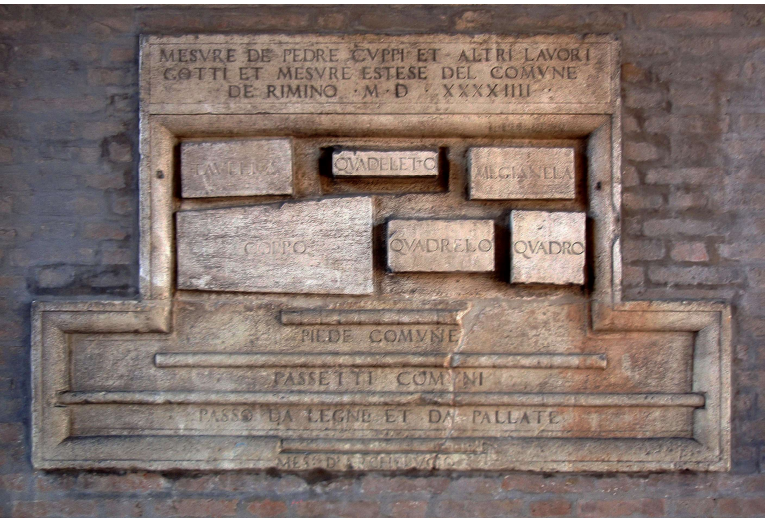
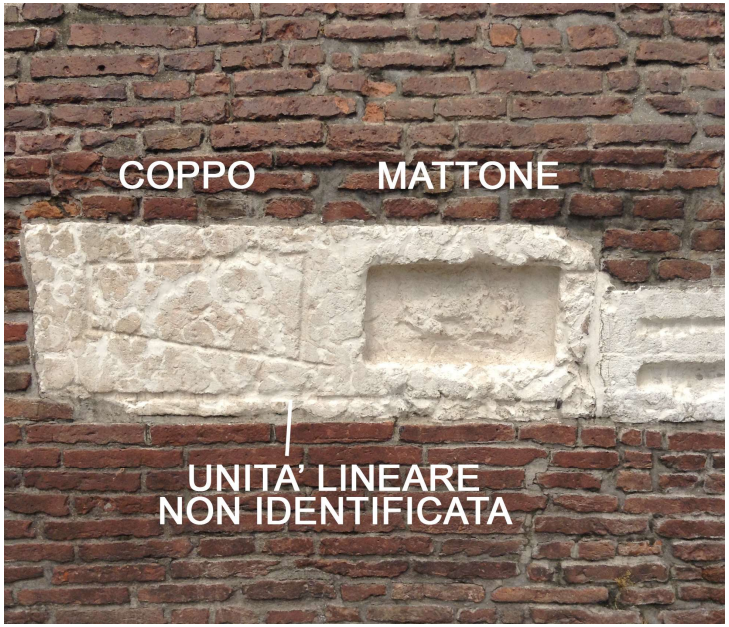
IoT, Digital Twins and Data sharing Standardization

Enrico Scarrone
TC SmartM2M Chair
oneM2M Steering Committee Chair

IFIP-IoT 2024 -

https://ilcapochiave.it/2019/01/15/antiche-unita-di-misura-tra-medioevo-e-rinascimento/





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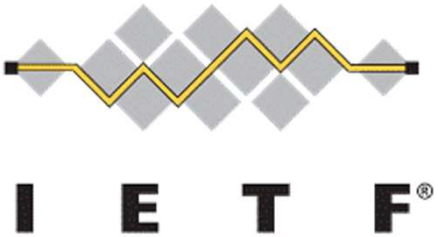
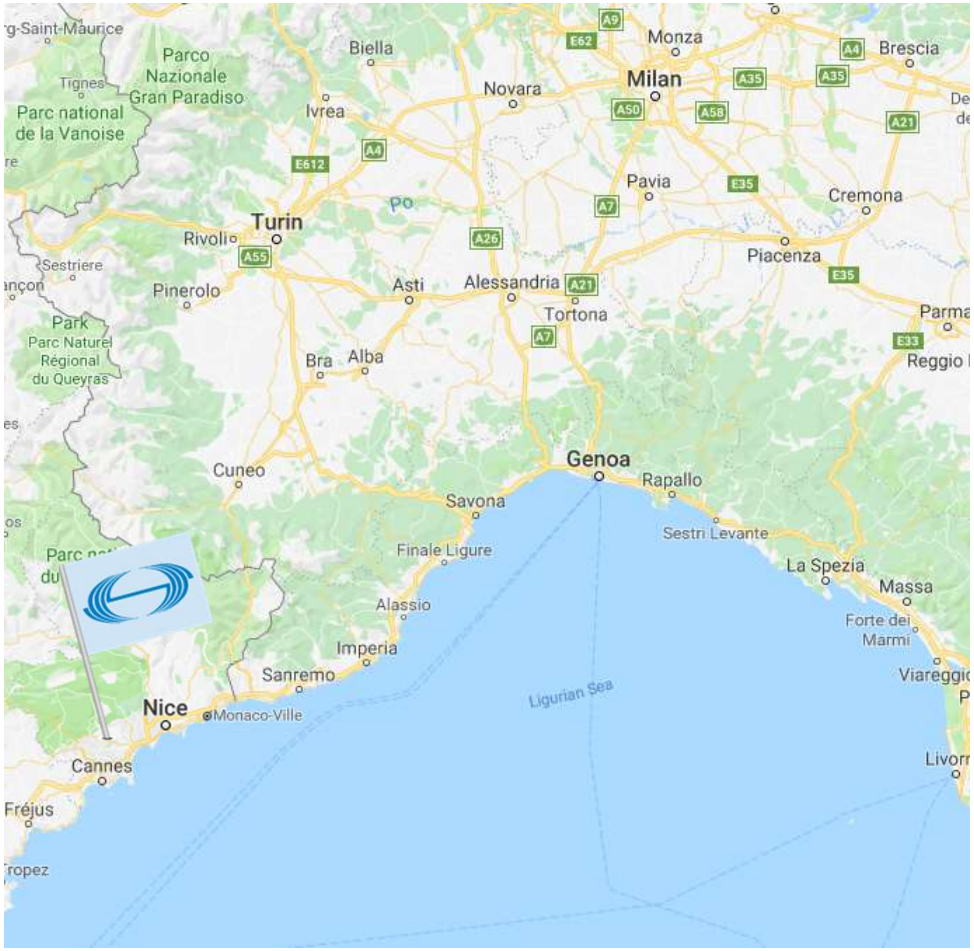
PAVILLON DE BRETEUIL
Bureau
International des
Poids et
Mesures
10

Do You know about?



