Toward open smart IoT Systems

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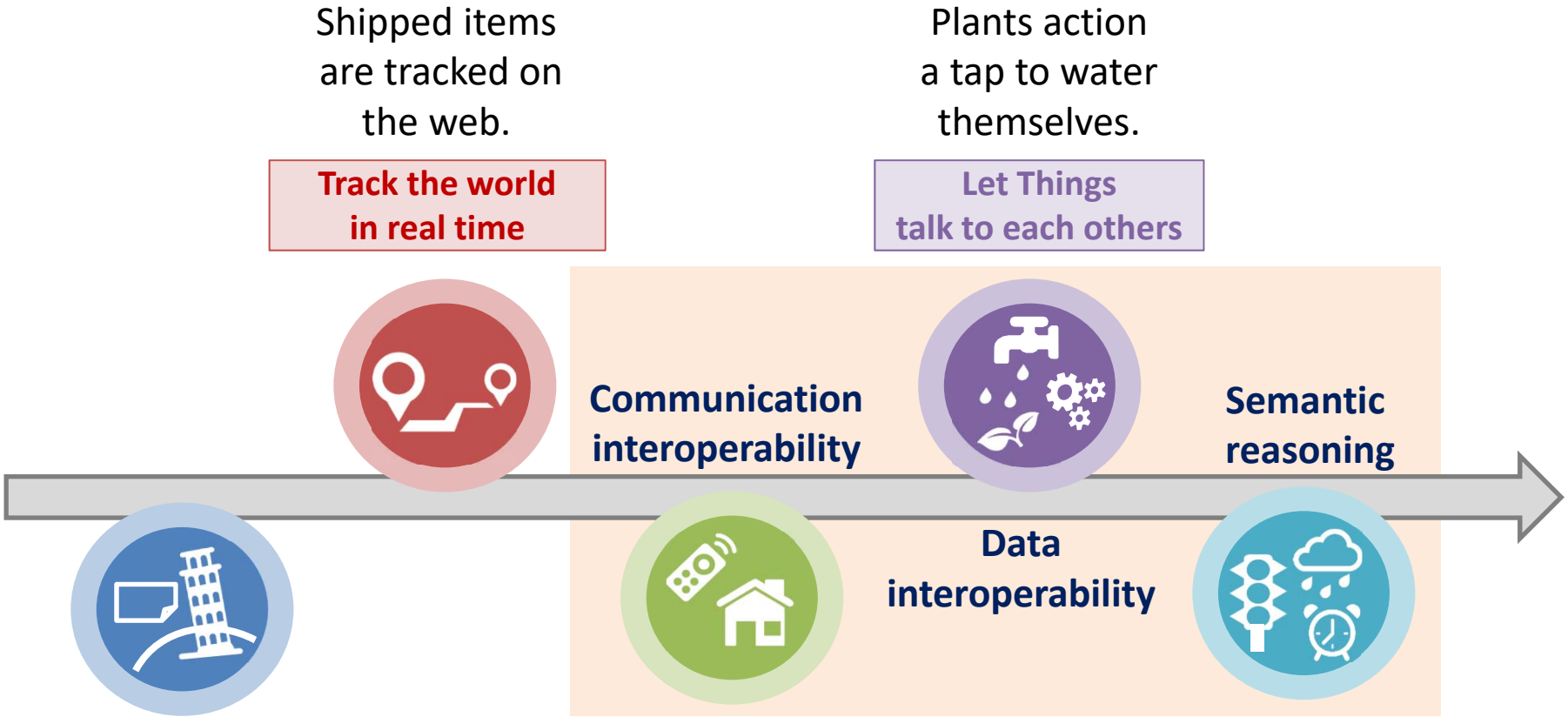
Workshop Blockchain and IoT opportunities for the SMEs, Turino, April 18, 2018

The evolution of IoT



IoT: Definition

By M. Sabzinejad Farash, et al. *An efficient user authentication and key agreement scheme for heterogeneous wireless sensor network tailored for the Internet of Things environment*. Ad Hoc Networks 36: 152-176 (2016)

> The concept of Internet of Things is that every **object in the Internet** infrastructure is **interconnected** into a global **dynamic** expanding **network**.

