**Grant Agreement N°:** 101016673
**Topic:** ICT-40-2020

**HUB4CLOUD**

The European Cloud Computing Hub
to grow a sustainable and comprehensive ecosystem

# D3.2: Cloud computing standardization and open source initiatives - version 2

Revision:v1.0

| Work package | WP3 |
|---|---|
| Task | Task 3.1 |
| Due date | 30/09/2022 |
| Submission date | 07/11/2022 |
| Deliverable lead | ATOS |
| Version | 1.0 |

# Abstract

This report includes an overview of the most relevant OSS and SDOs initiatives across the EU community as well as within the EU projects included in the second round of the EU Survey conducted by HUB4CLOUD.

**Keywords: Cloud, Edge, Open-source, Standards**

**Document Revision History**

| Version | Date | Description of change | List of contributor(s) |
|---------|------|----------------------|------------------------|
| V0.1 | 15/05/2022 | TOC | Enric Pages |
| V0.2 | 17/05/2022 | Refined TOC | Enric Pages |
| V0.3 | 23/06/2022 | Initial contributions | All |
| V0.5 | 10/07/2022 | Open-source initiatives | Enric Pages (ATOS), Lara Lopez (ATOS) |
| V0.7 | 20/09/2022 | Standardisation initiatives | Juncal (Tecnalia) |
| V0.8 | 27/09/2022 | Final contributions | All |
| V0.9 | 30/10/2022 | Quality review process | Tecnalia, Martel |
| V1.0 | 07/11/2022 | Final version | Enric Pages |

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| Project co-funded by the European Commission under ICT-40-2020 | | |
|---|---|---|
| Nature of the deliverable: | Report | |
| Dissemination Level | | |
| PU | Public, fully open, e.g. web | √ |
| CI | Classified, information as referred to in Commission Decision 2001/844/EC | |
| CO | Confidential to HUB4CLOUD project and Commission Services | |

*\* R: Document, report (excluding the periodic and final reports)*
  *DEM: Demonstrator, pilot, prototype, plan designs*
  *DEC: Websites, patents filing, press & media actions, videos, etc.*
  *OTHER: Software, technical diagram, etc*

# EXECUTIVE SUMMARY

HUB4CLOUD is a Coordination and Support Action (CSA) funded under topic ICT-40-2020 Cloud Computing: towards a smart cloud computing continuum. HUB4CLOUD runs coordination and support activities to assist growing the impact and relevance of Cloud Computing research, innovation and policy driven efforts while ensuring close coordination and networking among stakeholders in the cloud computing, including key players such as the various ECC projects.

This is supported by the 1) the Strategic Coordination Board (SCB) that will regularly coordinate to align on strategic direction and overall cross-programme objectives, priorities and common activities); 2) a set of dedicated community building and stakeholder engagement tools and services (H-CLOUD Forum animation, expert groups, webinars, liaisons, etc.) fostering the growth of a sustainable forum of stakeholders, representing research, industry and users that range across all HUB4CLOUD tasks and activities.

The pre-standardisation/standardisation and open source activities have been addressed via a dedicated set of activities under the lead of Task 3.1 that helps to promote contributions from ECC projects as appropriate, engaging the relevant (pre-)standardisation bodies and open source communities, including specific activities, which aims to boost the progress of innovative secure, trustworthy and environmentally sustainable CC infrastructures and solutions, by facilitating technology transfer and know-how exchange, while mapping ECC efforts into open source, pre-standardisation and standardisation activities.

This report "D3.2 Cloud computing standardisation and open-source initiatives v2" updates the previous report D.3.1, including the consultation and assessment of new EU funded projects not considered in the first HUB4CLOUD report. This final iteration shows up projects in a most mature state in comparison with the initial round of surveys, as most of the projects have been contacted during the last year of its execution.

## TABLE OF CONTENTS

## ABBREVIATIONS

| | |
|---|---|
| **CC** | Cloud Computing |
| **CNCF** | Cloud Native Computing Foundation |
| **ECC** | European Cloud Computing |
| **OSS** | Open Source Software |
| **SDOs** | Standards Developing Organisations |

# 1 INTRODUCTION

This section introduces the general purpose of the deliverable focusing on standardisation and open-source activities under the lead of Task 3.1.

## 1.1 Overview and Objectives

Contributions and engagement in open source, pre-standardisation and standardisation activities within the context of H2020 projects often suffer from the lack of visibility on directly relevant initiatives, but also from fragmented efforts. This report aims to help the ECC projects by analysing their planned open source / (pre-) standardisation efforts and strategies, identify good practices and come up with guidelines on how to effectively monitor, steer and inject into relevant cloud computing initiatives.

The pre-standardisation/standardisation and open source activities have been addressed via a dedicated set of activities that helps to promote contributions from ECC projects as appropriate, engaging the relevant (pre-)standardisation bodies and open source communities, including specific activities, which aim to boost the progress of innovative secure, trustworthy and environmentally sustainable CC infrastructures and solutions, by facilitating technology transfer and know-how exchange, while mapping ECC efforts into open source, pre-standardisation and standardisation activities.

## 1.2 Relation to other HUB4CLOUD activities

Information has been collected by directly liaising with the scientific / technical coordinators and innovation / exploitation managers of ongoing ICT-15 and ICT-40 projects. Two dedicated surveys have been run, in close collaboration with Tasks 1.1, 1.2, 2.1 and 2.3, together with dedicated webinars where open source and the standardisation activities where part of the main topics.

## 1.3 Target Audience

The target audience of this document are technicians and business stakeholders interested in open-source and standardisation activities and initiatives relevant for the European community. The primary target is to help H2020 and Horizon Europe projects to identify contributions on those activities while facilitating the technology transfer as well as the know-how exchange between them.

## 1.4 Structure of the Document

This document is structured as follows:

- Section 1; introduces the report and its objectives.
- Section 2; presents the methodology applied during the project lifetime.
- Section 3; provides and overview of the OSS and SDOs communities.
- Section 4; described the second round of the survey results
- Section 5; provides a summary of the identified OSS and SDOs per project.
- Section 6; provides final lessons learnt.

## 2 FOLLOWED METHODOLOGY AND WORKING PLAN

The methodology used for this set of reports was first of all a comprehensive review of the considerable established literature as well as the most recent published reports by the early identified SDOs and OSS initiatives in order to reflect an initial state of the art for both communities; standards, and open-source initiatives related with cloud computing. Afterwards, additional information has been collected through the HUB4CLOUD EUSurvey, which is an online survey-management system built for the creation and publishing of globally accessible forms, where several H2020 EU projects funded under ICT-16-2018, ICT-15-2019 and ICT-40-2020 have been selected to participate.

The methodology applied is an incremental iterative process which has been conducted through two major iterations of interviews and open surveys with scientific coordinators and innovation / exploitation managers of the running EU funded projects. HUB4CLOUD is willing to provide a collaborative framework for facilitating contributions to pre-normative, open source and standardisation activities, while encouraging the development of new business models and dedicated skills building programmes.

After every major cycle an analysis of the surveys and reports has been planned to produce two editions (M09 & M18) of a map of standards and open-source bodies/communities related to cloud computing initiatives in Europe.

