 10' 5. Stelios Piperidis: Data search and discovery in language data spaces: challenges and solutions - 10' 6. Florina Piroi, Artificial Researcher: local community talk - 10'	Lightning Talks that provide input for the break out sessions
11.15 - 11.30am CEST	**Short Break**	
11.30 - 12.30pm CEST	**Lightning Talks II - Position Papers - 10' each** **Requirements & Solutions: Interoperability in Data Spaces** 1. Gonzalo Gil: Semantic Interoperability, a Key Enabler for Good Quality Distributed Usage Control - 10'	Lightning Talks that provide input for the break out sessions

	2. Vladimir Alexiev: Data Spaces vs Knowledge Graphs - 10' 3. Achille Zappa: Design Principles supporting the Creation of Tools for the Interoperability of EU Digital Data Spaces - 10' 4. Jörg Langkau: Requirements for TRUST semantic interoperability - 10' 5. Phil Archer: Start with an identifier - 10'	
12.30 - 13.30pm CEST	*Lunch Break*	
13.30 - 15.00pm CEST	**Break Out Sessions / World Cafe: Interoperability in Data Spaces?!** ● Use Cases & Requirements in (semantic data) Interoperability. ● Existing solutions in Interoperability (vocabularies, tools, vocabulary clearing house …) ● Legal & Policies (IPR, constraint management, rights modelling, contracts…) ● Data Trading & Payment Solutions (purpose modelling, value …) ● Secure Data Sharing (Security UX in Data Spaces, certifications, standards, industrial, PII…)	*Remark*: every breakout session needs a facilitator from the organising team! Clear questions & topics to be discussed in the breakout sessions are to be specified by the organising team
14.30 - 16.00pm CEST	**Moderated discussion: Outcome of the Breakout Sessions, discussion of outcomes, and summary.**	1 Moderator, facilitators and 1 participant per break out session who wants to present the breakout session outcomes.
16.00 - 16.30pm CEST	**Summary of the workshop, outlook on next steps, fare well**	Programme Chair, Organisers

Table 4. Workshop 1 agenda.

In the evening, a get-together of workshop participants will be organised in a "Heurigen Location" in Vienna, covering costs by participants. Participants have to register for this evening's get-together to allow for proper planning.

Workshop Call for Participation - Position Papers

We are pleased to call for participation in a Workshop:

Data Spaces & Semantic Interoperability
June 03 2022, Vienna, Austria
https://www.trusts-data.eu/data-spaces-semantic-interoperability/

To address the topics of interoperability in data spaces and in particular (i) Use Cases in data spaces (ii) Requirements to interoperability and (iii) solution approaches to enable (semantic data) interoperability. While the web of data is an unconstrained space, data spaces are a more regulated vision for the web of data. Actors coming to a data space adhere to a certain concept of data sharing with rules and constraints. Hence the increased need to express options in interoperable ways.

All submissions must have a strong focus on real world applications beyond the prototypical status and demonstrate the power of interoperability in data spaces!

We ask for position papers in the listed and described topics, that can be presented at the workshop as 10-minute lightning talks. Described with (i) a title, (ii) a short description, (iii) the name, the role, and the affiliation of the authors as well as of the speaker(s) at the workshop. In total: 5 pages max. (A4, font size 11, in PDF format).

The following topics of discussion are expected:

- Use cases and their requirements on semantic interoperability.
- Existing solutions for interoperability such as
  - Vocabularies for data spaces
  - Tools for vocabularies and ontologies
  - Clearinghouse tools for vocabularies and ontologies
- Technically expressing constraints in a data space
  - use limitations & policy.
  - legal constraints and rights modelling
  - IPR
  - Smart contracts
- Data trading & payment solutions in data spaces
  - purpose modelling
  - value calculation

- Secure Data Sharing
  - Security
  - UX in Data Spaces
  - Certification
  - Data quality standards
  - Industrial standards
  - Data protection constraints

The Position Papers will be published on the workshop's website. If the number of Position Papers exceeds the availability of slots for presentation, a programme committee will select the papers that will be presented.

Plus: provision of URLs to the topic (if applicable), and the bio(s) of the speaker(s).

