The European IoT Hub

Growing a sustainable and comprehensive ecosystem
for Next Generation Internet of Things

D3.7: Recommendations on Research Priorities and Innovation Strategies to Standardisation I

Work package	WP 3
Task	Task 3.3
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Abstract

Deliverable D3.7 of EU-IoT relates with the work under development in WP3 – Catalyst, Task 3.3, focused on strengthening the bridge between IoT research under development in ICT-56, and Standards Development Organisations. The report provides a mapping of relevant pre-normative activities and Standardisation bodies, including relevant documentation and contact points, as well as its mapping based on the EU-IoT Scope Areas, and IoT European competitiveness domains. D3.6 integrates an intermediate version (version I) of recommendations on research priorities and innovation strategies for Standardisation, which will be continuously updated during the project lifetime, and published in D3.8, month 30 of EU-IoT.

Keywords: Standardisation, IoT and Edge research, open-source ecosystem.

Document Revision History

Version	Date	Description of change	List of contributor(s)
V0.1	14.07.2021	Table of contents	Rute C. Sofia
V0.2	15.09.2021	Full deliverable with input from projects and partners	Rute C. Sofia
V0.3	17.09.2021	Release to EU-IoT reviewers	Rute C. Sofia
V0.4	21.09.2021	Review	AU, Emilie Jakobsen
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V0.6	29.09.2021	Integration of comments and review	FOR, Rute C. Sofia

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Nature of the deliverable:	R	
Dissemination Level		
PU	Public, fully open, e.g. web	√
CI	Classified, information as referred to in Commission Decision 2001/844/EC	
CO	Confidential to EU-IoT project and Commission Services	

EXECUTIVE SUMMARY

D3.7 "Recommendations on research priorities and innovation strategies to standardisation Version 1" is focused on providing: i) an initial mapping of relevant standardisation, pre-standardisation/pre-normative initiatives to the EU-IoT scope areas; ii) a summary of standardisation tools under development and standardisation events organised by the EU-IoT consortium during the reporting period; iii) an overview on the current standardisation efforts of ongoing H2020 ICT-56 projects; iv) a summary of key research areas to the supported projects; and v) deriving research and innovation recommendations towards standardisation.

D3.7 comprises this report and the standardisation mapping tool available via the EU-IoT Website[1], for which information is also provided in Annex I.

D3.7 corresponds to an intermediate version report focused on Standardisation research and innovation recommendations. The final and complementary report to D3.7 is D3.8, to be publicly released in month 30 (May 2023) of the project.

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[1] https://www.ngiot.eu/archive-standardisation-bodies/

TABLE OF CONTENTS

ACRONYMS

Acronym	Description
AB	Advisory Board
AI	Artificial Intelligence
AR	Augmented Reality
BDVA	European Big Data Value Strategic Research Innovation Agenda
D2D	Device to Device
EC	European Commission
ETSI	European Telecommunications Standards Institute
H2020	Horizon 2020
IoT	Internet of Things
IP	Internet Protocol
MEC	Mobile Edge Computing
ML	Machine Learning
NGIOT	Next Generation IoT
NGIoT	Next Generation Internet of Things
NIST	National Institute of Standards and Technology
RAN	Radio Access Networks
RAT	Radio Access Technology
RIA	Research and Innovation Action
RNC	Radio Network Controller
SDN	Software Defined Networking
SDO	Standards Development Organisation
SDO	Standards and Development Organization
SDR	Software Defined Radio
TSN	Time Sensitive Networking
VR	Virtual Reality
WoT	Web of Things

LIST OF FIGURES

LIST OF TABLES

1   INTRODUCTION

The EU-IoT standardisation activities described in this deliverable have been developed under the umbrella of **Work Package 3 (WP3) – Catalyst**, Task 3.3. WP3 has the overall main goal of assisting the acceleration of the *Next Generation IoT (NGIoT)* initiative by engaging all relevant stakeholders in growing and strengthening a large-embracing ecosystem, while creating synergies among them. The smart goals of WP3 have been defined as follows:

1. **Broader IoT Ecosystem - open platform for a sustainable human-centric IoT community,** to grow the NGIoT ecosystem and assist in partnership creation and stakeholders networking, via actions that facilitate and promote the direct engagement of relevant stakeholders, reaching out to new players and across different research and innovation communities.

2. **Transfer and know-how exchange on open-source, pre-normative and normative activities**, to ensure development and adoption of innovative human-centric IoT concepts and solutions, fostering effective technology transfer and know-how exchange, while mapping NGIoT efforts into open-source, pre-Standardisation and Standardisation activities.

3. **Engagement**, to assist community building, ecosystem shaping, acceleration to contribute to the creation of a living and sustainable hub for all IoT initiatives in Europe.

4. **Foster early adoption of products and innovative concepts**, by providing concepts to stakeholders.

The standardisation activities described in this deliverable relate with goals 2 and 4, and the activities defined for the first year of the EU-IoT WP3 were:

- To develop a methodology to interact with IoT and Edge computing-oriented SDOs, pre-Standardisation (pre-normative) and other normative entities, based on i) the current needs and actions of the supported *Research and Innovation Actions (RIAs)*; ii) interaction with other CSAs and additional entities; iii) feedback from the EU-IoT pool of experts. *Refer to Chapter 2*.

- To create an initial database of *Standardisation Development Organisations (SDOs)* and discuss potential interactions with RIAs. *Refer to Chapter 3*.