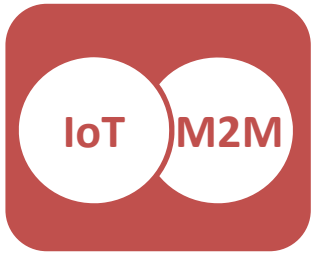
M2M: Definition

ITEA2 Project USENET
2007-2010

INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

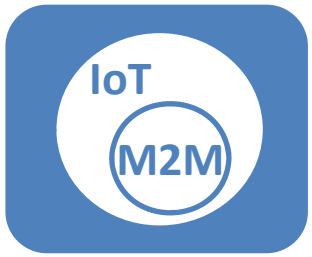
> M2M (Machine-to-Machine) communication: The ability of machines (sensors, devices, servers, appliances, etc.) to communicate with each other without human interventions.

IoT vs M2M: 3 visions



M2M as an industrial environment

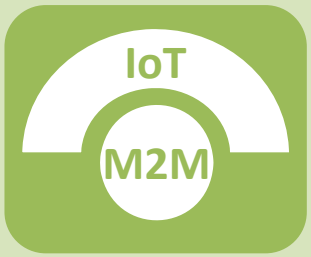
- M2M: based on industrial protocols, closed solutions.
- IoT: common usage applications, open solutions for mass.



M2M as a subset of IoT

- M2M: connects devices, electronic sensors, RFID tags.
- IoT: connects general things, animals, peoples.

We adopt this vision

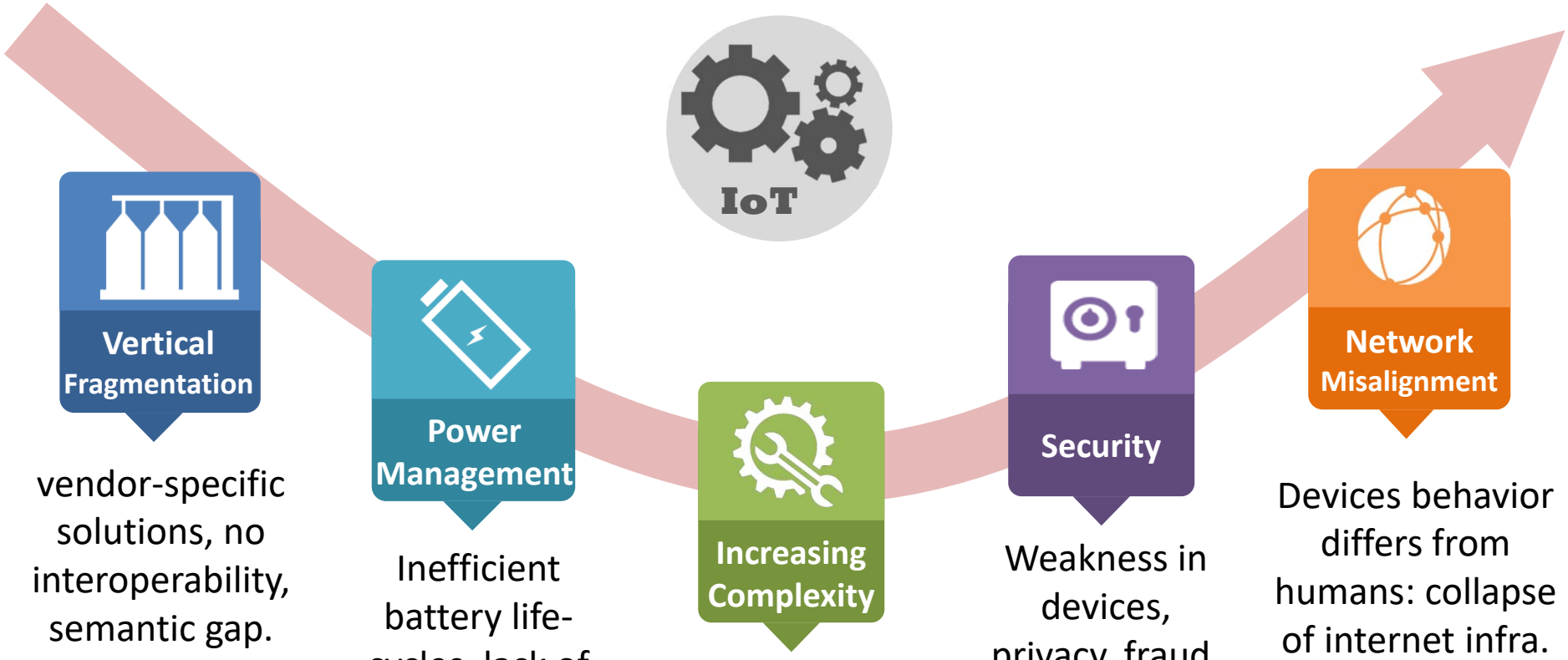


M2M as the kernel of IoT

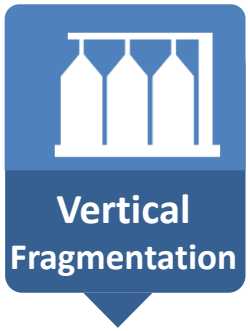
- M2M: communication platform for IoT applications.
- IoT: is implemented by M2M technology.