In addition to the aforementioned sources of information, additional feedback has been gathered continuously from HUB4CLOUD Advisory Board (AB) and Steering Committee Board (SCB) as well as through workshops and webinars with stakeholders.
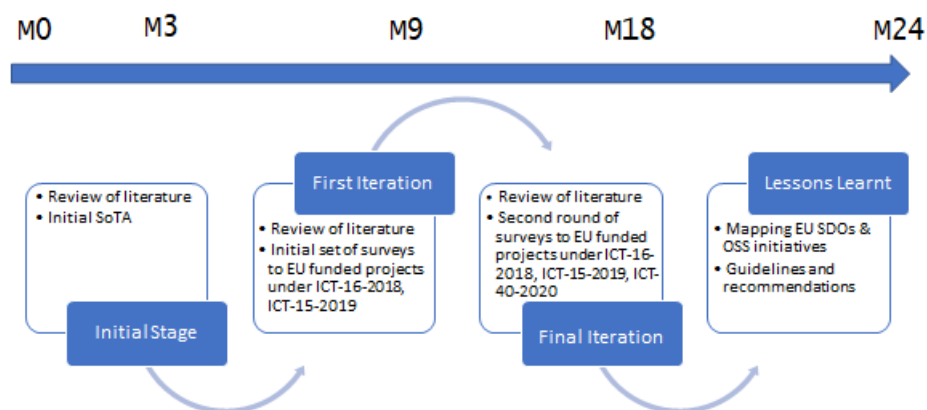


Methodology followed for the open source:

The European Commission approved the new Open Source Software Strategy 2020-2023 of the Commission.

The key objectives of the new strategy are to enable the Commission to:

- Progress towards digital autonomy of Europe's own, independent digital approach.
- Implement the European Commission Digital Strategy.
- Encourage sharing and reuse of software and applications, as well as data, information and knowledge.
- Contribute to the knowledge society by sharing the Commission's source code;
- Build a world-class public service;

The objective of this analysis is to identify the relevant open-source initiatives related with Cloud

Computing and Edge paradigms which are in line with the OSS strategy principles defined by the EU commission. The methodology used has been:

- Desktop research analysis of the considerable established literature and community events.
- Surveys to a set of identified projects related to Cloud/Edge topics from different perspectives.
- Close follow-up on the previous OS communities identified on the first report.

Methodology followed for the standards:

On 27th September 2012, the Communication from the Commission to the European Parliament and other European Institutions with the title "Unleashing the Potential of Cloud Computing in Europe" [1] already identified in its Key Action 3 the necessity to "*cut through the jungle of technical standards so that cloud users enjoy interoperability, data portability and reversibility*". The result of this Key Action was the launching of two initiatives, which are detailed next:

1.      Cloud Certification Schemes Metaframework (CCSM) [2]: The European Commission with the support of the European Union Agency for Network and Information Security (ENISA) and other relevant bodies worked towards a list of Cloud Computing Schemes (CCSL) and a Cloud Certification Schemes Metaframework (CCSM), with the definition of 27 security objectives.

2.      Cloud Standardization Coordination (CSC) initiative, led by ETSI which had as main goal a mapping of standards in critical areas such as security, interoperability, data portability and reversibility. It had two phases. Phase I of the CSC took place in 2013 and primarily addressed the Cloud Computing standards roadmap. In December 2013 the results were publicly presented in a workshop organized by the EC. Phase II was launched to address issues left open after CSC Phase 1, with the objective to provide a detailed report before the end of 2015. This Phase investigated some specific aspects of the Cloud Computing Standardization landscape, in particular from the point of view of Users (e.g. SMEs, Administrations). The result was also another report.

In spite of the above efforts, there are still numerous standards in the field of cloud computing that however can make sense taking into consideration the complexity of the cloud computing architecture and supply chain.

The objective of this analysis is to identify the most relevant standards coming from different standard bodies, international and European ones. As in similar tasks, the methodology used has been:

- Desktop research analysis: for the desktop research analysis several sources have been analysed based on the knowledge of the project partners.
- Surveys to a set of identified projects, to understand the use of standards in their research projects, the effort devoted to standardization as well as the intention to extend existing standards.

The main sources for the desktop research analysis at hand have been:

- standict.eu and its European Observatory
- the study SMART 20216 /0029 performed by TECNALIA,
- additional desktop research made throughout the different standardisation committees of ISO/IEC, especially JTC 1/SC 38 (Distributed Application Platforms and Services) and JTC 1/SC 27 (Information security, cybersecurity and privacy protection), ENISA, and OASIS.

● MEDINA project led by TECNALIA

In the case of the European Observatory of standict.eu the following search criteria has been used:
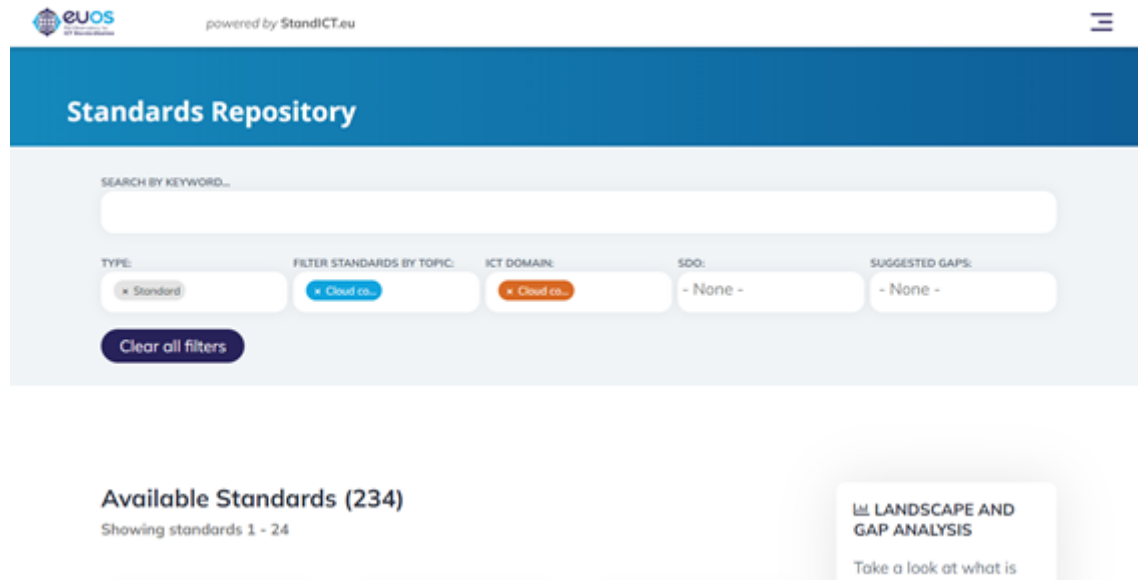


Figure: Standict.eu European Standards Observatory

The search obtains 24 standards out of the 234 in the database related to cloud computing. However, a closer filtering of the results yields that several of them are double and both recommendations and standards in draft status are considered as standards. Those are discarded for our analysis.

# 3   OVERVIEW OF CLOUD STANDARDS AND OPEN SOURCE INITIATIVES

This section provides an overview of existing CC (pre-)standardisation and open-source initiatives.

## 3.1 Overview of Open-Source Initiatives

The complexity of managing multiple resources across the Cloud-Edge-IoT continuum has been increased with the need of moving more computational power and resources closer to end users. This fact increases the number of endpoints to orchestrate and the heterogeneity of the devices to be managed by extending the capabilities of traditional data centres out towards the edge. This type of infrastructure grows organically based on the needs of the organisations in their specific market sectors, therefore trying to create one solution that fits all customers' needs is not possible due to the number of sector specificities and device typologies present in each of the Cloud-Edge-IoT architectures.