- To debate on an initial set of research priorities, discussion which will be further addressed together with the RIAs and relevant SDOs. *Refer to Chapter 4*.

- To develop events, white papers, and other tools within EU-IoT and with contributions from the broader NGIoT community, that could assist in igniting the discussion on relevant research priorities. *Refer to Annex I*.

1.1 Document Structure

The remainder document is organized as follows:

- **Chapter 2: SDO Collection and Mapping.** Describes the methodology proposed to collect, map, and to interact with SDOs, pre-Standardisation entities, and alliances.

- **Chapter 3: Early Analysis of Projects' Research Priorities Towards Standardisation**. Provides a summary of key research areas derived from interviews to the supported projects.

- **Chapter 4: Recommendations**. Provides a list of research and innovation recommendations towards standardisation, derived from the meetings, interviews and

studies developed during the reporting period, proposing next steps to take.

- **Chapter 5: Summary**. Concludes the deliverable.
- **Annex I**: List of EU-IoT Standardisation Material.
- **Annex II**: List of SDOs, Consortia and Alliances.

1.2 EU-IoT Scope Areas

The collecting, mapping and analysis work developed in the first year of EU-IoT had as basis the methodology that will be described in section 2, and the defined EU-IoT scope areas which are illustrated in Figure 1. These areas are therefore the conducting line for the work developed, but as shall be seen, the collection, mapping, and analysis developed considered other relevant aspects as well, e.g., European competitiveness domains (rf. to section 3):

- **Human/IoT interfaces**, relating to interfaces capable of integrating and adapting to human behaviour and human activities.
- **Far Edge**, relating to smart Edge functions reaching the end-user (also in end-user devices), and therefore supporting services beyond the reach of the operator. This implies the use of ML (e.g., federated learning) and the engineering of AI (TinyML) into embedded IoT devices, for instance.
- **Near Edge**, related to smart Edge functions, including context-awareness, within the access/core networking regions under the control of the operator.
- **Infrastructure**, related to the core networking region, and adaptation required to support end-to-end services in Industrial IoT environments (criticality, resilience) and consumer IoT environments (security, large-scale sensing).
- **Data spaces**, related to the data sharing and processing and to handling sovereignty across decentralized data spaces.
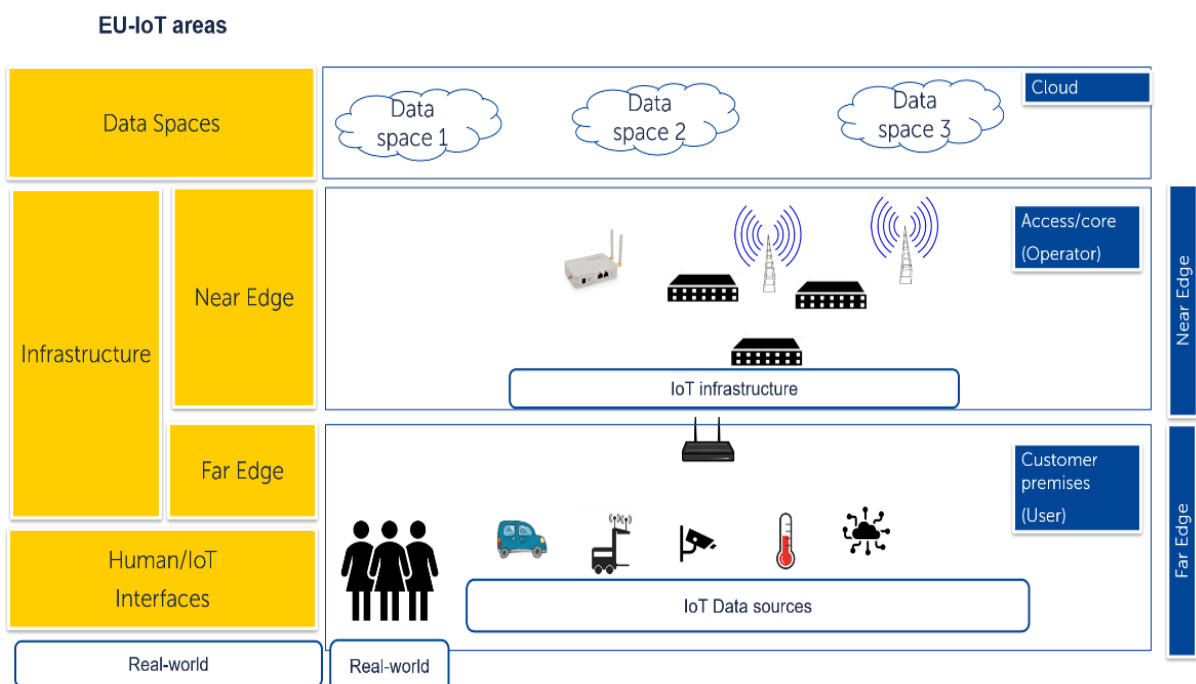

Figure 1: EU-IoT scope areas, end-to-end perspective.