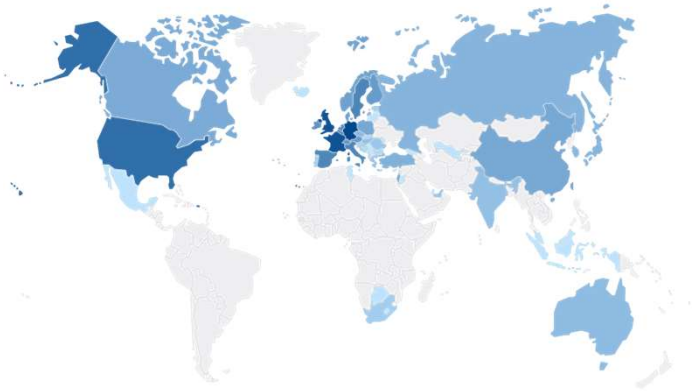
Do You know about ETSI impact on people life?

Sophia Antipolis - France



ETSI: open, global ICT standards organization

- Open, inclusive environment
  - To support the development and testing of globally applicable standards
  - For ICT systems and services across all sectors of industry and society
- Independent, non-profit organization with fair IPR policy
- 35-years track record of technical excellence in the ICT sector
- Available to all, our standards are free of charge (www.etsi.org ->standards)
- ESO:Officially recognized by the European Union to support EU regulation and policies https://www.etsi.org/standards/types-of-standards



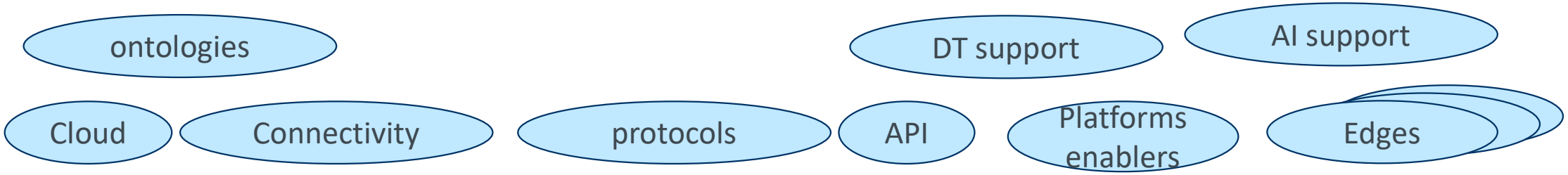
3GPP A GLOBAL INITIATIVE

oneM2M The IoT Standard

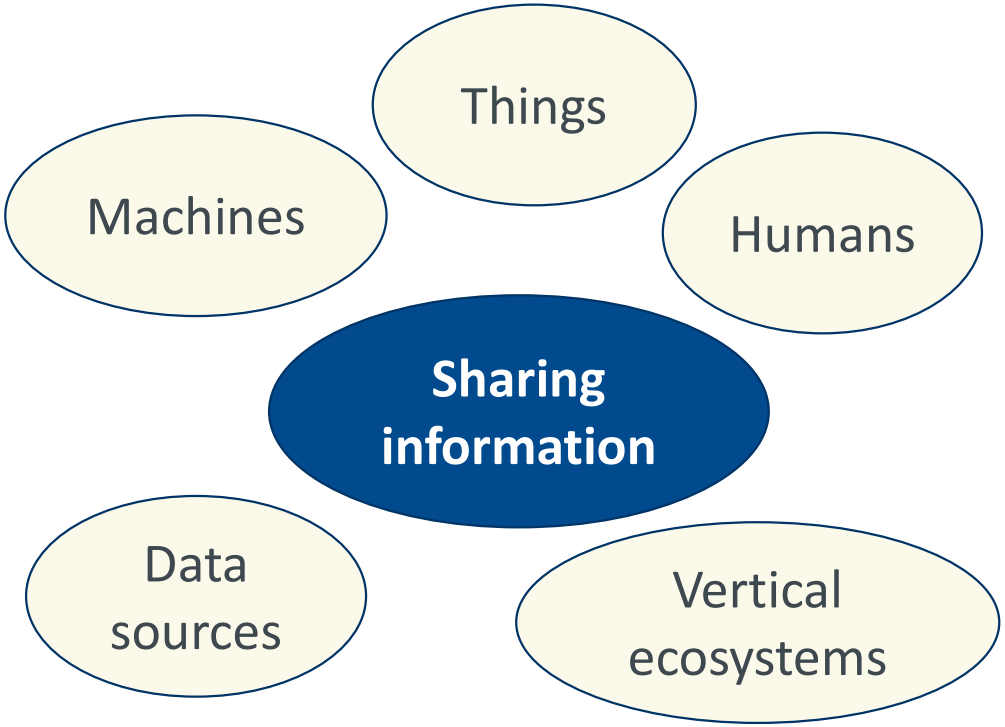
- over 50 000 standards published to date
- Over 2 500 standards published annually
- Over 18 million downloads annually