Timeline

Submission opens	March 14, 2022
Submission Deadline	April 24, 2022 (17.00 pm, Vienna time)
Notification of Acceptance	May 06, 2022 (17.00 pm, Vienna time)
Presentation Ready	May 27, 2022 (17.00 pm, Vienna time)

Workshop Programme Committee

Chair

Sebastian Steinbuss, CTO of International Data Space Association (IDSA)

Members (in alphabetic order)

- Vladimir Alexiev, Chief Data Architect at Ontotext AD
- Phil Archer, GS1, Director Web Solutions
- Sören Auer, Director TIB; Professor for Data Science & Digital Libraries at Leibniz University of Hannover
- Victor de Boer, Vrije Universiteit Amsterdam (VU), Assistant Professor at the User-Centric Data Science group at the Computer Science department
- David Bowden, Principal Research Scientist at EMC
- Silvia Castellvi, IDSA, Stakeholders Engagement Senior Consultant
- Pierre-Antoine Champin, W3C, Research Project Manager
- Oscar Corcho, Universidad Politécnica de Madrid, Professor at Ontology Engineering Group
- Edward Curry, Professor Data Science, NUI Galway | Director, Insight SFI Research Centre for Data Analytics | Director, Data Science Institute | VP, Big Data Value Association (BDVA)
- Mark Dietrich, CTO GaiaX - EGI
- Anna Fensel, Associate Professor at Wageningen University & Research; Associate Professor at University of Innsbruck
- Erwin Folmers, Kadaster Netherlands, Lead Data Science Team; Docent, PLD | Universiteit Twente
- Ahmad Hemid, Fraunhofer FIT, Data Engineer and Assistant Researcher
- Fabien Gandon, Head Wimmics Lab (Inria, UCA, CNRS, I3S); Vice Head of Science Inria Sophia, W3C rep. Inria; DSTI professor; Director Qwant-Inria Lab
- Stefan Gindl, Research Studios Austria (RSA), Senior Data Scientist/Senior Researcher
- Martin Kaltenboeck, Semantic Web Company, Co-Founder & CFO
- Petr Knoth, Open University, Senior Research Fellow in Text and Data Mining; Founder & Head of CORE
- Christoph Lange-Bever, Fraunhofer FIT, Head of Data Science and Artificial Intelligence department
- Andreas Müller, Schaeffler AG, Expert Knowledge Engineering / Data Architect
- Axel Polleres, University of Economics Vienna, Head of Institute at WU (Vienna University of Economics and Business)
- Felix Sasaki, Chief Expert for Knowledge Graph and Semantic Technology to the AI Unit at SAP
- Natalia Simon, IDSA, Project & Community Manager
- Ruben Verborgh, Professor of Decentralised Web technology, Ghent University

- Ray Walshe, Data Science Foundation International, Executive Director
- Rigo Wenning, ERCIM, Legal Counsel
- Josiane Xavier Parreira, Siemens AG, Senior Research Scientist

4.1.2 Workshop outcomes

In total, 65 people registered to the workshop whereby 40 participants showed up on the 3rd June 2022 at the venue University of Economics, Vienna.

One concrete outcome is the position papers that have been presented at the workshop and that have been published on the workshop website; see the list as follows:

- The "AluTrace" Use Case: Harnessing Lightweight Design Potentials via the Materials Data Space®
- Semantic approaches for facilitating interoperability between data-driven sources – A case study.
- Semantic Interoperability, a Key Enabler for Good Quality Usage Control
- The Vocabulary Hub to configure data space connectors.
- Data search and discovery in language data spaces: challenges and solutions
- Data sharing in smashHit: Making consent and contracts interpretable with knowledge graphs.
- Data Spaces vs Knowledge Graphs
- Do Track – A Do Not Track Use Case
- Design Principles supporting the Creation of Tools for the Interoperability of European Digital Data Spaces and Marketplaces
- Requirements for TRUST semantic interoperability
- Start with an identifier.