2   SDO COLLECTION AND MAPPING
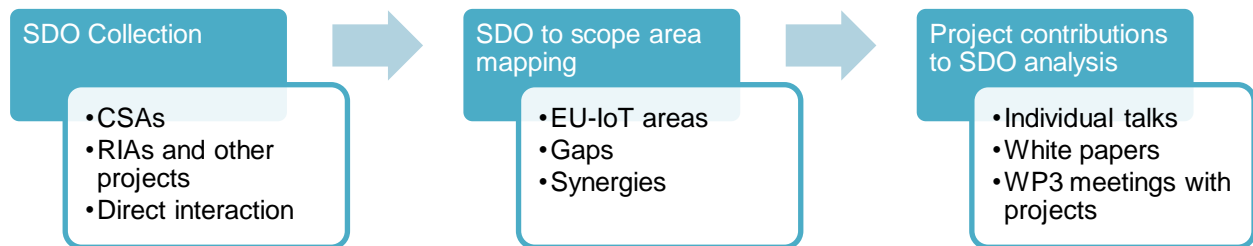
2.1   Methodology

Figure 2: SDO collection and mapping methodology.

Figure 2 provides a high-level illustration of the 3-phase methodology used during the first year, to derive a solid database of pre-normative and normative entities that are relevant to the IoT/Edge Research and Innovation (R&I) landscape.

Throughout this deliverable, we shall use the term SDO to refer to both normative and pre-normative entities, for the sake of simplification.

The first phase has been dedicated to the creation of a solid SDO database based on i) input provided by other coordination standardisation efforts, e.g., StandICT[2], Open DEI[3], AIOTI WG on Standardisation[4]; ii) input provided by the projects (NGIoT RIAs) via direct talks with standardisation contacts in each RIA; standardisation events organised in the context of WP3; iii) direct interaction with SDOs, in particular: AIOTI[5], BDVA[6], GAIA-X[7]. The full set of SDOs collected during the first 12 months of the project is provided in Figure 3 and in Annex II of this deliverable.

The SDO collection and mapping is a continuous process, which shall be regularly updated (approximately every 3 months) until the end of EU-IoT (May 2023).

The second phase – **SDO to EU-IoT scope area mapping** - has been dedicated to the mapping of the collected SDOs to the EU-IoT pre-defined scope-areas (rf. to section 1.2). This mapping currently reflects the following aspects: EU-IoT areas covered, and specific topics addressed; detection of gaps and possible synergies; detection of gaps and possible synergies; if required, establishment of specific "task-forces" (e.g., link towards GAIA-X; link towards 5G-PPP AI).

The third phase – **Analysis** - relates to the analysis of standardisation and pre-normative contributions by the ICT-56 projects, and with the mapping of such analysis to the EU-IoT scope areas, deriving recommendations from gaps detected. This third phase has been based on input directly collected from the different projects and based on meetings involving SDOs focused on discussing open-source solutions and intended standardisation contributions. For this purpose, in addition to meetings and individual interviews (rf. to Annex I), we have developed one white paper focused on debating a vision for smart, decentralised edges, and having as main goal to disseminate the projects' use-cases and expected standardisation contributions.

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[2] https://www.standict.eu/

[3] https://www.opendei.eu/

[4] https://aioti.eu/standardisation/

[5] https://aioti.eu/

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

[7] https://www.data-infrastructure.eu

Figure 3: Current set of SDOs, consortia and alliances collected.

2.2 Collected Data

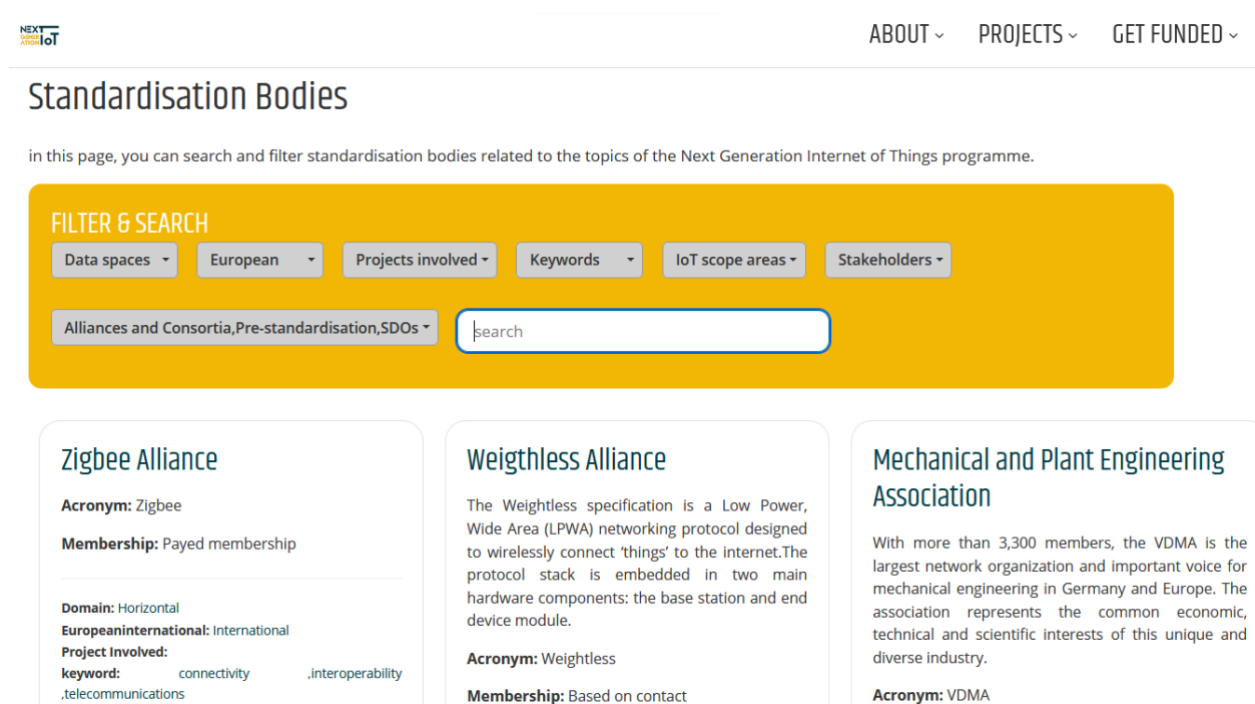Table 1 provides a description for the meta-data collected for each SDO, providing information for each field.