At present, while there are many tools available, the organisations willing to manage their workflows across the continuum need to pick out a number of a large amount of tooling and established processes from the ecosystem available to meet their unique needs.

Specific requirements and tooling may vary widely across organisations and Cloud-Edge-IoT use cases, but Cloud Computing open-source communities are a solid ground where these new cloud-edge paradigms can be successfully developed ensuring compatibility across near/far edge distributed clusters.

This section is going to cover the most relevant communities associated with the management of services and resources across the computing continuum, in addition a breakdown of the type of accompanying external custom tooling that complements the solutions offered by the most relevant communities.

| OSS Community | **Linux Foundation (LF)** |
|---|---|
| Link | https://www.linuxfoundation.org/ |
| Objective and brief description | The Linux Foundation provides a neutral, trusted hub for developers and organizations to code, manage, and scale open technology projects and ecosystems. This is the parent foundation of many relevant subprojects for this domain like CNCF or LFEdge |
| Main topics addressed | Support, promote, protect and standardise open-source software technologies. |
| IoT-Edge-Cloud specific | No |

| OSS Community | **Cloud Native Computing Foundation (CNCF)** |
|---|---|
| Link | https://www.cncf.io/ |
| Objective and brief description | Their mission is to make cloud native computing ubiquitous. The CNCF hosts critical components of the global technology infrastructure, including solutions like K8s for cluster orchestration; Prometheus, for monitoring and alerting as well as more than 120 other projects with over 142000 contributors worldwide. |
| Main topics addressed | Container Registry and Runtime, Service Discovery, Service Proxy, Application definition and Image Build, Logging and Tracing. |

| IoT-Edge-Cloud specific | Yes |
|---|---|

| OSS Community | **Red Hat** |
|---|---|
| Link | https://www.redhat.com/en |
| Objective and brief description | Red Hat is one of the largest open-source companies, their solution Red Hat® OpenShift® is an open-source container platform that runs on the Red Hat enterprise Linux operating system and Kubernetes. |
| Main topics addressed | Automation, Cloud Computing / Edge, DevOps, Digital Transformation, Linux, Microservices |
| IoT-Edge-Cloud specific | Yes |

| OSS Community | **OpenInfra Foundation** |
|---|---|
| Link | https://openinfra.dev/ |
| Objective and brief description | OpenInfra is the foundation associated to the OpenStack community as a way of engaging and influence the OSS community following a set of principles and guidelines based on Open Source, Open Design, Open Development, Open Community. OpenInfra has five confirmed projects around OpenStack, one pilot project around connecting OSS to production and two working groups: the Edge Computing Group and the Computing Force Network (CFN) |
| Main topics addressed | Automated Cloud Provisioning, Lightweight containers, Programmable infrastructure stack for edge and cloud, DevOps. |
| IoT-Edge-Cloud specific | Yes |

| OSS Community | **Eclipse Foundation** |
|---|---|
| Link | https://www.eclipse.org/org/foundation/ |
| Objective and brief description | Eclipse is an open source community whose projects are focused on building an extensible development platform, runtimes and application frameworks for building, deploying and managing software across the entire software lifecycle. The foundation is part of several R&D projects associated to IoT, Edge and Cloud in Europe (AGILE-IoT, NEMO, NEPHELE, OpenContinuum, SmartCLIDE) |
| Main topics addressed | Visual editing, development, and modelling framework |
| IoT-Edge-Cloud specific | No |

| OSS Community | **FIWARE** |
|---|---|
| Link | https://www.fiware.org/ |
| Objective and brief description | FIWARE has been growing as an open community committed to promote the adoption and growth of the FIWARE platform as a de-facto standard to developed innovative cloud-based services and applications in multiple sectors, leading to the recent creation of the FIWARE Foundation. |
| Main topics | Empower Users, Developers and organisations for the creation of Smart |

| addressed | Applications in multiple sectors. |
|---|---|
| IoT-Edge-Cloud specific | Yes |

| OSS Community | **Open Source MANO (OSM) Project** |
|---|---|
| Link | https://osm.etsi.org/ |
| Objective and brief description | OSM is developing an open-source Management and Orchestration (MANO) stack aligned with ETSI NFV Information Models. As a community-led project, OSM delivers a production-quality MANO stack that meets operators' requirements for commercial NFV deployments. |
| Main topics addressed | NFV Orchestrator, VNF manager, MEC, VIM support |
| IoT-Edge-Cloud specific | Yes |

Other OSS frameworks and external tooling needed to enable the cloud/edge management across the continuum are:

- App Definition and Development
    - Database storage systems
    - Communication trough streaming and messaging
    - Application specs and packaging
    - Continuous integrations and delivery
    - GitOps
- Orchestration and management:
    - Scheduling / Orchestration
    - Service Discovery / Localization
    - Service Mesh
- Provisioning
    - Automation & Config
    - Registry
    - Security / Privacy
    - Identity and Key management
- Runtime
    - Computing Runtime
    - Cloud Native Storage
    - Cloud Native Network management
- Observability and Analysis
    - Monitoring
    - Logging/Tracing
    - Testing

## 3.1.1 The impact of OSS and OSH on technological independence, competitiveness, and innovation in the EU economy

**Open source market overview**

Open source has gained global importance in the last years, growing at a CAGR of 18.2% from 2021 and it is expected to reach USD 50 billion by 2016[1]. Unlikely to other businesses, the

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[1] https://www.marketsandmarkets.com/Market-Reports/open-source-services-market-27852275.html

pandemics situation has fostered its adoption, due to lower licensing costs and innovation speed. At the same time, working from home has defeated the reluctancy of some companies about the location of the open source companies itself allowing the growth of the European ones[2]. The following figure shows the evolution of open source in the last 30 years[3].
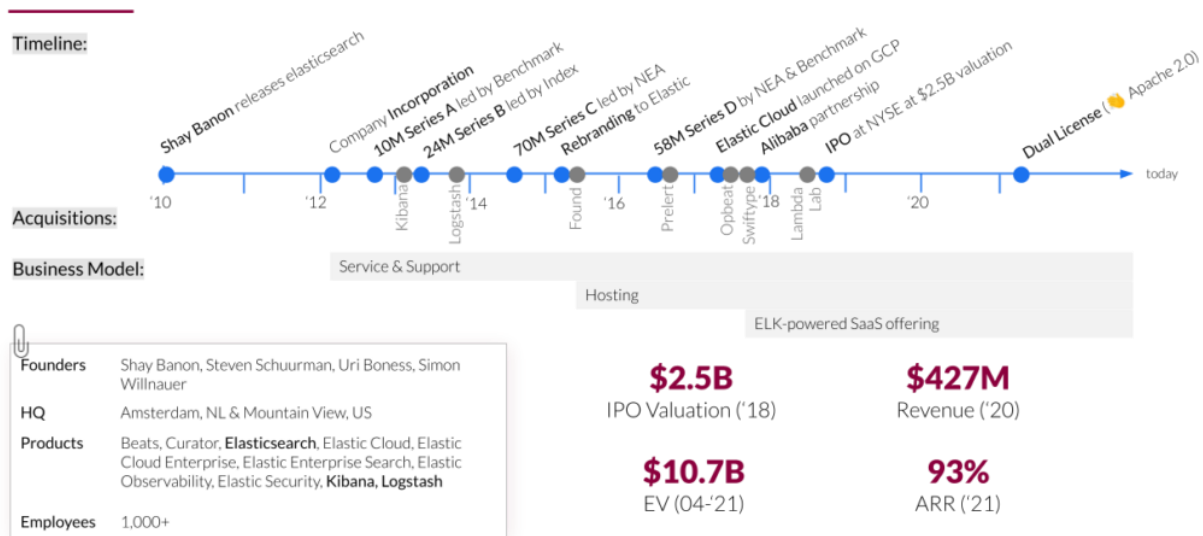


According to the same study, approximately 55% of the software used by different companies is already open source, and it is expected that by the end of this year it will represent 65% of the total software used. However, there is still room for a bigger growth, as 42% of the companies immersed in a digital transformation process rely on open source to support it[4].