See all details and the papers here: https://www.trusts-data.eu/data-spaces-semantic-interoperability/workshop-report-pictures-slides/

Furthermore, the Breakout Sessions / World Cafe: Interoperability in Data Spaces, taking place at the workshop in the afternoon, provided lots of space for brainstorming, discussions and specifications of gaps on-site at the workshops. The following 5 breakout sessions have been carried out:

- Use Cases & Requirements in (semantic data) Interoperability.
- Existing solutions in Interoperability (vocabularies, tools, vocabulary clearing house …)
- Legal & Policies (IPR, constraint management, rights modelling, contracts…)
- Data Trading & Payment Solutions (purpose modelling, value …)
- Secure Data Sharing (Security UX in Data Spaces, certifications, standards, industrial, PII…)

Figure 4. Pictures of the workshop in Vienna.

4.1.3 Recommendations and findings

The main findings and recommendations of this workshop can be summarised as follows:

The most important identified gaps in Data Space interoperability are:

- Interoperability is often available on the metadata level only but not on the data level.
- No industry-specific controlled vocabularies & Knowledge Graphs exist.
- Resources are not available in languages other than English.
- Insufficient data usage control mechanisms are in place (right-, value-, purpose modelling):
- The connection between the physical and digital world is still missing.

As final conclusions of the workshop we can highlight that the harmonization of data, and the metadata, coming from different sources is a critical and key element to address in the data space interoperability standardisation. In the las decade we have seen the generation of data grow exponentially, this data is coming from different regions, or applications generated with open data, by industry, personal data or for research amongst others. The data generated has different types, formats, licenses and use different metadata or schemas, so the standardisation of methodologies or mechanism to make data interoperable between countries, industries and applications becomes crucial.

During this workshop we agreed on the importance of semantic interoperability according to common reference and interoperability framework for data spaces development. The participants to the workshop settled that vocabularies enable standardized data exchange in data ecosystems, and they supported the need for tooling to support SDOs and end users to design, publish, share and maintain those vocabularies. Furthermore, the use of “shared” vocabularies for the documentation of resources is a necessary step towards interoperability.

For this purpose, certain metadata vocabularies such as DC, DCAT, schema.org, DataCite have become more or less de facto standard, but still it is needed more fine-grained documentation and more detailed requirement to achieve machine actionability.

One important aspect of secure data sharing is the availability of good quality agreed policies when the parties negotiate the conditions for sharing data. In the data ecosystems where data providers and consumers may use their own data models to represent policies, the use of ontologies or controlled vocabularies for data usage control and agree policies can help solving the semantic interoperability challenge.

Based on the results of the workshop in June 2022, the second workshop at the European Big Data Value Forum 2022 (EBDVF 2023)[28] in Prague on 21-23 November 2023 has been planned and accomplished. For more information about this 2nd workshop, please see the following subsection.

In addition, the main organisers of the workshop and several workshop participants showed clear interest (and commitment) to organise one or more follow-up events and activities in the interoperability in Data Spaces field.

[28] https://european-big-data-value-forum.eu/

4.2 Workshop 2

European Big Data Value Forum is BDVA's flagship event, bringing the whole European data-driven AI research and innovation community together to share knowledge, collaborate and celebrate achievements. This year, the event took place in Prague, Czech Republic, on 21-23 November.

The European Big Data Value Forum (EBDVF) is an annual event organised by Big Data Value Association. The sessions look especially into the topics of trustworthy AI, data spaces and high-performance computing. They are discussed from the perspective of all European sectors, but focusing on smart cities, energy, healthcare, manufacturing and automotive industries, and also the impact on society at large.

This chapter reports on the TRUSTS workshop "**Towards Data Spaces Interoperability Workshop on standardisation co-organised by BD4NRG, TRUSTS and IDSA**" in Prague on 23th November 2022, during the EBDVF 2022 edition. There were 30 attendees and five presenters. The workshop contributed to the data spaces interoperability topic. The workshop content is useful for both participants and attendees participating in projects to present and review existing work on the field, as well as the relationship between TRUSTS members and other projects and initiatives that participate, and to identify requirements and potential gaps that standardisation may need to address.

The workshop on data space and data marketplaces interoperability topics was co-organised by TRUSTS – BD4NRG and IDSA.

The BD4NRG projects aim to establish new market opportunities in the energy sector by unlocking and exploiting the potential of big data to enable improved operation for all stakeholders in the energy value chain.