Table 1: Data collected for each SDO.

Field ID	Description
Acronym	Acronym of the entity
Name	Title of the entity
Scope	European, Regional, International
EU-IoT Areas	IoT interfaces; near Edge; far Edge; infrastructure; Data spaces (multiple choice). "All areas" has been used to identify the mapping across all areas.
Domains	European competitiveness domains, stemming from the European Commission definition of Industrial competitiveness clusters within Horizon Europe, in alignment with the UN's Sustainable Development Goals. "Horizontal" stands for all domains. Horizontal; Manufacturing; Energy, Healthcare and Well-being; Culture, creativity and inclusive society; Civil security for society; Information and Communications; Aeronautics and Space; Smart Cities; Food, Bioeconomy, Natural resources; Agriculture and fishing; Transportation and Storage; Publication, Administration and Defence; Education; Climate and Energy.
Stakeholders	EU-IoT identified stakeholder groups: Industry/SMEs; Government; Research; Policy makers; Academia.
Description	Public description of the entity
URL	Public URL
ICT-56 projects involved	Mapping of current project contributions to the SDO
Membership	Type of membership, e.g., paid, free, volunteer
Additional keywords	The definition of technological scope is based on the value-chain of Internet services, from an end-to-end perspective. **Examples** of additional keywords considered are: data analytics; data processing; telecommunications; 5G; 6G; cybersecurity; IoT; Edge; Sovereignty; trustworthiness; tactile Internet, SDN.

2.3   Online Tool

To assist in a stronger interaction with SDOs, the collected data has been integrated online in a searchable tool, on the EU-IoT Website via the URL **https://www.ngiot.eu/archive-Standardisation-bodies/**. The tool, illustrated in Figure 4, is searchable via different fields, e.g., European domain, EU-IoT scope area, stakeholder group, or even specific keywords.

The tool is expected to facilitate the promotion and contributions to SDOs, by facilitating the online search based on the fields described in section 2.2.

Figure 4: the EU-IoT online SDO Mapping Tool.

3   EARLY ANALYSIS OF PROJECTS' RESEARCH PRIORITIES TOWARDS STANDARDISATION

To further understand potential gaps, the analysis developed in this first year has been done based on input from the six NGIoT flagship projects (ICT-56 RIAs):

- ASSIST-IoT: Architecture for Scalable, Self-*, human-centric, Intelligent, Secure, and Tactile next generation IoT.
- VEDLIoT: VEDLIOT: Very Efficient Deep Learning in IoT.
- IntellIoT: Intelligent, Distributed, Human-centered and Trustworthy IoT Environments.
- IoT-NGIN : Next Generation IoT as part of Next Generation Internet.
- Ingenious : Next-GENeration IoT sOlutions for the Universal Supply chain.
- TERMINET: NexT GeneRation Smart InterconnectEd IoT.

These projects have started in either in October or November 2020 and therefore, the analysis of project priorities and contributions towards SDOs is initial. A final analysis shall be provided in D3.8 (May 2023) as well as via intermediate white papers expected to be released during the lifetime of EU-IoT.

3.1   Early Standardisation Directions

Based on input provided by each project, the starting point for expected contributions of each project to relevant SDOs is provided in *Table 2*, while expected pre-normative contributions are provided in Table 3. Overall, relevant normative contributions are expected to ETSI, W3C as well as 3GPP and IEEE (Region 8). Additional efforts regarding Standardisation contributions are being developed by the projects in the context of AIOTI, BDVA, 5GPPP and IETF:

- **ETSI**, SAREF, Ontologies Standards.
- **W3C**: WoT, multi-agent system.
- **ETSI**: MANO, M2M, STF601 (Usability with AI), MEC (GS MEC 003).
- **ISO**: TC42, Trusted Platform Module.
- **ITU-T**: mostly monitorization.
- **3GPP**: satellite integration in 5G, interoperability, IoT.
- **IEEE**: WGs focused on AI and Edge computing (IEEE SA), specially IEEEP2961, TSN.
- **IETF**: some contributions to existing standards (WG not yet identified).
- **RISC-V**: Open hardware focus: SPGA and accelerator development.

Pre-normative contributions are still in an initial state, but relate with relevant alliances: AIOTI, BDVA, 5GPP/5G IA:
- **AIOTI**: Contributions to existing white papers on use cases and semantics and about "Beyond 5G"and collaboration with Standardisation WG; Contributions within the Standardisation WG; Monitoring activities via associated partners.
- **BDVA**: members, monitoring.
- **5G PPP/5G IA**: interoperability, federated learning; monitoring, 5G TSN.

Table 2: Expected starting points for Standardisation contributions by projects supported in EU-IoT.