- 900+ members
- 65 countries
- 25% SME

IoT standardization



IoT standardization



ontologies

DT support

AI support

Cloud

Connectivity

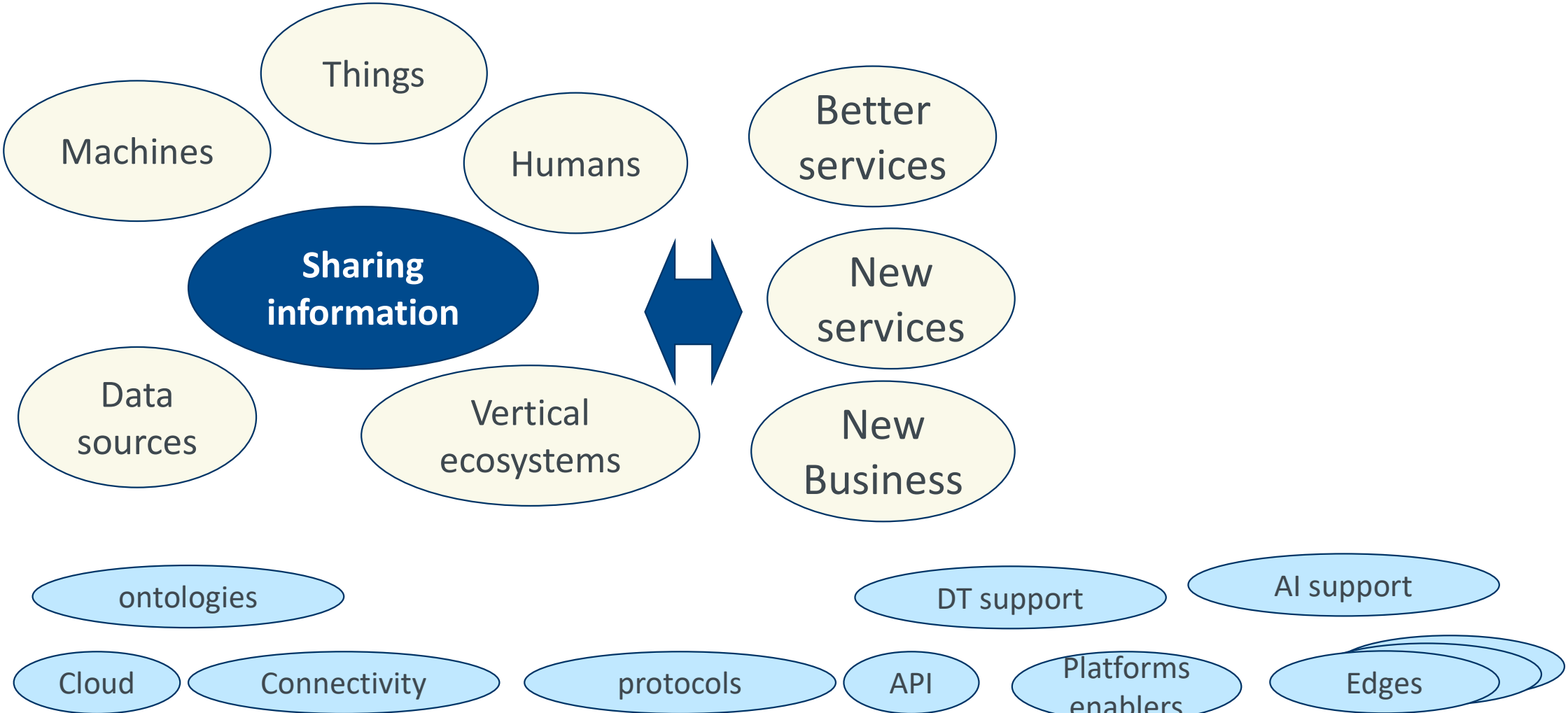
protocols

API

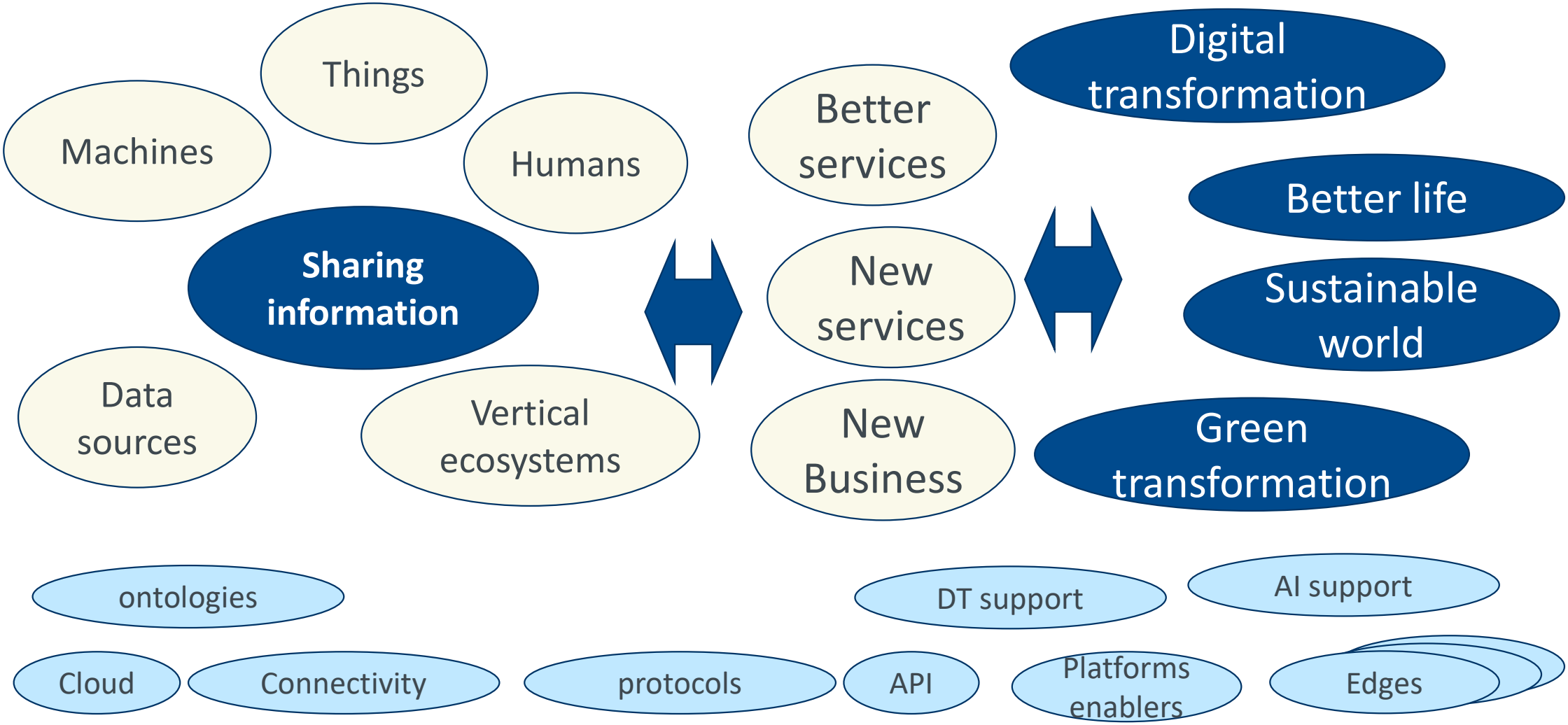
Platforms enablers

Edges

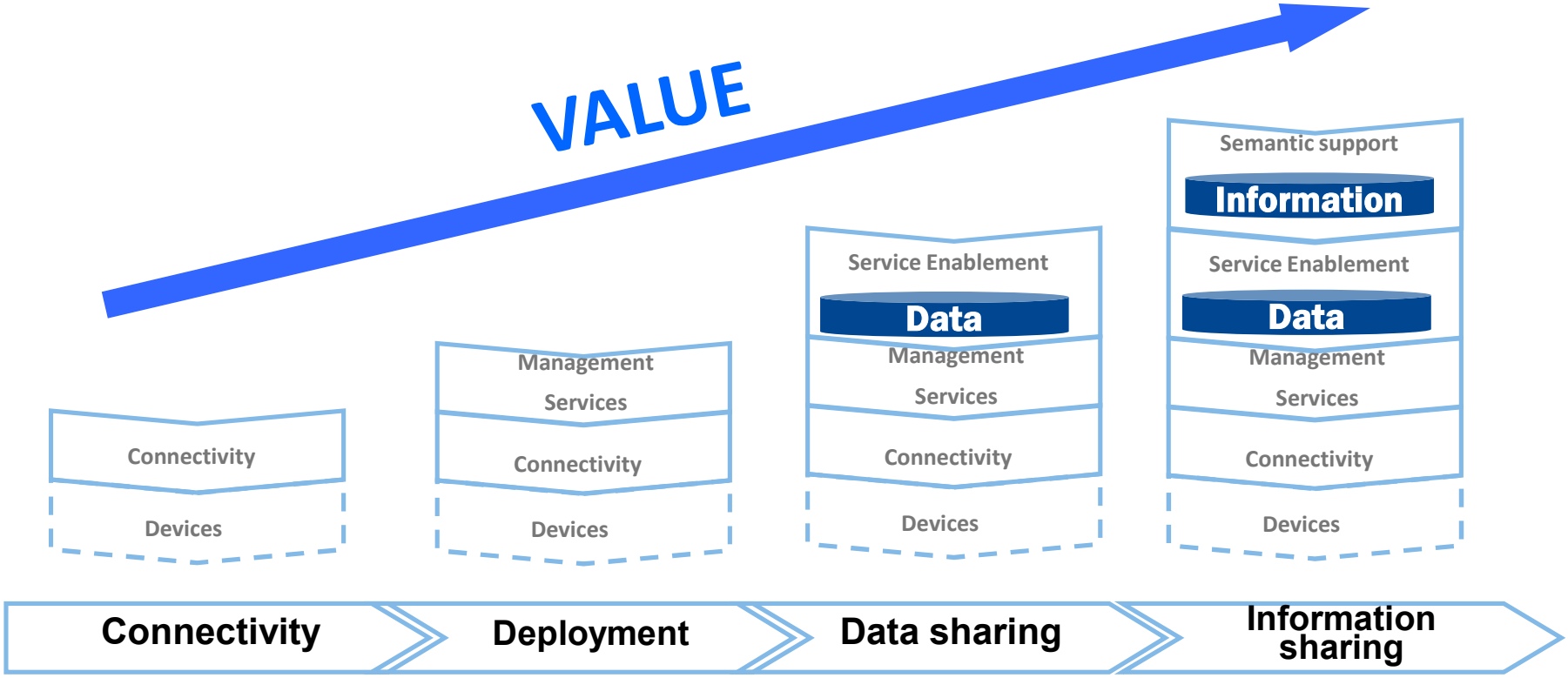
IoT standardization



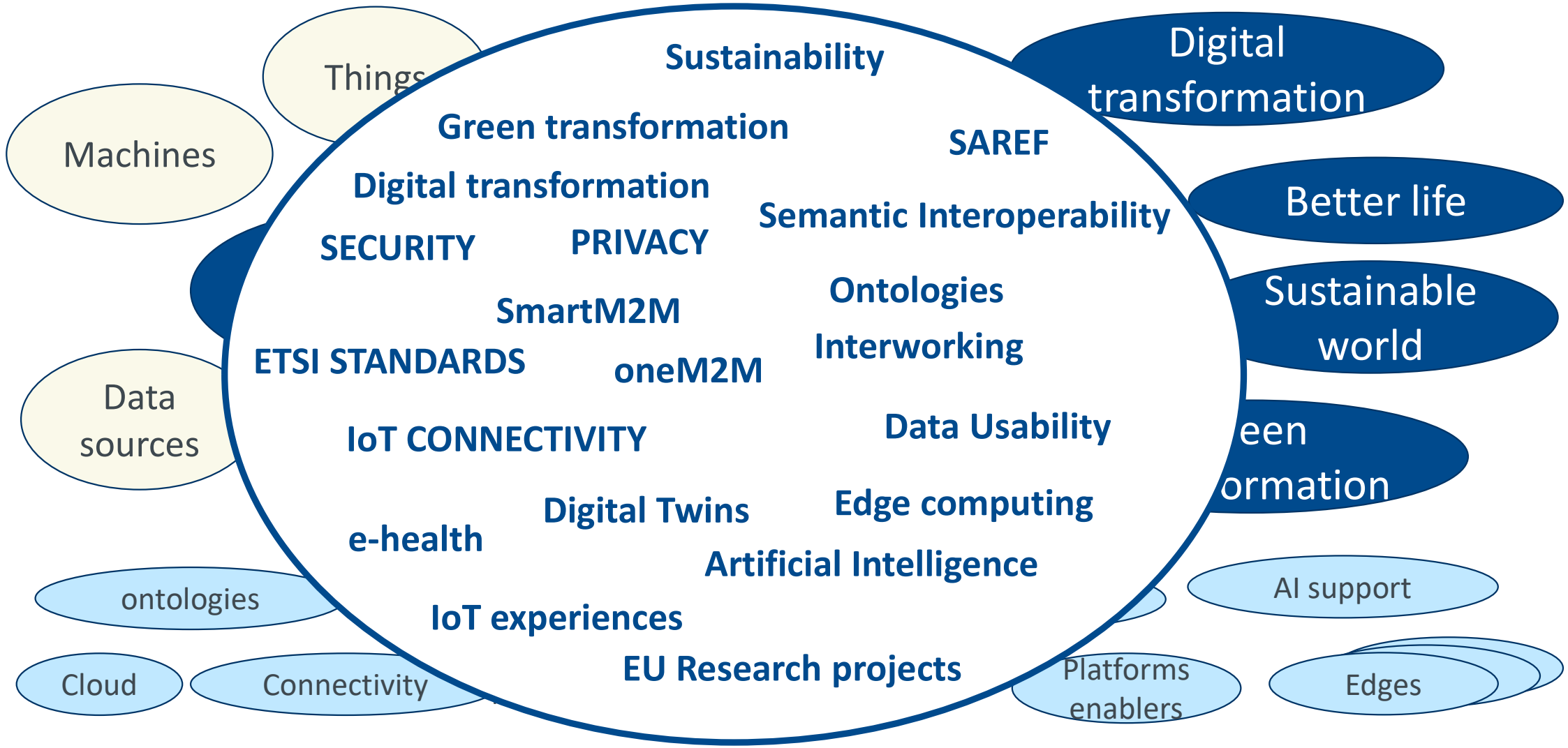
IoT standardization



From Connectivity to Information sharing



IoT standardization



Take a “simple” IoT example

Car incident in a Smart City:

- The incident is detected by the Car and by the road side sensors.
- Traffic is rerouted controlling traffic lights and electronic signals
- The ambulance and the emergency team are sent to the incident place.
- The persons are rescued and their medical conditions are evaluated.
- E-health consultation with the medical experts in the hospital.
- The best hospital is selected based on availabilities, traffic conditions, position and expertise, and the patient(s) are transported
- The overall traffic is controlled giving priority to the ambulance
- During the transportation an initial set of examination are done
- The relatives of the patient are alerted using the municipality information
- Etc….