In this run to cope with the market, Europe is becoming a relevant player in the global arena: two out of the three major open source committers countries are Germany and UK; 27% of active contributors on GitHub are from Europe and four of the ten fastest-growing countries are also European[5].

Within this open source environment, France is leading the European market with a CAGR of 8.3%, representing a 9.9% of the total French IT market, while UK remains at 6.5% followed by Germany at 6.4%[6].

According to a study performed by Nauta Capital[7], open source software is considered as strategic for the EU economic growth as it allows a reduction on the dependency of big US players.

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[2] https://nautacapital.com/insight/why-open-source-is-eating-europe/

[3] https://nautacapital.com/wp-content/uploads/2021/05/Open-Source-Is-Eating-Europe-Report-2021.pdf

[4] https://www.fortunebusinessinsights.com/open-source-services-market-106469

[5] https://nautacapital.com/insight/why-open-source-is-eating-europe/

[6] https://joinup.ec.europa.eu/collection/open-source-observatory-osor/news/market

[7] https://nautacapital.com/wp-content/uploads/2021/05/Open-Source-Is-Eating-Europe-Report-2021.pdf

Furthermore, this situation is attracting US big players relocating their headquarters to Europe, as Eclipse Foundation, or even allowing European companies, such as SUSE or Elastic, to acquirie other big American ones.

According to a study conducted by the European Commission[8], only increasing by10% the number of open-source contributors will increase the European GDP by 0.6%, which represents approximately EUR 95 billion per year.

## 3.2 Overview of Standards Initiatives

In the previous version of this deliverable (D3.1, *Cloud Computing Standardisation and Open Source Initiatives, version 1*)[9] we analysed relevant standards according to the proposed methodology, based on the desktop research analysis and on the surveys answered by the projects.

This initial sources for the desktop research were:

- standict.eu and its European Observatory
- the study SMART 20216 /0029 performed by TECNALIA
- additional desktop research made throughout the different standardization committees of ISO/IEC, especially JTC 1/SC 38 (Distributed Application Platforms and Services) and JTC 1/SC 27 (Information security, cybersecurity and privacy protection), ENISA, and OASIS

In this second version of the deliverable, we have incorporated into the desktop research a new source: The rolling plan on ICT standardisation 2022[10]. From the information contained there, we have enlarged the standardisation analysis including also Edge Computing relating topics and other frameworks, mainly related to multi-cloud. We enlarged the list with 10 standards more.

All standards below are detailed in the same way, following the approach in D3.1:

- Identification of the standard: ID and name
- Link: source of the standard
- Goal and brief description of the standard: brief explanation of the objective of the standard
- Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...): classification of the standard
- Cloud specific (Y/N): whether it is a generic IT standard or a cloud specific one. In principle, for this iteration, with rare exceptions, the focus has been on cloud specific standards.
- Year published: year in which the standard has been published and / or late revised.

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[8] https://op.europa.eu/en/publication-detail/-/publication/29effe73-2c2c-11ec-bd8e-01aa75ed71a1/language-en

[9] https://www.h-cloud.eu/download/d3-1-2/?wpdmdl=1654&masterkey=616d7b71bbdc0

[10] https://joinup.ec.europa.eu/collection/rolling-plan-ict-standardisation/rolling-plan-2022

| Identification of the standard | DGS/NFV-IFA040 - DGR/NFV-IFA038 - DGR/NFV-IFA036 |
|---|---|
| Link | https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=58433 |
| Goal and brief description of the standard | Capabilities of the NFV framework to support the management of network connectivity, and its associated network resources, for VNFs based on containers. support of multiple network interfaces per container, management of cluster nodes network and external VNF connectivity. |
| Main topics addressed (privacy, security, interoperabilit y, portability, vocabulary, architecture, terms, ...) | Architecture, interoperability. |
| Cloud specific (Y/N) | N |
| Year published | 2021 |

| Identification of the standard | ISO/IEC TR 23186 -- Cloud computing -- Framework of trust for processing of multi-sourced data |
|---|---|
| Link | https://www.iso.org/standard/74844.html |
| Goal and brief description of the standard | Proposal of a framework of trust for the processing of multi-sourced data that includes data use obligations and controls, data provenance, chain of custody, security and immutable proof of compliance as elements of the framework. |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Privacy, Security. |
| Cloud specific (Y/N) | Y |
| Year published | 2018 |

| Identification of the standard | ISO/IEC NP TR 23187 -- Cloud computing — Interacting with cloud service partners (CSNs) (work in progress) |
|---|---|
| Link | https://www.iso.org/standard/74845.html |
| Goal and brief description of | This document provides an overview of and guidance on interactions between cloud service partners (CSNs), specifically cloud service brokers, cloud service developers and cloud auditors, and other cloud service roles. |

| the standard | In addition, this document describes how cloud service agreements (CSAs) and cloud service level agreements (cloud SLAs) can be used to address those interactions |
|---|---|
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Interoperability, Portability. |
| Cloud specific (Y/N) | Y |
| Year published | 2020 |

| Identification of the standard | ISO/IEC PDTR 23613 -- Cloud service metering and billing elements |
|---|---|
| Link | https://www.iso.org/standard/76404.html |
| Goal and brief description of the standard | This document describes a sample set of cloud service metering elements and billing modes |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Others: Billing, metering |
| Cloud specific (Y/N) | Y |
| Year published | 2020 |

| Identification of the standard | ISO/IEC 22624 -- Cloud Computing -- Taxonomy based data handling for cloud services |
|---|---|
| Link | https://www.iso.org/standard/73614.html |
| Goal and brief description of the standard | Describes a framework and the usage of that framework for the structured expression of data-related policies and practices in the cloud computing environment, based on the data taxonomy in ISO/IEC 19944. |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, | Interoperability |

| terms, ...) | |
|---|---|
| Cloud specific (Y/N) | Y |
| Year published | 2020 |

| Identification of the standard | **ISO/IEC TR 23188 -- Cloud computing -- Edge computing landscape (work in progress)** |
|---|---|
| Link | https://www.iso.org/standard/74846.html |
| Goal and brief description of the standard | Presentation of the concept of edge computing, its relationship to cloud computing and IoT, and the technologies that are key to the implementation of edge computing. |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Architecture, terms. |
| Cloud specifc (Y/N) | Y |
| Year published | 2020 |

| Identification of the standard | **ISO/IEC TR 3445 — Cloud computing — Audit of cloud services** |
|---|---|
| Link | https://www.iso.org/standard/79582.html |
| Goal and brief description of the standard | The goal of this document is to presents the aspects that are relevant to the audit of cloud services including, i.e., role and responsibilities of parties conducting audit, approaches for conducting audits of cloud services, available frameworks and standards which can be used for audit schemes, for certification, and for authorization. |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Security, Interoperability. |
| Cloud specifc (Y/N) | Y |
| Year published | 2022 |