Project	SAREF	W3C	ETSI	ISO	ITU-T	3GPP	IEEE	IETF	RISC-V
ASSIST-IoT	Ontologies		Use cases on STF601, ENI, MANO		Monitoring SG-13, SG-16, SG-17, SG-20,	interoperability, IoT	WGs focused on AI and Edge computing (IEEE SA), specially IEEEP2961	Contributions to existing standards	
VEDLIoT									Open hardware focus: SPGA and accelerator development
IntellIoT		W3C WoT, multi-agent system		TC42			TSN		
IoT NGIN	Ontologies		MANO, and M2M			IoT	TSN		
Ingenious						Collaborating with 3GPP on release 17 and beyond for the use of satellite 5G communications in IoT			
TERMINET		W3C WoT	GS MEC 003	Trusted Platform Module					

Table 3: Contributions to pre-Standardisation and standards related associations/Fora.

Project	AIOTI	BDVA	5G PPP/5G IA
ASSIST-IoT	Contributions to existing white papers on use cases and semantics and about "Beyond 5G"and collaboration with Standardisation WG	Member, Monitoring	Interoperability, Federated Learning
VEDLIoT			
IntellIoT	Contributions within the Standardisation WG		Monitoring via partner liaison
IoT NGIN			
Ingenious			Expected contributions to the 5G TSN standard
TERMINET	Monitoring activities via associated partners		

3.2 Standardisation Contributions per EU-IoT Scope Area

Table 4 provides input on the initial contributions to the EU-IoT scope areas that are currently envisioned by the different projects.

In what concerns human/IoT interfaces, the interests of the projects rely on tactile Internet and AR/VR integration.
As for far Edge and near Edge topics, all projects are covering relevant aspects, in particular the integration of intelligence (ML) into hardware and software; decentralized learning and local decisions (far Edge) are also a concern.

As to infrastructure, the most common topics concerns integration with the 5G core and SDN/NFV orchestration aspects.

In data spaces topics, the common concern relates with semantic interoperability, involving the use of SAREF and WoT concepts. We further address recommendations on these aspects in section 4.

Table 4: Project contributions towards the scope areas of EU-IoT.

Project	Human/IoT interfaces	Far Edge	Near Edge	Infrastructure	Data Spaces
ASSIST-IoT	AR/VR, secure tactile support, novel smart wearable	Device/user Self-awareness, novel Far Edge gateway (ASSIST-IoT Far Edge node or Smart Device)	Intelligent IoT gateways, ASSIST-IoT Edge Node	5G core integration, SDN and NFV all along the network, Multi-link connection	Edge data space based on semantic orchestration
VEDLIoT	-	ML integrated into open hardware to allow the support of more complex functions on the Edge	ML integrated into open hardware to allow the support of more complex functions on the Edge	-	-
IntelIIoT	Tactile interface	Local AI decisions: distributed AI to assist learning from IoT data sources; offloading between near and Far edge	Intelligent offloading (e.g., due to energy consumption) between Near and Far Edge	5G core; TSN on the Edge	WoT interoperability integrated
IoT NGIN	Tactile internet and intelligent ambient monitoring	-	Device or edge side intelligence Supporting federated ML	5G, D2D / improvements to resource management, VFN based on MANO; integration of federated AI into networking nodes; TSN interconnection for real-time application support	SAREF ontologies for data modelling
Ingenious	Tactile and immersive interfaces	Neuromorphic computing	Integration of the developed solutions with MEC	5G core and VFN orchestration based on MANO; 5G TSN	Data virtualisation Layer to support the data exchange on highly heterogeneous data spaces interconnected via 5G
TERMINET	AR/VR, tactile IoT, smart wearable devices	SDN interfaces to provide a better integration to the infrastructure; new Edge node based on open hardware acceleration and ML software integration	SDN-enabled vMEC	Private 5G RAN, SDN infrastructure	Semantic and abstraction mechanisms, data visualization

Quantitatively (rf. to *Figure 5*), the envisioned standardisation contributions fit equally far Edge and human/IoT interfaces (25% of the total contributions); 20% of the contributions go towards near Edge features; 15% towards infrastructure and data spaces' features.
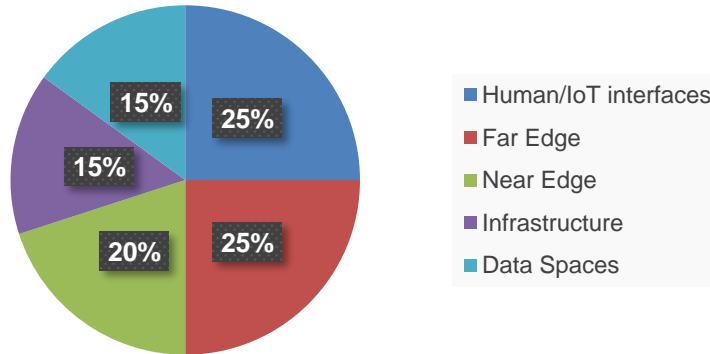
Figure 5: Quantitative perspective, NGIoT projects contributions towards standardisation.

3.3 Standardisation Contributions per Domain

In terms of domain applicability and expected use-cases or pilots per European competitiveness domain, a summary of the current contributions is depicted in *Figure 6*. Most contributions (23% of all pilots/use-cases provided by the projects) fall into Logistics and Manufacturing, followed by Transportation (15%) and Healthcare (11%). The domains with a lower number of contributions are Smart Cities (4%) and Home automation (4%).
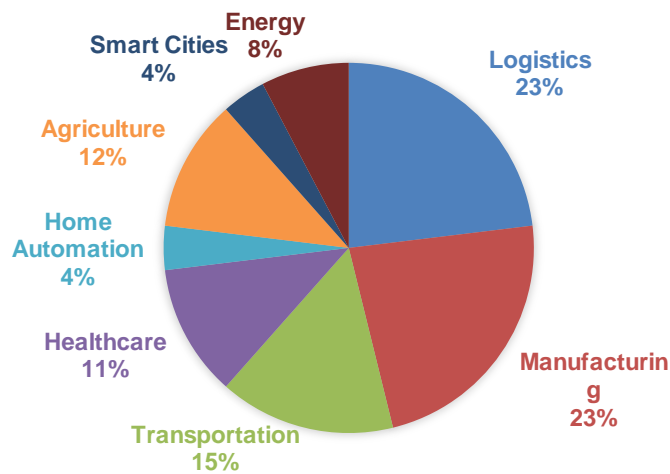
Figure 6: Envisioned project SDO contributions per domain.