Internet of Things

The main effort is today on **INTEGRATION** of **DATA PLATFORMS**, **TECHNOLOGY, COMMUNICATION PROTOCOLS**

FRAGMENTATION is the major SHOW STOPPER:

FRAGMENTATION and Solutions LOCKING

ARE DRAINING MOST of the IOT Resources

While the main effort should be on the SERVICES DEVELOPMENT and the INTEGRATION OF INFORMATION generated by the different data sources.

The role of Standardization for IOT

Simplify the environment, **remove** the unnecessary duplicated solutions (economy of scale), **preserve** the necessary/opportune solution specialization by **interworking**

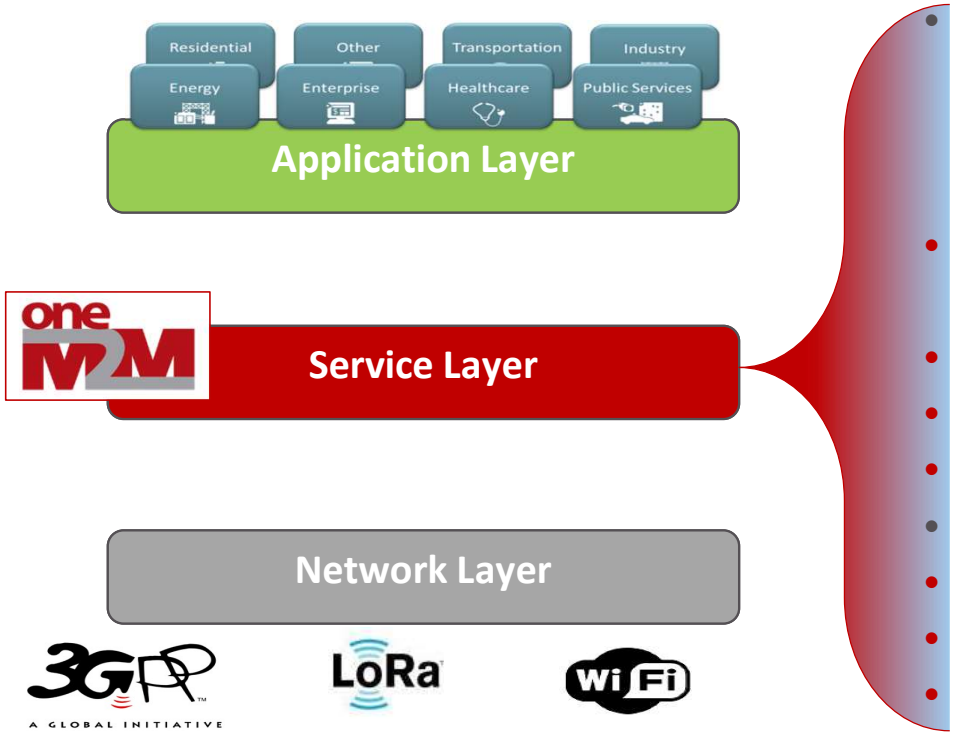
Support the **developers community** accelerating the development of IoT

Transfer the competition from integration and platforms **to services unlocking the market**

Enable Inter-technology and inter-domain data sharing generating **new services and new business opportunity**

Reduce platform development and integration costs,
Enlarge the market,
Enable real competition on services

SHARING DATA - Interworking Data Framework: OneM2M



- oneM2M specifies a **distributed software/middleware layer**, sitting between applications and underlying communication networking HW/SW,Integrated into **devices gateways & servers**
- **Bridges** communication technologies, e.g.: **fixed, NB-IoT, 3GPP 4G, 5G, LoRa..**
- **Interworks** existing solutions
- **Manages data** (communicate, store, share)
- **Manages devices and nodes**
- Allows to **annotate data** with **semantic descriptions**
- **It is IP based and URL/URI based**
- **Identifiers** are IP domain based **(URI-like format)**
- **Separation** of **communication** (data management) from specific **semantic** aspects (the information)

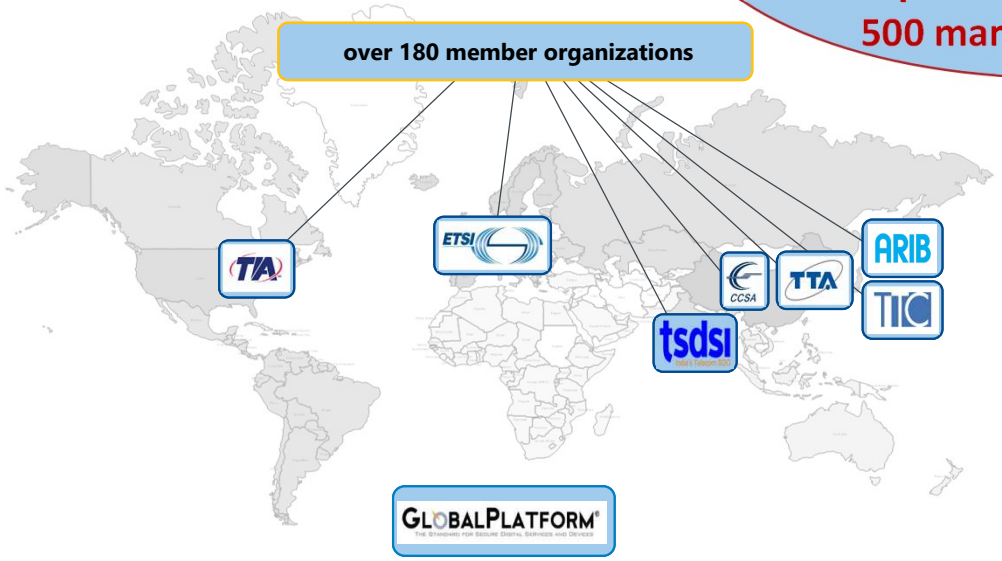
…and most importantly: ***is a Global Standard – not controlled by a single private company!***

WHY to use oneM2M For Smart Lifts?

oneM2M is a global Standard
- It is open and not controlled by a single private company!