| Identification of the standard | **Recommendation ITU-T Y.4122 "Requirements and capability framework of edge computing-enabled gateway in the IoT"** |
|---|---|
| Link | https://www.itu.int/itu-t/workprog/wp_item.aspx?isn=14644 |
| Goal and brief | Edge computing technologies can benefit the IoT providing computation, storage, networking and intelligence in proximity to IoT devices. Compared |

| | |
|---|---|
| description of the standard | with the common gateway [ITU-T Y.4101], the edge computing-enabled gateway in the IoT (EC-enabled IoT gateway) has additional capabilities supporting service layer interworking, and application layer interworking among IoT devices, IoT platforms and IoT application servers. In addition, the EC-enabled IoT gateway supports data transmission capabilities for IoT applications sensitive to time, latency, jitter and packet loss. Based on common requirements and capabilities of a gateway for Internet of things applications [ITU-T Y.4101] and IoT requirements for support of edge computing [ITU-T Y.4208], additional capabilities and capability framework of the edge computing-enabled gateway in the IoT are specified. Examples of applicability of the edge computing-enabled gateway in the IoT are also given |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Edge Computing |
| Cloud specific (Y/N) | N |
| Year published | 2021 |

| | |
|---|---|
| Identification of the standard | ITU-T X.1604 "Security requirements of network as a service (NaaS) in cloud computing" |
| Link | https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-X.1604-202003-I!!PDF-E&type=items |
| Goal and brief description of the standard | It analyses security threats and challenges on Network as a Service (NaaS) in cloud computing and specifies security requirements of NaaS in NaaS application, NaaS platform and NaaS connectivity aspects based on corresponding cloud capability typ |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Security. |
| Cloud specific (Y/N) | Y |
| Year published | 2020 |

| | |
|---|---|
| Identification of the standard | ITU-T X.1605 "Security requirements of public infrastructure as a service (IaaS) in cloud computing" |
| Link | https://www.itu.int/rec/T-REC-X.1605-202003-I/en |
| Goal and brief description of the standard | Infrastructure as a Service (IaaS) platforms and virtualized services face different, and perhaps more, challenges and threats than traditional information technology infrastructure and application. IaaS platforms that share computing, storage and networking services need protections specific |

| | |
|---|---|
| | to threats in an IaaS environment. Recommendation ITU-T X.1605 documents security requirements of public IaaS in order to help IaaS providers to improve security of the IaaS platform throughout the planning, building and operating stages. |
| Main topics addressed (privacy, security, interoperability, portability, vocabulary, architecture, terms, ...) | Security |
| Cloud specific (Y/N) | Y |
| Year published | 2020 |

The table below summarizes the standards analysed classified by topic. Notice that this table includes the standards analysed in D 3.1 and the new ones incorporated in D3.2.

| Topic | Standards analysed | | | | |
|---|---|---|---|---|---|
| Virtualization | DMTF OVF | ISO/IEC 17203 | DGS/NFV-IFA040 - DGR/NFV-IFA038 - DGR/NFV-IFA036 | | |
| Architecture | ISO/IEC 17889 | ISO/IEC TR 23188 | | | |
| Dataflow | ISO/IEC 19944 | ISO/IEC 22624 | | | |
| Security | ISO/IEC 2700x | EUCS | ISO/IEC 19086-4 | ITU-T X.1605/1604 | ISO/ IECTR 3445 |
| | | | | | ISO/IEC TR 23186 |
| Interoperability and portability | ISO / IEC 19941 | OASIS CAMP | OASIS TOSCA | ISO/IEC 22624 | ISO/IEC NP TR 23187 |
| SLA | ISO/IEC 19086-1 | ISO/IEC 19086-2 | ISO/IEC 19086-3 | | |
| Storage | ISO/IEC 17826 | | | | |
| Edge | ITU-T Y.4122 | | | | |
| Billing/metering | ISO/IEC PDTR 23613 | | | | |

## 3.3 Relationship between SDOs and OSS communities

SDOs and OSS communities are considered as Key players in the adoption of Cloud Computing technologies towards the implementation of the digitalization roadmap of the European Industry. The European Commission has promoted several initiatives to analyse the benefits and impacts of the collaboration of such communities: SDOs and OSSs.

This section provides an overview of the main conclusions of two of the more relevant initiatives:

1. "Standards and Open-Source Bringing them together" - Open Forum Europe[11]
2. "The impact of Open-Source Software and Hardware on technological independence, competitiveness and innovation in the EU economy" – Fraunhofer ISI and Open Forum Europe[12].

### 3.3.1 Standards and OSS

The report "Standards and Open Source Bringing them together" by Open Forum Europe identifies the main benefits of the collaboration of SDOs and OSS communities, which are:

| Benefits of the collaboration of SDOs and OSS communities |
|---|
| Standards help stakeholders in the creation and management of their products and of their processes |
| Standards efficiently reduce the variety of goods and services necessary to operate in a market, providing a basis for innovation and thus enabling the creation of new products and services |
| Standards facilitate interoperability of technologies and processes |
| Market creation |
| Market conditioning |
| Collaborative R&D |
| Displacing an incumbent |
| Strategic Influence |
| Technical influence |
| Early access |
| Messaging |
| Joint marketing |
| Certification and branding |

Also, the reports extract some successful experiences about collaboration between SDOs and OSS communities. We have highlighted the ones related with the SDOs from the section 3.2 and how the collaboration between these SDOs and the OS communities are addressed. Here are the most relevant ones:

- SNIA Cloud Storage Technical Work Groups CDMI specification, now an ISO Standard: ISO/IEC 17826:2012 has produced an open source reference implementation. Moreover, SNIA standards are used in Open Source projects in various stages of development. SNIA also has a contact point in place for OSS communities.
- ETSI is one SDO that hopes to increase cooperation with Open Source communities. In fact, the baseline of the debate as defined in the ETSI context suggested that SDOs and OSS communities need to cooperate. In practical terms, this means that in at least one case, ETSI engaged with OSS communities, in this case OpenStack, directly. In fact, from

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[11] https://openforumeurope.org/publications/standards-and-open-source-bringing-them-together/

[12] https://digital-strategy.ec.europa.eu/en/library/study-about-impact-open-source-software-and-hardware-technological-independence-competitiveness-and

the answers supplied by OSS communities, we are aware that the ETSI Network Functions Virtualisation Industry Specification Group is open to the participation of OSS communities. Therefore, ETSI has very flexible membership term allowing for OSS communities to participate. Nevertheless, understanding that the traditional standardisation process was too slow in comparison with the pace of development in OSS communities.

- DMTF does not mention any Open Source communities as participants in the standardisation, it does maintain a list of Open Source Projects using DMTF technologies.

- OASIS considers that open standards and Open Source projects work together very well, and has a policy in place for OSS projects related to Technical Committee work. Moreover, OASIS supports the participation of OSS communities in their work. For example, it counts certain OSS communities among its members. However, it is important to note here that (as far as we are aware) those communities, are not present in the groups specifically working on Cloud computing. Moreover, OASIS is currently developing a new methodology to align the development times of SDOs with those of OSS communities (the OASIS Open Projects, see below).