4.2.1 Workshop planning and implementation

One of the biggest challenges of data spaces is interoperability. As closed data ecosystems evolve into open and federated data ecosystems – better said: data spaces – one thing is essential: interoperability. Data spaces require data interoperability as well as metadata for data exchange and sharing. Thus, a harmonised vocabulary is needed. This enables a common understanding of the data and its meaning. And for participants in one data space to operate in other data spaces, unique digital identities are required.
They ensure that participants can be identified and authenticated. Several initiatives and projects are working to address these challenges, helping to standardise data spaces and make them.
To prepare for the workshop, we invited different experts to form the project and from data space initiatives such as DSBA, DSSC and BDVA and the i3 Market project that already participated in the first workshop.
The final agenda and speakers are indicated in the figure below:

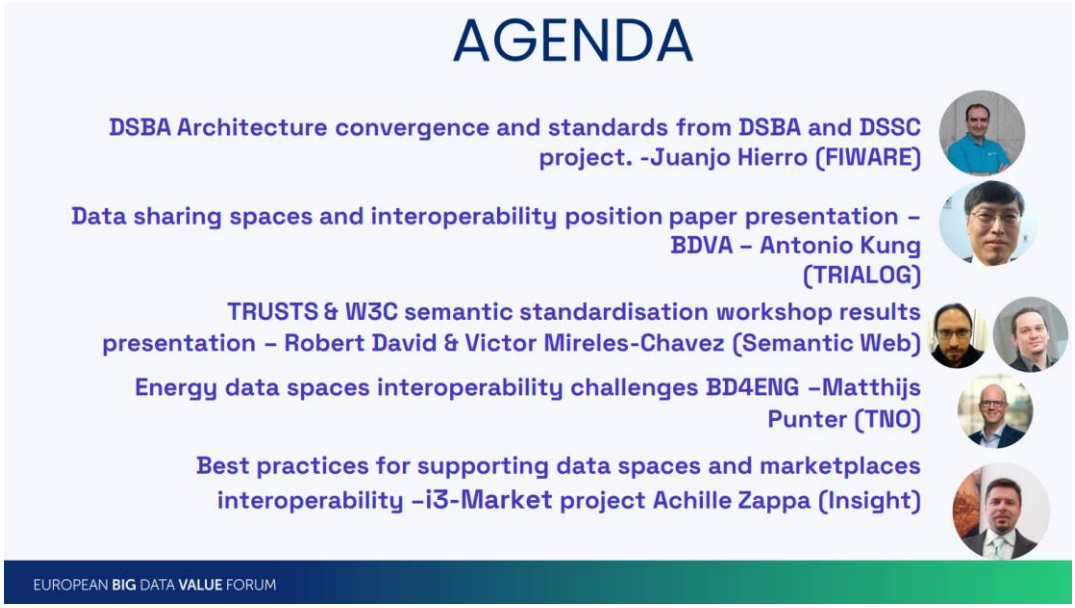

Figure 5. Workshop "Towards Data Spaces Interoperability Workshop on *standardisation co-organised by* BD4NRG, TRUSTS and IDSA" agenda.

4.2.2 Workshop outcome

DSBA Architecture convergence and standards from DSBA and DSSC project.

Juanjo Hierro (FIWARE)

Juanjo Hierro presents the activities developed by the technical convergence discussion document elaborated by the CTOs of DSBA to work towards defining a common reference technology framework. Technology convergence aims to achieve interoperability and portability of solutions across data spaces by harmonising technology components and other elements.

The technical convergence is guided by an implementation-driven plan around the evolutionary version of a Minimum Viable Framework (MVF) in four parallel workstreams:

- Workstream 1: Incorporation of Decentralised Identifiers (DIDs) and Verifiable Credentials / Presentations (VC/VPs) in the IAM framework, Trust Anchor services aligned with Gaia-X
- Workstream 2: Incorporating IDS Connector functions and support to ODRL for access/usage control policies.
- Workstream 3: Shared Catalogue and Federated Marketplace services based on TM Forum standards and aligned with Gaia-X and IDS RAM specifications.
- Workstream 4: Incorporation of additional IDS architectural elements for usage control

It is proposed to extend the interoperability mechanisms from IDS Reference Architecture Model (IDS-RAM), the IDS Infomodel and the Vocabulary Hub, with NGSILD API and the smart data models for actual data exchange.