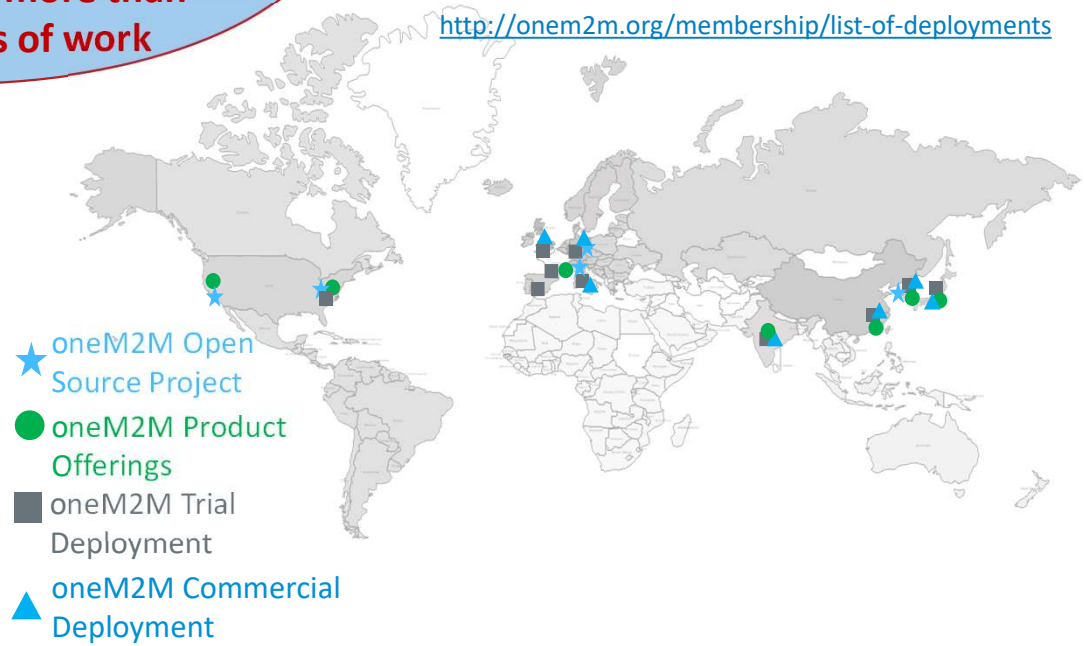
oneM2M is hugely stable and complete
It shares the innovation effort of hundreds of companies with more than 500 man years of work

Full Ecosystem:
open “de jure” specs – opensource-interoperability – certification-products and services



www.oneM2M.org
All documents and specifications are publically available

http://onem2m.org/membership/list-of-deployments



WHY toneM2M?

- **THE ONLY STANDARD "DE JURE" DEDICATED TO ENABLE HORIZONTAL IOT INTEGRATION**
- **DATA MANAGEMENT - DATA HISTORIZATION - INFORMATION SHARING**
- **VERY DYNAMIC PRIVACY AND ACCESS CONTROL**
- **SECURE: MULTIPLE SECURITY LEVELS**
- **STORAGE AND EXPOSURE FOR**
  - **Historical data**
  - **Data search and aggregation**
  - **Context information**
  - **Dynamic data**
  - **Real time control and actuation**
  - **Field device management**
  - **Network technologies independence**
- **EASY DB AND CLOUD INTEGRATION**
- **NATIVE DEVICE MANAGEMENT (DM; TR 069)**
- **FLEXIBLE IN THE DEPLOYMENT to adapt to the requirements of the various domains**
- **SCALABLE ARCHITECTURE**
- **INTER-PROVIDER NATIVE SUPPORT**
- **DESIGNED BE AN INTERWORKING FRAMEWORK FOR**
  - **Legacy field and core server technologies**
  - **Other technologies**
  - **Proprietary solution**

  -> Not an additional solution, but a standard to integrate the different solutions
- **SEMANTIC ENABLED TO SHARE INFORMATION**
- **INTERNET FRIENDLY FOR HUMAN INTERACTION**
- **SIMPLE if you use the core functions and know your deployment architecture**

SHARING INFORMATION Semantic Interoperability: SAREF Methodology

- SAREF is a suite of individually versioned ontologies that contains
  - a core ontology
  - a set of reference ontology patterns that provide guidelines on how to use and extend SAREF
  - different extensions for vertical domains

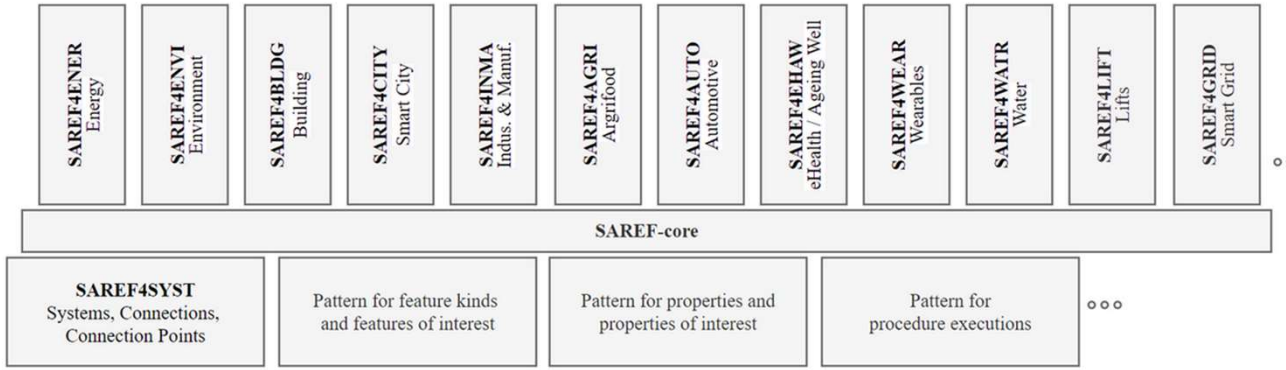
  providing a mature, sustainable and **standardised framework of ontologies for IoT**

- SAREF **enables interoperability** at the semantic level **between solutions from different providers** and **among various activity sectors in the Internet of Things**

- SAREF is based on the **fundamental principles** of
  - **reuse and alignment** of concepts and relationships that are defined in **existing assets**, e.g. oneM2M base ontology, W3C® SKOS ontology, OGC® GeoSPARQL vocabulary
  - **modularity** to allow separation and recombination of different parts of the ontology depending on specific needs,
  - **extensibility** to allow further growth of the ontology,
  - **maintainability** to facilitate the process of identifying and correcting defects, accommodate new requirements, and cope with changes in (parts of) SAREF.