4 RECOMMENDATIONS

This section provides recommendations concerning research priorities towards standardisation, and towards innovation strategies. The list of research priorities and innovation strategies have been collected via the different meetings and WP3 activities, listed in Annex I.

The recommendations and strategies described in this document are still in an early stage of development and will serve as basis for further discussion on research priorities and proposals for innovation strategies.

4.1 Current Research Priorities

Based on the collected information, we derive a set of research priorities per EU-IoT scope area, addressed in the next sub-sections.

4.1.1 IoT interfaces/tactile Internet

The key research directions discussed are:

- AR/VR, secure tactile support, novel smart wearable.
- Tactile interfaces are an active research priority by several projects and relevant across multiple domains [10].

However, specific contributions and concrete identification of SDOs are aspects still to be developed. Hence, recommendations for research in this context and standardisation interaction are:

- IETF, as a relevant placeholder for the development of interoperability aspects, requirements, and use-case integration. Contributions can be provided to existing drafts, e.g., [11], or new proposals.
- IEEE, the P1918 "Tactile Internet Working Group"8 is also a relevant placeholder where projects can contribute to in this context.
- ITU-T, Tactile Internet[9], about watch reports, white papers.
- ETSI ISG IP6[10], participation in work items.
- AIOTI WG on Standardisation, specifically focusing on ontologies and semantic technologies.

4.1.2 Far Edge

The key research directions discussed are:

- Local AI decisions: distributed AI to assist learning from IoT data sources.
- Intelligent offloading across near and far Edge.
- Neuromorphic computing, regarding the integration of AI in chipsets (e.g., spike networks and open hardware).
- Brownfield integration [3], of relevancy to the manufacturing domain where long-lived

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[8] https://grouper.ieee.org/groups/1918/1/
[9] https://www.itu.int/en/ITU-T/techwatch/Pages/tactile-internet.aspx
[10] https://portal.etsi.org/tb.aspx?tbid=827&SubTB=827#/50610-contributions

legacy machines are not easily interconnected with current IT/IoT systems, require the support of Edge computing (local data processing and analysis).

- Open hardware. Open hardware is highly relevant for the future of future IoT systems, to handle an adequate integration of AI and of new concepts, e.g., deterministic wireless, neuromorphic computing. Software Defined Radio (SDR) platforms are relevant to the development of advanced research. Some initial contributions are being considered in the context of RISC-V, with focus on SPGA and accelerator development.

Concrete contributions are therefore already ongoing in the context of ETSI SAREF and W3C WoT. We propose additional contributions to consider in this context:

- IEEE, federated learning application standards.
- BDVA, regarding consultation, position papers.
- IETF, *Reliable Available Wireless (RAW)* [11] working group about deterministic use-cases and requirements, mobile far Edge environments and TSN integration into wireless.
- IETF IoT operations Working Group [12], as for, for instance, brownfield device integration, large-scale onboarding, trustworthiness, etc.

4.1.3 Near Edge

- MEC integration and support across different use-cases is a research direction by different projects.
- Device or Edge intelligence supporting federated learning.
- Intelligent offloading (e.g., due to energy consumption) between near and far Edge.
- ML integrated into open hardware to allow the support of more complex functions on the Edge.

The key contributions in this area relate with ETSI MEC, already covering relevant topics. No further recommendations are provided at this stage.

4.1.4 Infrastructure

- 5G core integration, SDN and NFV all along the network, multi-link connection. Here, the ETSI Open Source NFV Management and Orchestration (MANO) initiative seems to be a relevant placeholder to boost infrastructure aspects, such as NFV orchestration
- Satellite integration in 5G and their role in IoT end-to-end services [8], the future role of Satellites-as-a-service is a growing trend which is expected to impact IoT end-to-end services significantly.
- Deterministic support (TSN interconnection) is a current priority, regarding the 5G TSN specifications and to the IEEE TSN 13specifications. Deterministic wireless, considering the new IEEE 802.11ax and 802.11be standards [1].
- Integration of federated AI into networking nodes

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[11] https://datatracker.ietf.org/wg/raw/about/
[12] https://datatracker.ietf.org/wg/iotops/about/
[13] https://1.ieee802.org/tsn/

Additional suggested interaction towards SDO could concern:

- IETF COIN (Computing in the Network Research)14, about service and network decentralisation aspects, SDN, ICN.
- IRTF Network Management WG15, 5G and Edge integration aspects.

4.1.5 Data Spaces

- Edge data space based on semantic orchestration and AI-based based Knowledge representation and improving IoT task/process management and configuration.
- ETSI SAREF [4], is acknowledged as highly relevant by different projects to assist in cross-domain interoperability. The W3C WoT architecture and in particular, meta-models for defining multi-agent WoT systems has been mentioned by the projects.
- Specific contributions to ETSI STF601 proposal [5] focused on enabling usability via the use of AI for knowledge representation and management has also been proposed.