- OGF develops its standards through an open process that gathers input and contributions from the community, and refines them through peer review and public comment to produce standards, guidance and information of value to the community through the Grid Final Document (GFD) series. The OGF is a standards group where the participation of very easy for OSS projects. In the particular case of the OCCI, some of its members are OSS communities, (eg: Open Nebula). This openness is explained by OGF as the result of its openness towards new members and of its IPR policy. This means that the OGF is ready to accommodate Open Source projects without changes.

- For ITU, OSS communities and development are expected to play an important role in many areas. Therefore, bridges should be found in order to permit OSS communities t participate in the SDO's activities. However, ITU believes that this is not easy - a particularly relevant barrier to this happening being the IPR policies used by SDOs.

- For ISO, OSS is a useful methodology that can be used in order to improve the development of standards. Therefore, there are initiatives in ISO in order to use these methodologies. However, because of its membership (representatives from various national standards organizations, OSS communities find it difficult to participate in its activities. In fact, as long as ISO maintains that membership structure, it is difficult to see how OSS communities could successfully participate, unless those communities could first engage with their national SDOs.

- The success of W3C in bringing together OSS and SDO communities can be explained as being the result of its open approach towards its membership. Members of W3C include businesses, non-profit organizations, universities, governmental entities, and individuals. Membership requirements are transparent, except for one requirement: any application for membership must be reviewed and approved by W3C itself. Many guidelines and requirements are stated in detail, but there is no final guideline about the process or standards by which membership might be finally approved or denied. Moreover, the cost of membership is given on a sliding scale, depending on the character of the organisation applying and the country in which it is located. The success of W3C can also be explained because of its Royalty Free patent policy and its liberal copyright (allowing for maximum reuse, something that suits the development model of open source). Moreover, W3C creates specifications with comprehensive documentation, which helps promote the implementation of its standards by OSS communities.

# 4    PROCESS

During the first months of the project, and in collaboration with other tasks, a survey was launched. This survey was addressed to project coordinators of identified cloud related projects funded under H2020 and published on EUsurvey.

The following 13 projects provided their answer: RAINBOW, SmartCLIDE, ACCORDION, IntelComp, PLEDGER, MARVEL, MORPHEMIC, MEDINA, PolicyCLOUD. DECIDO, PHYSICS, CHARITY, AI-SPRINT.

During the second part of the project a second round of the questionnaires was launched. Some questions were kept for this second questionnaire while others were new. This document collects the answers of the new questions and the questions that were repeated in the two versions of the questionnaires.

These are refined questions related with open source and standardization initiatives proposed for the second round of questionnaires:

| | |
|---|---|
| **Open Source** | Please indicate the number of PMs devoted to open source activities and the total amount of PMs in your project. |
| | How many already existing OS software tools are you using within your project (not developed by project partners)? |
| | Will you be able to develop project results without using any of these tools? Please provide a brief explanation. |
| | How many of your project results will be released under an open-source licensing scheme? |
| | What are your plans for your open source results after the end of the project? |
| | If you plan to contribute to an existing project or create a new one within an OS community, how are your approaching the community? Please explain which community(ies) are your targeting and how you are doing so. |
| | If you plan to create a new OS community, please explain why and how you are doing so. |
| | Do you find any difficulty reaching already existing OS communities? Please briefly explain your answer. |

| | |
|---|---|
| Standardisation | Will you consider useful to have a set of recommendations and guidelines for contributing to standards and/or OS communities before starting the project activities? What kind of information do you expect in such a list? |
| | Please indicate the number of PMs devoted to standardisation and the total amount of PMs in your project. |
| | Do you have a standardisation plan in your project? |
| | Which cloud/edge standards in general do you consider as the most relevant ones? |
| | Are you adopting any standard within your project? If yes, specify which ones. |
| | Are you already contributing to any cloud/edge related standard or planning to do so? Please explain your answer. |
| | Do you find difficulties reaching standardisation bodies? Please briefly explain your answer. |

In the context of open source, nine questions were asked. The answers are reported next.

1. **Indicate the percentage of person-months devoted to the open source activities in the project (number of projects: 13)**



Open Source activity in the project

■ Less than 1%  ■ 1 % - 25%  ■ 25%-50%  ■ More than 50%  ■ Not specified
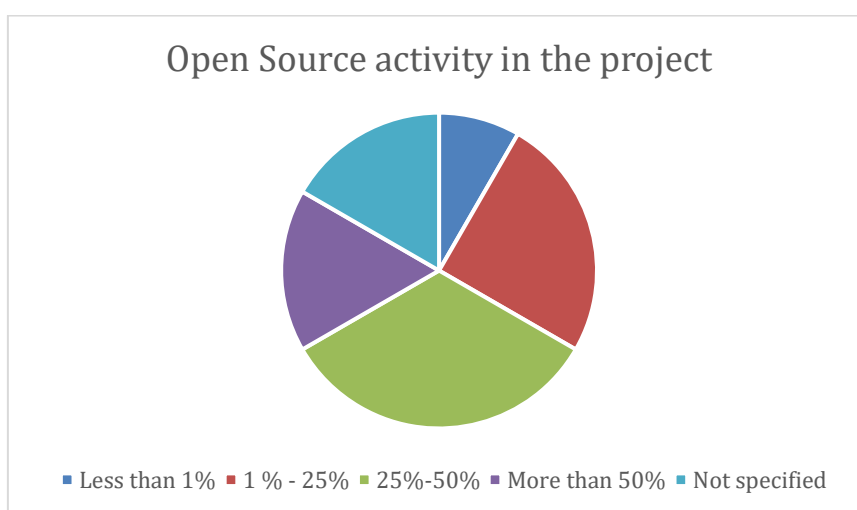
**2. How many already existing OS software tools are you using within your project (not developed by project partners)?**
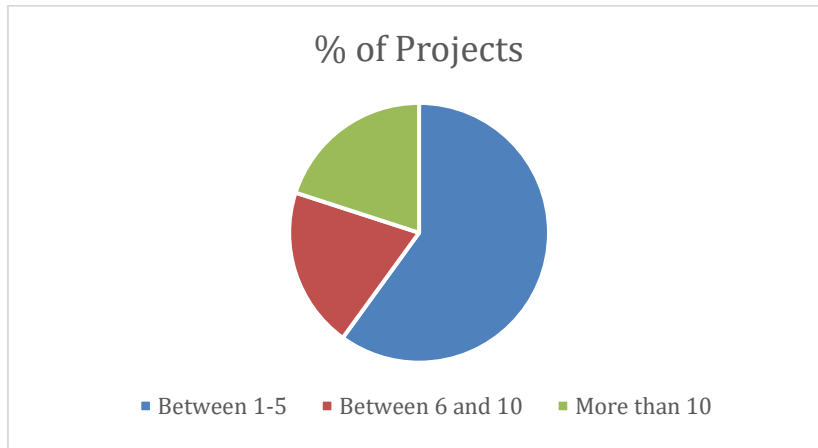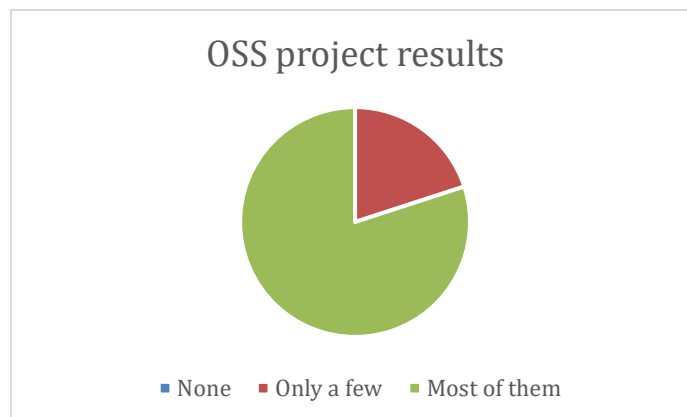