SAREF – Documentation and Tools

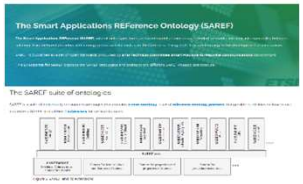
SPECIFICATIONS



SAREF is built of a **series of Technical Specifications** specifying the SAREF suite of ontologies

TOOLS

SAREF ontology portal



https://saref.etsi.org/

SAREF forge

https://labs.etsi.org/rep/saref/

SAREF pipeline

https://labs.etsi.org/rep/saref/saref-pipeline/

In order facilitate the SAREF suite of ontologies and to enable the SAREF community and industry stakeholders to contribute directly to the SAREF evolution **accompanying tools** have been developed in ETSI

SAREF on the Move …and in Use

SAREF is designed to evolve and expand in future

2013
SMART 2013/007 **study launched by European Commission & ETSI TC SmartM2M**
- Agreed semantics for smart appliances
- Build a reference ontology

2014
Publication of **SAREF V1** as ETSI TS 103 264

2015
STF 513
- Publication of **SAREF V2** extensions: **Energy, Environment, Buildings**

STF 534
- Publication of SAREF extensions: **Smart Cities, Industry and Manufacturing, Smart Agriculture and Food Chain**

2016
Follow-up SMART 2016/0082 study launched by European Commission:
- Interoperability for Demand Side Flexibility (DSF)

2017
STF 556
- Publication of SAREF extension: **Systems**
- **SAREF Forge**, publication **SAREF framework**: a uniform documentation website for SAREF and its extensions (prototype)

2018
STF 566
- Publication **SAREF V3** extensions: **Automotive, Water, Health, Wearables**)

2019
STF 578
- SAREF development **framework and workflow**
- SAREF **ontology portal** (https: …tsi.org/)

2020
STF 602
- SAREF extension: **Lifts**
- **oneM2M allignment**

2021
STF 653
- SAREF **harmonization**
- **Consolidation** of SAREF extensions
- SAREF development **framework and workflow V1.2**
- SAREF **ontology portal update**

STF 641
- SAREF harmonization
- Consolidation of SAREF extensions
- **SAREF V3.2.1**
- SAREF and **Digital Twins**
- **SAREF EN**

TC SmartM2M
- SAREF extension: **Smart Grid**

2022

2023

- SAREF has been developed and maintained by ETSI since 2015 under stimulus and continuous support of the European Commission in collaboration with ETSI
- SAREF provides a **standardized suite of ontologies,** a shared model of consensus, with currently 12 extensions in different domains:
  Energy, Environment, Building, Smart Cities, Industry and Manufacturing, Smart Agriculture and Food Chain, Automotive, eHealth/Ageing-well, Wearables, Water, Lift, Smart Grid

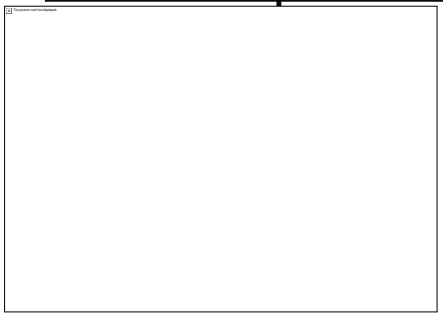
SAREF implementations:
Some Pilot projects:
INTERCONNECT, OMEGA-X, Hedge Companies, universities, organizations

➔ **SAREF is designed to evolve and expand in future**

 Adapted from images by Laura Daniele (TNO) and STF 641 Terms of Reference

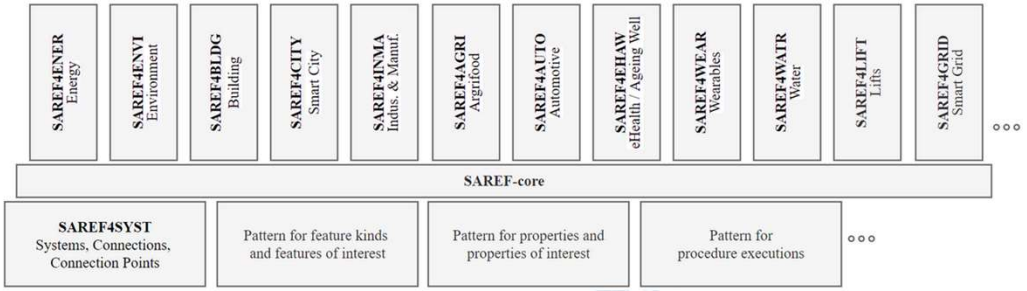
SAREF EN – Principles

SAREF Europen Norm



references to

SAREF Technical Specifications (TSes)



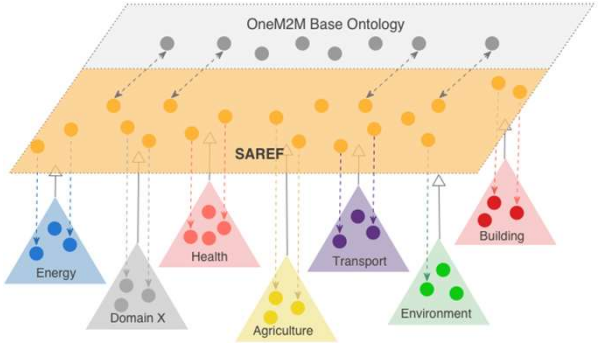
- **Specifies a process**
- Brings together widely considered **good practice in semantic interoperability** for IoT smart applications in a **set of high-level outcome-focused provisions**
- Provides **guidance** on making IoT smart applications and products interoperable in compliance to the SAREF framework to the SAREF process and SAREF TSes
- Provides a static **basis to support normative and regulation recommendations**

- Heart of SAREF ontology suite: Core Specification and currently 12 Extension Specifications
- TSes allow to maintain the **SAREF evolution flexible and dynamically**