In addition to ETSI, suggestions for standardisation interaction are:

- GAIA-X. In the context of the different working groups there is the possibility to contribute to the design of the overall GAIA-X architecture. Relevant WGs for the topics of the projects are the GAIA-X Data Interoperability group and the GAIA-X Network and Interconnection working group.
- BDVA/DAIRO and AIOTI joint initiative for DATA Spaces [10]. There is the possibility to contribute to white papers focused on aspects such as trustworthiness and privacy, use-cases, interoperability. These aspects are already under development in EU-IoT (refer to Annex II, second standardisation meeting with RIAs).
- *Trust and Trustworthiness* [3]. Trustworthiness should be designed as part of an IoT end-to-end system, considering aspects such as reliability, dependability, safety. Projects are specifically focusing on the ISO TC42. Via the BDVA/DAIRO joint initiative, it is also possible to extend this support to other relevant ISO standards.

4.2 Innovation Strategies

- The IoT and Edge ecosystem in Europe gathers multiple open initiatives with a high degree of fragmentation in what concerns Industrial IoT. As can be seen from the collected SDOs, currently innovation is being driven by consortia and alliances, such as AIOTI, BDVA, LFEdge [2]. In the industrial IoT area, relevant initiatives are based in consortia that are adopting open-source (Linux-based) solutions.
- To reduce fragmentation, strengthen the IoT/Edge ecosystem, it is important to provide European projects, already at a proposal phase, with an open innovation strategy (and respective support to develop that strategy) that allows to develop and to open, at an early project stage, open-source software and hardware results.
- There is a lack of experimental large-scale worldwide facilities. The possibility to explore aspects such as data processing across Europe would be a catalyst for the European Edge computing ecosystem.
- The analysis developed shows that there is a lack of understanding on standardisation initiatives, and on the value-add of participating in standardisation initiatives, including

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14 https://datatracker.ietf.org/rg/coinrg/about/
15 https://datatracker.ietf.org/rg/nmrg/about/

open standardisation. This also leads to fragmentation, given that specific consortia need them to be formed to boost a specific research and innovation direction. There is therefore the need to invest in training, from an early development phase, also reaching out to junior researchers and students).

5   SUMMARY AND NEXT STEPS

Deliverable D3.7 describes the standardisation activities and provides recommendations aimed at strengthening and broadening the impact of ongoing ICT-56 projects, on the one hand, and in best serving the overall IoT and Edge research and innovation communities, on the other hand. For this purpose, the EU-IoT standardisation activities have been focused on a sound analysis of an initial set of SDOs and on the development of tooling and strong liaisons between projects, SDOs and CSAs. The individual meetings with standardisation representatives of the ICT-56 projects have helped in understanding potential gaps and assisted in pinpointing initial research directions that are relevant to be further addressed in EU-IoT.

All the developed standardisation tools (online standardisation map, white papers, meetings, events) shall continue to be updated until the end of the project. The related updates will be documented in Deliverable D3.8.

Future work in EU-IoT concerning standardisation shall be focused in providing the projects with additional SDO liaisons, where the projects may be interested in contributing. Based on joint work developed with the ICT-56 projects and with the other NGIoT CSAs, WP3 will develop a coordinated view on relevant standardisation efforts, and relevant Edge research guidelines towards SDOs. Specific next steps are:

- To pursue the regular meeting organization to ignite discussion on research directions and recommendations to standardisation.

- To strengthen the interaction with a subset of SDOs based on i) feedback from experts; ii) feedback from projects; iii) feedback from other CSAs and iv) feedback from the Commission. Already identified SDOs are: SAREF (ontologies), IETF (infrastructure, near and far Edge), GAIA-X (Data spaces), AIOTI (WG Standardisation and WG Research) and BDVA (Data Spaces), IRTF (Network Management WG).

- To develop discussion meetings with the international EU-IoT experts and with selected SDO representatives, to support a regular debate on strategic recommendation directions.

REFERENCES

[1] O. Vermesan (Editor), AIOTI Strategic Foresight through Digital Leadership, IoT and Edge Computing Convergence. October 2020.

[2] Linux Foundation Edge, Sharpening the Edge: overview of the LF Edge Taxonomy and Framework. White paper, 2020.

[3] H. Thomson, Next Generation IoT and Edge Computing. Report from the Next Generation IoT and Edge Computing Strategy Forum April 2021.

[4] *ETSI TS 103 673 v1.1.1 "SAREF Development Framework and Workflow. Technical Specification*

[5] *ETSI, Cross-domain usability of IoT devices for humans and machines. ETSI STF601,* Ref. Body TC SmartM2M, *February 2021.*

[6] ETSI, Multi-access Edge Computing (MEC); Framework and Reference Architecture. ETSI GS MEC 003 V2.2.1 (2020-12)

[7] 5G-ACIA, Integration of 5G with Time-Sensitive Networking for Industrial Communications, White paper. 2021.

[8] NetWorld2020's – SatCom WG The role of satellites in 5G. 2019

[9] BDVA, Towards a European Data Sharing Space – Enabling data sharing and unlocking AI potential. BDVA position paper, April 2019.

[10] A. Kung, R. Walshe. AIOTI/BDVA Joint Initiative for Data Spaces. Presentation, July 2021.

[11] C. Sarathchandra , M. Kheirkhah, M. Ghassemian, Tactile Internet Service Requirements. IETF draft (active, informational). July 2021.