IoT/M2M main challenges

M2M Communications A Systems Approach. *David Boswarthick, Omar Elloumi, Olivier Hersen* (Wiley April 2012)



IoT/M2M main R&D directions



- **Common services & horizontal architectures**
- **Semantic Interoperability:**

Communication,

Data levels

Energy Saving & Harvesting:

Device-level,

Protocols-level,

Application/Process/Mission-level

-**Autonomic Management**

Scalability & virtualization

-Dynamic deployment & discovery

-Model-based design & mgt

- Data Analytics & ML

Authentication, Authorization, Accounting

Privacy

-Softwarized & Virtualized Networks: SDN, NFV, LPWAN (LoRa, NB-IoT),

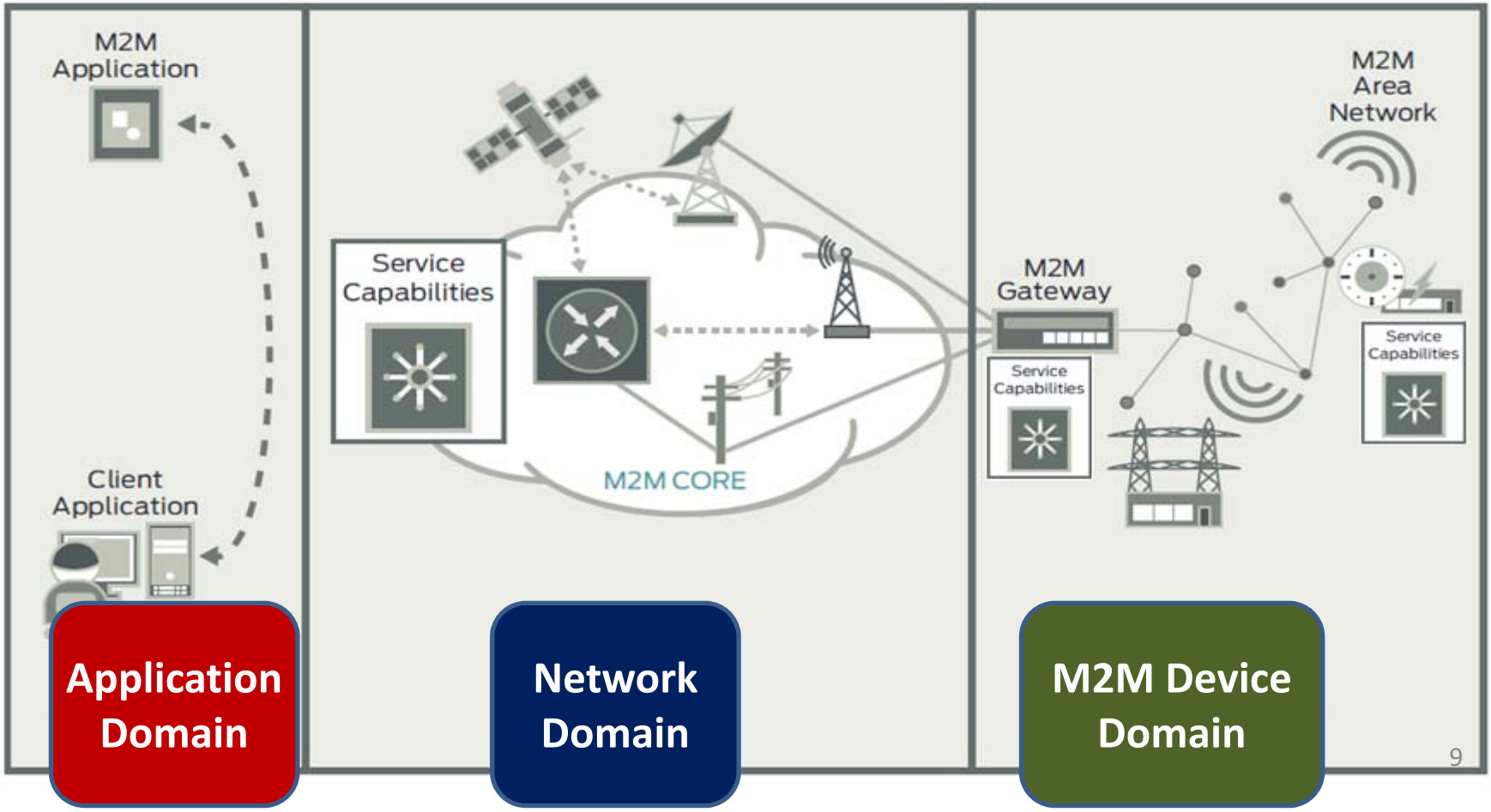
-Sliced Networks (5G)

-Data filtering

Standards landscape for IoT/M2M

143 organizations around the world are involved in IoT/M2M standardization according to the Global Standards Collaboration M2MTask Force.