**3. Will you be able to develop project results without using any of these tools? Please provide a brief explanation.**

As expected, none of the projects will be able to achieve similar project results without this tooling as some of the main developments are extensions of these tools from the open-source communities. They claim it won't be realistic to try to build everything from scratch as their impact/usage would achieve lower results without the OSS community. In addition, most of the projects define open-source as one of the key elements for their strategies for the future.
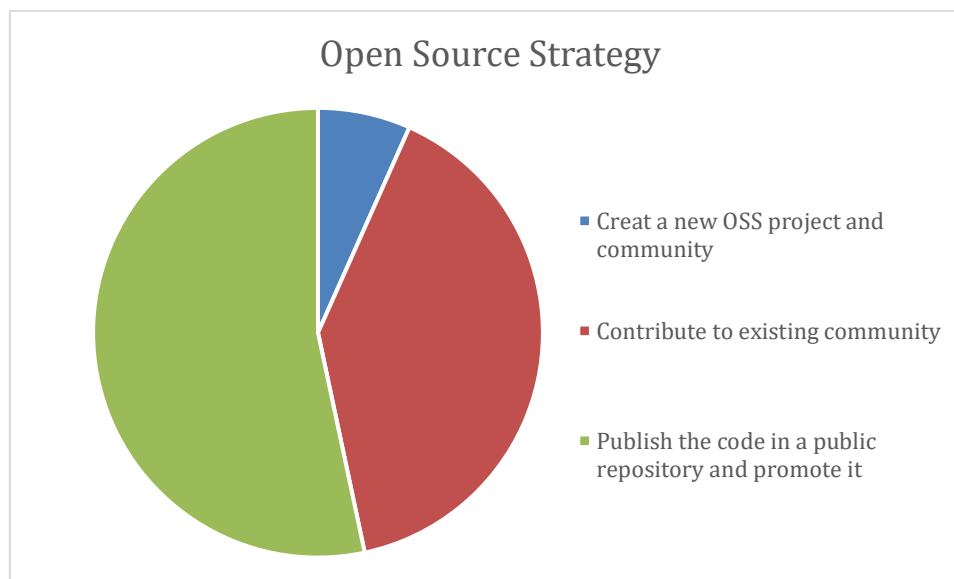
Most of the projects main dependency is Kubernetes which is an open-source container orchestration engine, but other open source technology enablers and frameworks comes into play depending on the project selected toolchain (i.e: LibCloud, MorpheusData, AARMAnetworks, OpenNebula, Prometheus …).

**4. How many of your project results will be released under an open-source licensing scheme?**

The aim of the frameworks developed in the scope of the EU projects is to release most of their components as open-source, some as an extension of existing OSS products contributing to its community or publishing standalone open source artifacts into public repositories like GitHub for promoting their future usage by the OSS community after the project ends.

**5. What are your plans for your open source results after the end of the project?**



Open Source Strategy

- Creat a new OSS project and community
- Contribute to existing community
- Publish the code in a public repository and promote it

**6. If you plan to contribute to an existing project or create a new one within an OS community, how are your approaching the community? Please explain which community(ies) are your targeting and how you are doing so.**

The two preferred ways selected for the projects for approaching OSS communities are through liaisons with contacts of partners within the same consortium or following the path defined by the communities that they want to approach. For example, participating in working groups of these communities or sending enhancements and bug reports through the established channels.

**7. If you plan to create a new OS community, please explain why and how you are doing so.**

None of the consulted projects has an ongoing strategy for the creation of a new OS community however most of them are willing to be part and contribute to the OSS existing communities that they identified as relevant for their projects.

**8. Do you find any difficulty reaching already existing OS communities? Please briefly explain your answer.**

Most of the projects declare to have an easy entry-path for reaching the existing OSS communities, on the one hand as some of the beneficiaries of the consortium are already members and active contributors across these communities, and on the other hand there are projects which have an established Open-Source company/community as part of their consortium members (i.e: RedHat, Eclipse Foundation, OpenNebula).

**9. Will you consider useful to have a set of recommendations and guidelines for contributing to standards and/or OS communities before starting the project activities? What kind of information do you expect in such a list?**

Some projects find useful to have a list of relevant contact points for standardisation bodies and

open-source foundations in order to make more agile the process for approaching the right people within these communities. Most of the projects find helpful to define at project start a set of recommendations and guidelines within the projects for contributing to standards and OSS communities.

In the context of standardization, five questions were asked. The answers are reported next.

**1. Indicate the percentage of person-months devoted to the standardization task in the project (number of projects: 13)**

The picture below depicts the planned effort reported by the projects in terms of standardisation compared to the overall effort of the project. The majority report to dedicate an average of 1% to 3% of the effort to activities related to standardization, be them observing or contributing. Also a good number of the projects (23% of them) reported higher effort 4-5%.
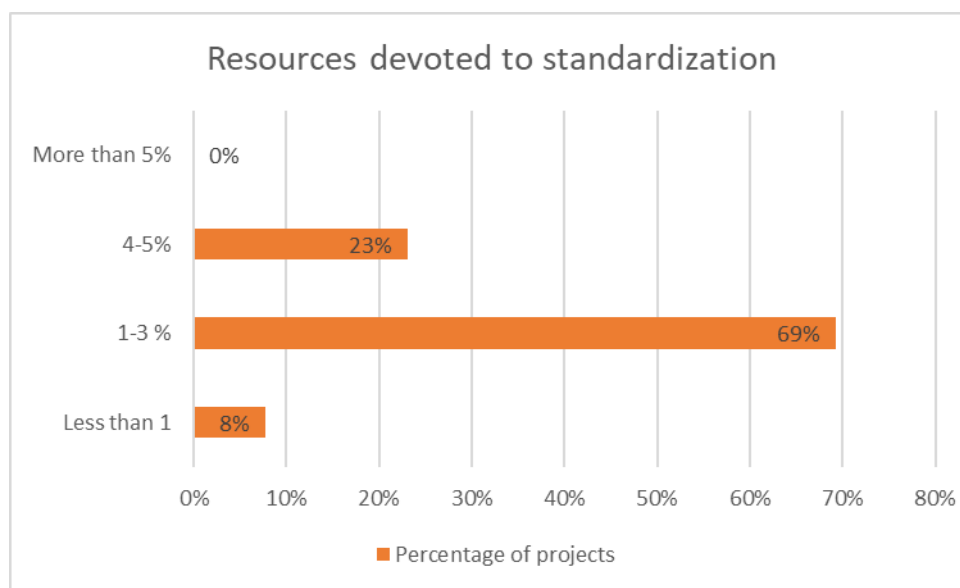


**2. Do you have a standardisation plan in your project? (number of projects: 5)**

Four out of five projects have already a standardization plan to be implemented during the lifecycle of their projects. The one who answered "No" was a CSA which won't contribute to any standard.