[12] BDVA, Speeding Up Industrial AI and Trustworthiness. Franco-German position paper. September 2021.

ANNEX I: LIST OF EU-IOT STANDARDISATION MATERIAL

Title	When/release	Type	Description	URL
EU-IoT SDO Online Mapping Tool	Continuous	Online catalogue	Rf. to section 3.1	https://www.ngiot.eu/archive-Standardisation-bodies/
A **Vision on Smart, Decentralized Edge Computing Research Directions**	30.09.2021	White paper	The white paper provides an overview on different Edge computing concepts and how they map to the EU-IoT scope areas; discusses current Edge research directions being taken by NGIoT flagship projects. *R. C. Sofia, J. Soldatos*	https://drive.ngiot.eu/index.php/s/PwCMcTmoKPRPjzi?path=%2FEU-IoT%20White%20papers
EU-IoT Standardisation Meeting I	27.04.2021	Organized event	Open-source and Standardisation aspects, 27.04.2021 -. Online event.	Report and Material
EU-IoT Standardisation Meeting II	15.09.2021	Organized event	Open-source and Standardisation Aspects 2,	Report and Material.
Workshop on IoT and Edge Computing Research and Standardisation Convergence	13-14.09.2021	Participation	Panel discussion on "What are key priorities for IoT and Edge Computing Standardisation for industrial IoT, telecommunications and automotive domains? *With the presence of all speakers plus Gael Blondelle, Eclipse foundation, and Rute Sofia, CSA EU-IoT*	https://www.ngiot.eu/event/workshop-on-iot-and-edge-computing-research-and-Standardisation-convergence/?instance_id=167
IoT Week	30.08.2021	Organization/participation		
IoT and Edge computing, Future Directions for Europe	11.09.2020	Participation	Together on the Edge (PDF) *Monique Calisti, Martel*	https://www.ngiot.eu/iot-and-edge-computing-future-directions-for-europe/
IoT and Edge computing II, the Far Edge	7-8.12.2020	Participation	The role of Standardisation and Open Source *(PDF)*. *Rute Sofia,* Fortiss	https://www.ngiot.eu/event/iot-and-edge-computing-ii-the-far-edge/

ANNEX II: LIST OF SDOS, CONSORTIA AND ALLIANCES

Acronym	Title	URL
SDOs		
3GPPP	3rd Generation Partnership Project (3GPP)	https://www.3gpp.org/
CENELEC	European Committee for Electrotechnical Standardisation	https://www.cenelec.eu
ETSI	European Telecommunications Standards Institute	https://www.etsi.org/ https://www.etsi.org/technologies/internet-of-things
GS1		https://www.gs1.org
IEC	International Electrotecnical Commission	https://www.iec.ch
IEEE	Institute of Electrical and Electronics Engineering	https://www.ieee.org
IETF	Internet Engineering Task Force	https://www.ietf.org
ISO	International organisation for Standardisation	https://www.iso.org
ITU-T	International Telecommunication Union	https://www.itu.int
OASIS	Organization for the Advancement of Structured Information Standards	https://www.oasis-open.org
ODVA	ODVA	https://www.odva.org
OGC	Open Geospatial consortium	https://www.ogc.org
OPC	Open Platforms Communication Foundation	https://opcfoundation.org/
W3C/WoT	World Wide Web Consortium/Web of Things	https://www.w3.org/
Pre-normative entities		
5G-ACIA		https://www.5g-acia.org/
5GIA	5G Industry Association	https://5g-ia.eu/about/
IRTF	Internet Research Task Force	https://irtf.org/
Alliances and Consortia		
AIOTI	Alliance for Internet of Things Innovation IVZW	https://aioti.eu/
BBF	Broadband Forum	https://www.broadband-forum.org/
BDVA	Bid Data Value Association	https://www.bdva.eu/
CNFC	Cloud Native Computing Foundation	https://www.cncf.io/
Eclipse	Eclipse foundation	https://www.eclipse.org
EdgeX	EdgeX Foundry	https://www.edgexfoundry.org/
EEC	European Edge Computing Consortium	https://ecconsortium.eu/
FIWARE	FIWARE: The Open Source Platform for Our Smart Digital Future	https://www.fiware.org/
Gaia-X	A federated data infrastructure for Europe	https://www.data-infrastructure.eu
GSMA	GSMA Alliance	https://www.gsma.com/aboutus/
IIC	Industrial Internet Consortium	https://www.iiconsortium.org/

Acronym	Title	URL
Industry4.0	Platform Industrie 4.0	https://www.plattform-i40.de/PI40/Navigation/DE/Home/home.html
Linux	Linux Foundation	https://www.linuxfoundation.org/
LoRA	LoRa Alliance	https://lora-alliance.org
OAA	Open Automotive Alliance	https://www.openautoalliance.ne
OCF	OCF, Open Connectivity Foundation	https://openconnectivity.org
OMA	Open Mobile Alliance	https://www.openmobilealliance.org
OMG	Object Management Group	https://www.omg.org/
One M2M	One M2M Standards for M2M and the Internet of Things	https://www.onem2m.org/
ORAN	Operator Defined Open and Intelligent Radio Access Networks	https://www.o-ran.org/
RISC-V	RISC-V International	https://riscv.org/
VDMA	Mechanical and Plant Engineering Association	https://www.vdma.org/
Weightless	Weigthless Alliance	https://www.weightless-alliance.org/
Zigbee	Zigbee Alliance	https://zigbeealliance.org

Acronym	Title	URL