IoT/M2M high level **Reference Architecture**

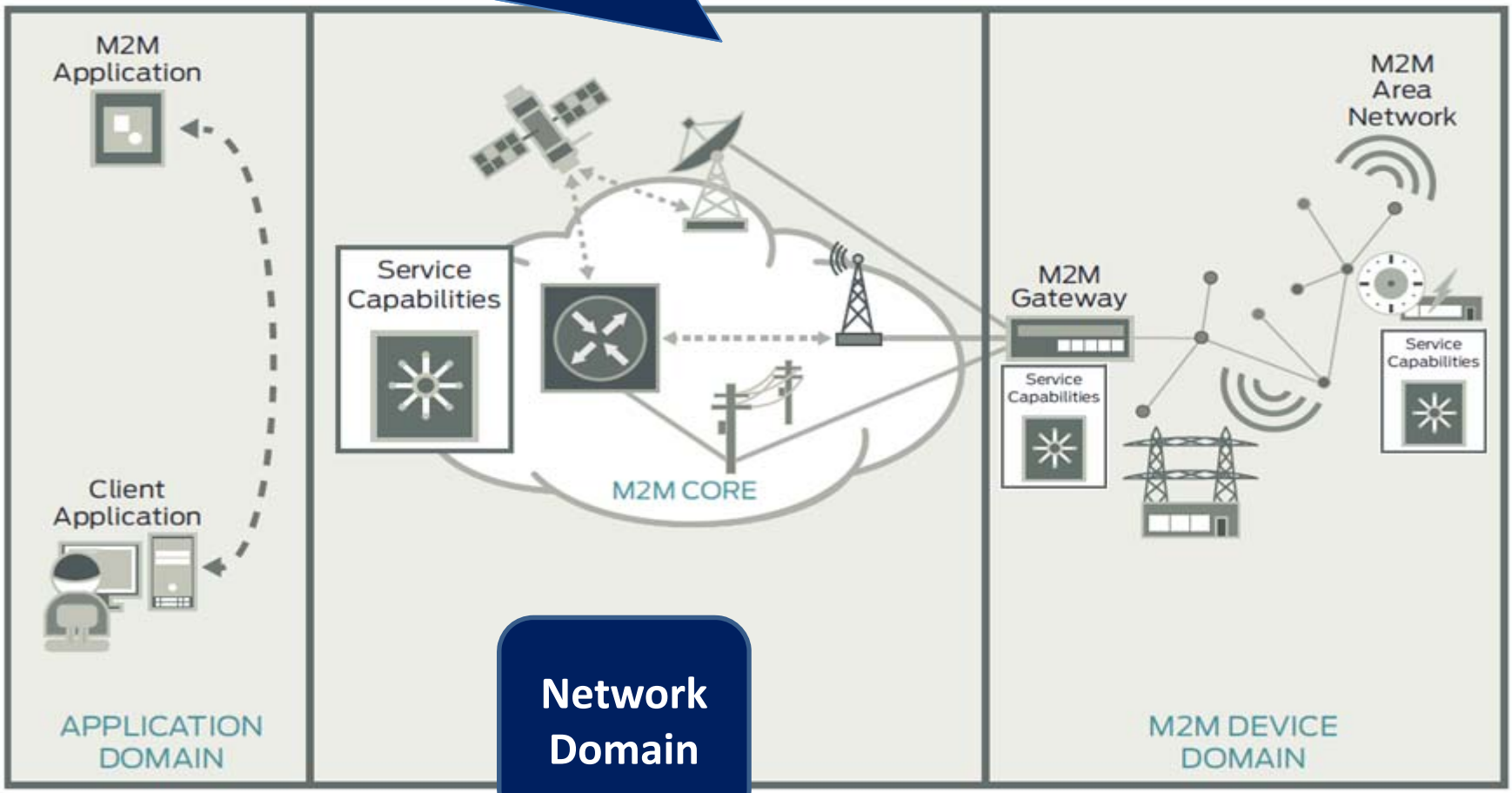


Source: http://www.etsi.org/technologies-clusters/technologies/m2m

Standards for Wide Area Networks

Standards for Wide Area Networks
(3GPP; LPWAN: LoRa, NB-IOT)