## Standardization plan
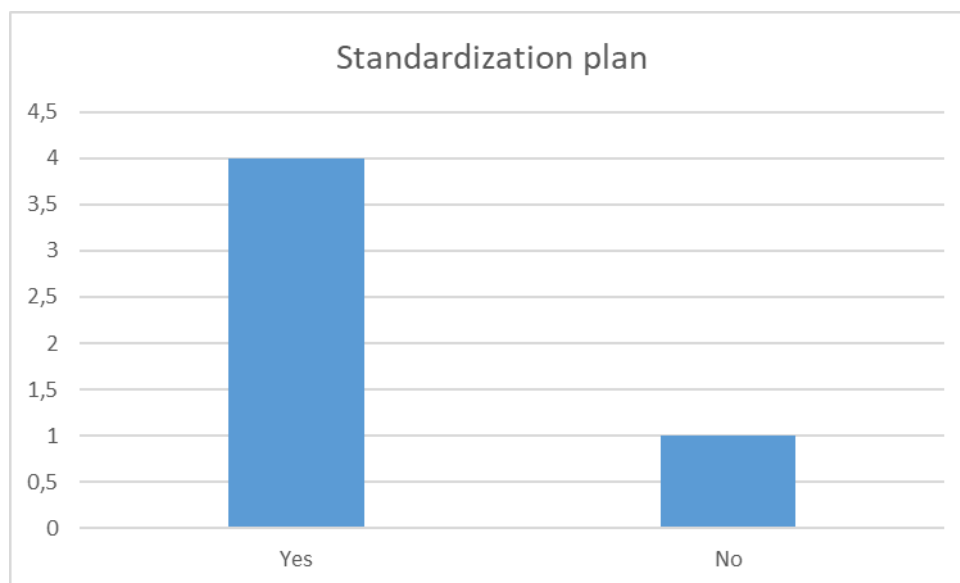


**3. Which Cloud related standards are you adopting in your project or do you consider relevant for your project?**

With respect to the standards that are being adopted by the projects participating in the survey or that are seen as relevant for the projects, it can be seen that TOSCA OASIS is the most popular one. 7 projects are adopting TOSCA OASIS, 6 of them in its "pure" status, while one of them, MORPHEMIC, is adopting it in its CAMEL flavour, an extension developed in previous projects such as MELODIC. Other standards include security related ones such as the upcoming European Cloud services certification scheme (EUCS), NIST OSCAL and TPM. OMG is also mentioned; however no further details are provided on which exact standard is being observed. 2 of the projects also considered ETSI's standard for virtualised networks as a relevant one.

| Standard | Number of projects |
|----------|---------------------|
| OASIS TOSCA | 7 |
| NIST OSCAL | 1 |
| ISO19086 | 1 |
| EUCS | 1 |
| OMG | 1 |
| ETSI-NFV | 2 |
| TPM | 1 |

**4. To which Cloud related standards are you contributing or planning to contribute in your project?**

With respect to the standards to which the projects aim to contribute, the projects have responded "other", but few details have been provided in the "please specify" textbox. One of the projects has mentioned ITU-T but not the exact number of the standard. As in the standards that are being observed it can be seen that the OASIS TOSCA is the standard to which most projects aim or will aim to contribute.

**5. Do you find difficulties reaching standardisation bodies? Please briefly explain your answer (5 projects).**

The projects that answered that are not facing problems reaching the SDOs reported the following reasons for this:

- Some consortium members are already part of the standardisation bodies.
- They rely on open-source upstream communities and the events organized by them.

For the ones who did experiment problems, these were mainly due to the process to accept and adopt a new contribution in a standard requiring long time which easily can exceed the scope and implementation plan of a research project.

As a conclusion we can see that standards are getting more and more relevant in the implementation of the projects, seeing the figures of the standards usage and contribution to standards of the projects. **.**
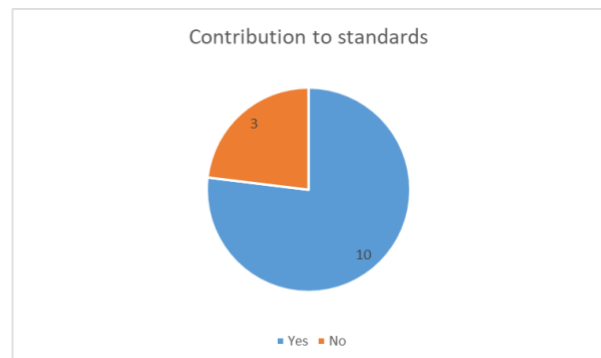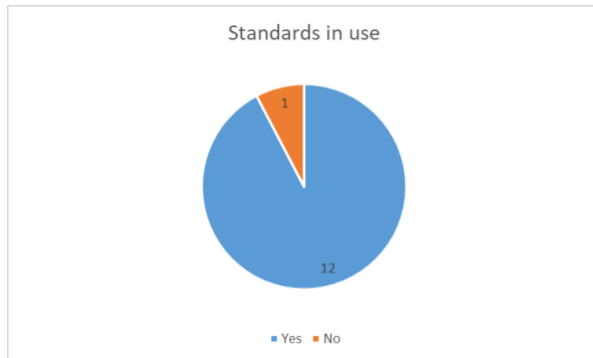
# 5    ASSESSMENT

These are the CC open-source communities and standardisation initiatives mapping around the H2020 EU projects selected within the final iteration of the HUB4CLOUD EU Survey.

| Project | Topic | OS Potential Target Community | OS Projects Contribution Planned | CC Standards Adopted | CC Standards Contribution Planned |
|---------|-------|-------------------------------|----------------------------------|----------------------|-----------------------------------|
| RAINBOW | Fog Computing | Open Horizon, Linux Foundation Edge | Open Horizon Scenarios | Trusted Platfom Module standard others | Open Horizon, Trusted Computing Group |
| SmartCLIDE | AI for the Cloud/Cloud Federation | Eclipse Foundation | Eclipse Theia, Eclipse Che | OASIS; OMG | OASIS TOSCA |
| ACCORDION | Cognitive cloud/Cloud Federation | Eclipse Foundation | Cloud Application Management Framework | OASIS; ETSI-NFV | ITU-T |
| IntelComp | Cognitive cloud; AI for the Cloud | Open Data communities | Github, Zenodo | NA | NA |
| PLEDGER | AI for the cloud / Green Cloud | LF Edge, CNCF | EdgeX Foundry and KubeEdge | OASIS | OASIS TOSCA |
| MARVEL | AI for the Cloud | OpenAire, GitHub, Zenodo | BDVA, FIWARE, ETP4HPC, EuroHPC | Cloud Security Alliance | Cloud Security Alliance |
| MORPHEMIC | AI for the Cloud | OW2 | OW2 Melodic OS Project | TOSCA adapted in CAMEL | CAMEL |
| MEDINA | Cloud certification | NIST OSCAL | NIST OSCAL, Clouditor, Azure at Github | OSCAL; ISO19086; EUCS | OSCAL; EUCS |
| PolicyCLOUD | Legislation aware Cloud | n/a | n/a | StandICT | Others |
| DECIDO | Cloud Federation | GitHUB | None | OASIS | OASIS TOSCA |
| PHYSICS | Workflow designer / deployment / optimization of Faas workflows | CNCF | GitHub | NA | NA |
| CHARITY | Cloud | CNCF | NA | ETSI-NFV / | NA |

| | | | | | |
|---|---|---|---|---|---|
| | Federation | | | 3GPP / MPEG / IETF / ITU-T / Khronos Group / EUROCAE / RTCA / TOSCA | |
| AI-SPRINT | Cognitive cloud / Self-healing cloud | OpenInfra / CNCF / RedHat | NA | OASIS TOSCA | OASIS TOSCA |