To conclude, Juanjo explained that the Discussion Paper would be updated, and creating a new version based on the results of the Workstreams and the Data Space Support Center project may contribute to this work. Other activities to be developed are the (1) Integration of IDS Connectors, (2) Marketplaces: The description of how specific IDS and Gaia-X concepts will be supported with an architecture based on TM Forum recommendations and (3) create a big picture explaining the relation of the 4 DSBA partners.

Data sharing spaces and interoperability position paper

Antonio Kung – TRIALOG

Antonio Kung explains during his presentation that data spaces need to be a collaborative work from different **stakeholders** in the agriculture, healthcare, energy and manufacturing sectors; data **spaces initiatives** such as the DSBA, Gaia-X, FIWARE and IDSA **support actions from EC** such as DSSC, Bridge, Agridataspace, European Health Data Space, Open DI and StandICT and **communities** around AIOTI, BDVA, Eclipse, Gaia-X, FIWARE and IDSA in close collaboration with **Standardisation Bodies** such as ISO, IEC, ITU, ETSI and CEN CENELEC.

During 2021-2022 different position papers have been published and will support the contribution to standardisation activities in the field of (1) Digital platforms, (2) data spaces, (3) digital wins standards of the standardisation bodies: ISO, IEC and ITU during the following period 2022 -2025. These position papers are:

- Design principles for data spaces (April 2021) contribute to data spaces by defining the soft infrastructure and conceptualising twelve building blocks.
- Guidance for integrating IoT and Edge Computing in Data Spaces (September 2022). This paper provides three recommendations for standardisation:
  - To agree on data space principles.
  - Data space standards following an architecture of standard based on (1) use cases applications needed, (2) the data spaces concepts that enable specification of processes, architectures, interoperability and systems, (3) data spaces architecture and interoperability standards, (4) data space system standards provide means to construct and operate systems of systems (ecosystems).
  - To integrate IoT, Edge and digital twin concerns in data space standards.
- Reference architectures and interoperability in digital platforms (September 2022). The first recommendation is to agree on standardise a cross-domain convergence framework, and the second recommendation is to coordinate and standardise associated building blocks in the design of data spaces.
- Data Sharing Spaces and Interoperability (November 2022), the proposed recommendations are related to:
  - Policy level: Promotion of data space standards; see the picture below for an example of how to promote it and create synergy with other position papers.
  - Technical and engineering level: (1) Interoperability mapping (where - why) (2) Interoperability construction tools (how) (3) Inventory of metadata

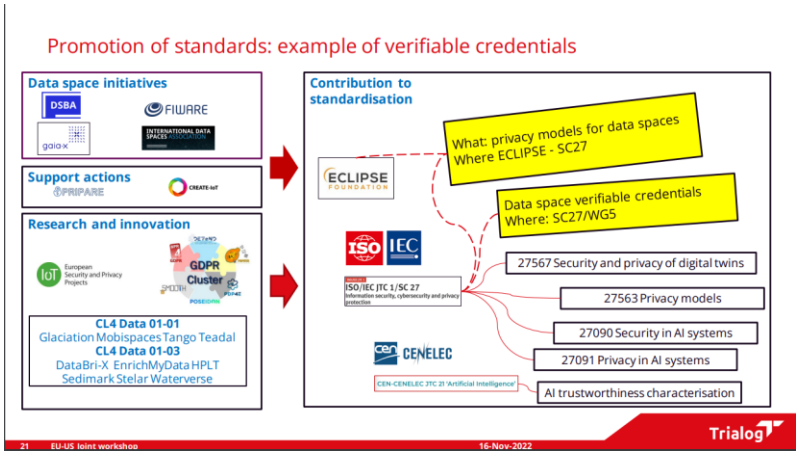

Figure 5. Example of promotion of standards

TRUSTS & W3C semantic standardisation workshop results presentation

Robert David & Victor Mireles-Chavez - Semantic Web

Robert David presents Knowledge Graph for Interoperability in the TRUSTS project: (1) It provides controlled vocabularies/code lists for all metadata, (2) enables entity linking for metadata (schema) mapping, (3) allows enrichment of metadata by analysing metadata and data, and (4) contextualises data, services, organisations, users and their interactions.

The TRUSTS Knowledge Graph is based on IDSA Information Model and DMA information model, several code lists such as ISO language, DCAT themes, NACE and others, taxonomies such as EuroVoc[29] and domain-specific vocabularies and established standards for metadata and data management.