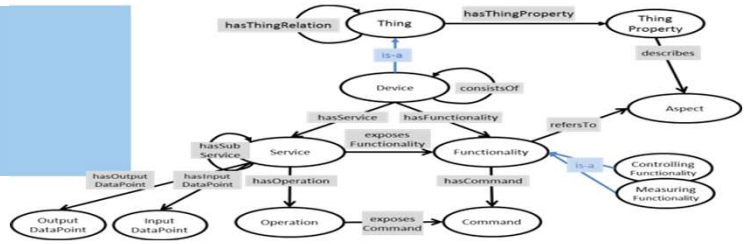
In the year 2022 the EC/EFTA has commissioned ETSI to draft an European Norm on SAREF (beside other documents). This technical work has been assigned to an ETSI Specialist Task Force (STF641 – SAREF for Digital Twins), founded in November 2022.
High Level Objective: Giving provisions, how to implement, prove and show SAREF compliance with EN SAREF process and SAREF Technical Specifications

Universal semantic interoperability SAREF/oneM2M

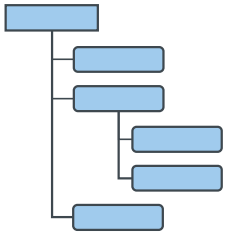
Specific Abstraction Models, grouped around a core common ontology



General base Ontology



OneM2M resources
Semantic annotation of data



1) Vertical ontologies support → **SAREF and its extensions**

2) Semantic Support → **IoT base ontology + Data annnotation**

3) Communication Framework → **IoT Data sharing**

EU DATA ACT Chapter VIII - High Lights

Chapter VIII – Interoperability

Article 33 – Essential requirements regarding interoperability of data, of data sharing mechanisms and services, as well as of common European data spaces

- Participants in data spaces that offer data or data services to other participants shall comply with the following essential requirements to facilitate the interoperability of data, of data sharing mechanisms and services, as well as of common European data spaces which are purpose- or sector-specific or cross- sectoral interoperable frameworks for common standards and practices to share:
  - the dataset content, use restrictions, licences, data collection methodology, data quality and uncertainty shall be sufficiently described, where applicable, in a machine-readable format, to allow the recipient to find, access and use the data
  - the data structures, data formats, vocabularies, classification schemes, taxonomies and code lists, where available, shall be described in a publicly available and consistent manner
  - the technical means to access the data, such as application programming interfaces, and their terms of use and quality of service shall be sufficiently described to enable automatic access and transmission of data between parties, including continuously, in bulk download or in real-time in a machine-readable format where that is technically feasible and does not hamper the good functioning of the connected product
  - where applicable, the means to enable the interoperability of tools for automating the execution of data sharing agreements, such as smart contracts shall be provided

EU DATA ACT Chapter VIII - High Lights

Chapter VIII – Interoperability

Article 35 – Interoperability of data processing services

Open interoperability specifications and harmonised standards for the interoperability of data processing services

- shall (paragraph 1):
  - achieve, where technically feasible, interoperability between different data processing services that cover the same service type
  - enhance portability of digital assets between different data processing services that cover the same service type
  - facilitate, where technically feasible, functional equivalence between different data processing services referred to in Article 30(1) that cover the same service type
  - not have an adverse impact on the security and integrity of data processing services and data
  - be designed in such a way so as to allow for technical advances and the inclusion of new functions and innovation in data processing services
- shall adequately address (paragraph 2):
  - the cloud interoperability aspects of transport interoperability, syntactic interoperability, semantic data interoperability, behavioral interoperability and policy interoperability
  - the cloud data portability aspects of data syntactic portability, data semantic portability and data policy portability
  - the cloud application aspects of application syntactic portability, application instruction portability, application metadata portability, application behavior portability and application policy portability.

EU DATA ACT Chapter VIII - High Lights

Chapter VIII – Interoperability

Article 36 – Essential requirements regarding smart contracts for executing data sharing agreements

- Paragraph 1

  The vendor of an application using smart contracts shall ensure that those smart contracts comply with the following essential requirements of:

  - robustness and access control, to ensure that the smart contract has been designed to offer access control mechanisms and a very high degree of robustness to avoid functional errors and to withstand manipulation by third parties
  - safe termination and interruption, to ensure that a mechanism exists to terminate the continued execution of transactions and that the smart contract includes internal functions which can reset or instruct the contract to stop or interrupt the operation, in particular to avoid future accidental executions
  - data archiving and continuity, to ensure, in circumstances in which a smart contract must be terminated or deactivated, there is a possibility to archive the transactional data, smart contract logic and code in order to keep the record of operations performed on the data in the past (auditability)
  - access control, to ensure that a smart contract is protected through rigorous access control mechanisms at the governance and smart contract layers
  - consistency, to ensure consistency with the terms of the data sharing agreement that the smart contract executes

Supporting the EU Data Act

Communication by means of interoperable standards is the focus ETSI standardization, and communication requires on top of the connectivity, the ability of sharing data, but even more relevantly, the ability share (AKA understand) the information carried by the data.

SmartM2M with SAREF (Smart Application REFerence Ontology) methodology, offering an ontology framework for semantic interoperability across ontologies from different sectors, and supporting their dynamic evolution.

Not only that: This is a widespread approach in ETSI: all the TBs deals with data are considering these aspects

Why especially SAREF?

SAREF is a methodology for integrate and interoperate existing ontologies and for creating new ones.

-It is **open**, with a **portal** (https://saref.etsi.org/) to propose SAREF modifications and extensions also open to **non-ETSI members**

-It is **dynamic**, it can evolve quickly

-It can be applied **flexibly** according to different needs

-It has a very good level of **acceptance**

-It is **complementary** and aligned to the W3C ontology approach and definitions

-the process adopting SAREF is supported by the **Draft EN303 760 (SAREF Guidelines for IoT Semantic Interoperability; Develop, apply and evolve Smart Applications ontologies)**, which is currently under NSO revision

-it already integrates a **very wide set** of ontologies from **12 sector domains** (see https://saref.etsi.org/extensions.html), and smartM2M is working, in collaboration **with ISG CDM, to add also the maritime ontologies**, comprehensive of the already consolidated **CISE** data model

-If used with **oneM2M**, they almost **symbiotically** completing one each other, and covering a wide set of the requirements. They are designed to **avoid solution lock-in**

IoT is all about sharing information(s)!!!!

Grazie!
Thank you!

Dr. Enrico Scarrone

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TIM | Communication and Standards

OneM2M Steering Committee Chairman
ETSI TC SmartM2M Chairman

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