Robert presents the TRUSTS W3C workshop on "Identifying and Specifying Gaps regarding Interoperability in Data Spaces". This workshop brought together researchers, decision-makers and practitioners to discuss requirements, standards, tools, and licenses for semantic interoperability in data spaces. The workshop contributed to standardisation by identifying the following challenges in Interoperability:

1. Ontologies for detailed data description
2. A repertoire of industry–specific vocabulary
3. Incentives for collaboration among dataspaces/marketplaces
4. Refined data usage control mechanisms (purpose, right, value)
5. The connection between the physical and digital worlds

[29] https://eur-lex.europa.eu/browse/eurovoc.html?locale=es

Energy data spaces interoperability challenges BD4ENG.

Matthijs Punter -TNO

Matthijs explains that interoperability within a data space requires participants to understand each other. It also demonstrates that according to the IDS Reference Architecture Model (IDS-RAM), data space participants need to use a common language whose responsibility lies with an intermediary role called a **vocabulary provider** (see image below).

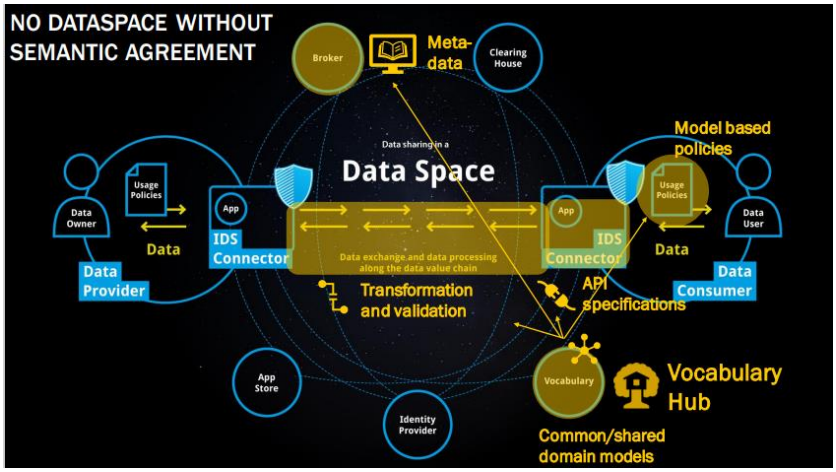

Figure 6. Data spaces and the vocabulary Hub *Source: TNO*

According to a recent Open DEI publication, the design and implementation of a data space comprise several functional building blocks. One of the categories describing those building blocks is 'interoperability', including data exchange APIs, data representation formats and data provenance and traceability. TNO, with the IDSA community, is elaborating on the Vocabulary Hub functionality contributing, based on TNO's implementation of a vocabulary hub called Semantic Treehouse. It is an online community platform for data models and vocabularies and gives vocabulary providers the tools they need to facilitate semantic interoperability in their data space.

Finally, Matthias explained the data space components of semantic interoperability that are developed or implemented in BD4NRG and ENERSHARE projects and under the initiatives: NLAIC and IDSA:

- Vocabulary Hub: registry service providing facilities for publishing, editing, browsing and maintaining vocabularies and related documentation.
- Transformation Engine: service that provides semantic transformation/conversion between data formats.
- Dataspace Connector configuration: service to configure the semantic interoperability of dataspace connector implementations.
- Semantic validation and certification: validation service to determine if implementations comply with the specifications.

Conclusions from the presentation about contributing to standardisation:

- There are reference implementations on how SDOs enable standardised data exchange in business communities using vocabularies.
- Raise the need for tooling to support SDOs and end users to design, publish, share, and maintain those vocabularies.

Best practices for supporting data spaces and marketplaces interoperability- i3-Market project

Achille Zappa -Insight

Achille explained how the i3Market project contributes to semantic interoperability. The i3Market semantic model integrates different vocabularies and taxonomies concerning Marketplaces Operation and Management, formalises the state of current marketplaces by using best practices and standards and provides vocabularies and ontologies for collecting, accessing, storing, utilise and selling data. Furthermore, the i3Market project has developed and implemented dedicated components for Semantic Engine System, a metadata framework and semantic vocabulary management.

Also, he explained the i3Market data offerings description (W3C DCAT), the identification management (IDM) and self-sovereign identity based on W3C Distributed identifier (DID) and Verifiable Credentials (VC) model and the smart contracts for data sharing agreements.

Finally, Achille explained the i3Market standardisation activities:

- **Use of standards** such as JSON: API, JsonLD, W3C DID, VC and OIDC OpenID (Open ID Connect)
- **Extending and promoting semantic interoperability** ICT standardisation: DCAT extensions to MarketPlaces, payment and smart Contracts, W3C Semantic Web for Metadata Distributed Storage and Open APIs for data exchange across different marketplaces.

4.2.3 Recommendations and findings

In this workshop, we stipulated the importance of semantic interoperability according to common reference and interoperability frameworks. The proposed recommendations for data spaces and interoperability standardisation are:

- Interoperability mapping (where & why)
- Interoperability construction tools (how)
- Inventory of metadata
- Promote data spaces standards creation following an architecture based on:
  - Use cases applications needed.
  - Data spaces concepts for process specifications.
  - Data spaces architecture standards.
  - Interoperability standards.
  - Data spaces systems standards.
- To agree on data spaces principles.

5 Conclusion

The desk research carried out by the TRUSTS team showed that there are clear requirements regarding standardisation in Data Spaces and data sharing activities. The main areas identified here are (i) interoperability, (ii) privacy-preserving technologies and (iii) the use case specific requirements and standards. A high number of existing standards are available for the three mentioned areas by different standardisation bodies, like W3C, ISO, IDSA or GAIA-X. These standards are already in use or could be used in Data Spaces, and TRUSTS makes use of several of them already.

Summarising the standardisation activities in the TRUSTS project, mainly centred around the two workshops:

a) **Workshop on Data Spaces and Semantic Interoperability**, organised by TRUSTS as a full-day workshop on the 3rd of June 2022 in Vienna at the University of Economics Vienna, co-organised by the World Wide Web Consortium (W3C) and the International Data Space Association (IDSA), and

b) **Workshop: Towards Data Spaces Interoperability Workshop on standardisation co-organised by BD4NRG, TRUSTS and IDSA**, taking place on 23rd November 2023 as a one hour session in the course of the European Big Data Value Forum 2023 (EBDVF2023).

The goal of these activities was to (i) identify relevant standards in the field of data spaces and secure, trustful data sharing - in TRUSTS, together with experts and data space operators and implementers, as well together with standardisation bodies and organisations working in standards and recommendations in the field - (ii) identify gaps in existing standards or even missing standards that are required, and (iii) to specify recommendations for existing standards or needed standards or concrete action items in the field of data spaces and data sharing.

The main gaps identified and recommendations for actions are as follows:

- Interoperability exists or is discussed often on metadata level ONLY, but also the data should be taken into account to reach real data interoperability (and thereby its benefits as lower costs for data integration etc.).
- No industry-specific controlled vocabularies & Knowledge Graphs are in place.
- And if such resources are in place, these are not available in languages other than English.
- Insufficient data usage control mechanisms are specified as well as implemented, mainly: right-, value-, and purpose modelling.
- The connection between the physical and digital world is still missing.

The open challenges are:

- Develop and, if possible, publish Ontologies for detailed data description
- Develop and make use of a repertoire of industry-specific vocabularies (if possible, in several languages).
- Develop, specify and provide incentives for collaboration among dataspaces/marketplaces.
- Refine comprehensive data usage control mechanisms for purpose, right, value, and implement such.
- Work on the connection between the physical and digital worlds.

Concluding we can say that the las decade the data production had an exponential growth, we realise of the importance and impact that data have in the economy, industry and society. Applications based on technologies such as IoT, AI, Big Data and digital twins needs data coming from different sources and different types (Open, industry, research) build on top of data spaces developed under common references and interoperable frameworks.

As of the strong interest of many stakeholders - inside and outside of TRUSTS - in these activities carried out, as well as in the related results, the TRUSTS team is convinced that the work done is of use for the community and stakeholders and beyond in the field of data spaces and data sharing and will be continued.

The standardisation bodies that work on semantic interoperability has a huge challenge ahead, but as we have seen in the workshops the rara a large number of high qualified professionals and researchers willing to work on it.