Target: protect networks against negative effects of M2M traffic (huge number of devices, non-human new traffic …)

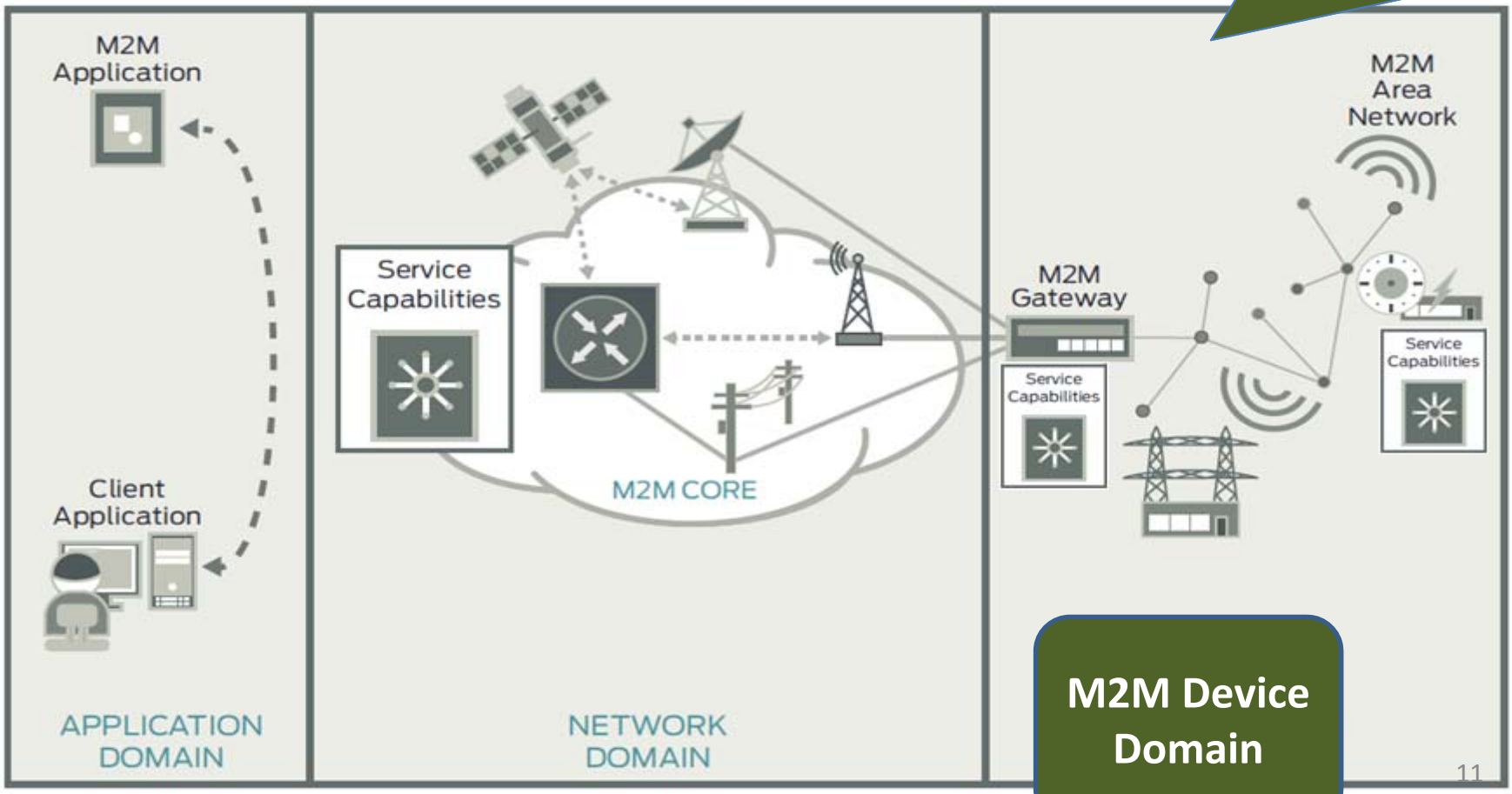


http://www.etsi.org/technologies-clusters/technologies/m2m

Standards for IoT/M2M Area Networks

Standards for Local Area Networks (ZigBee, Bluetooth, PLC, etc.)

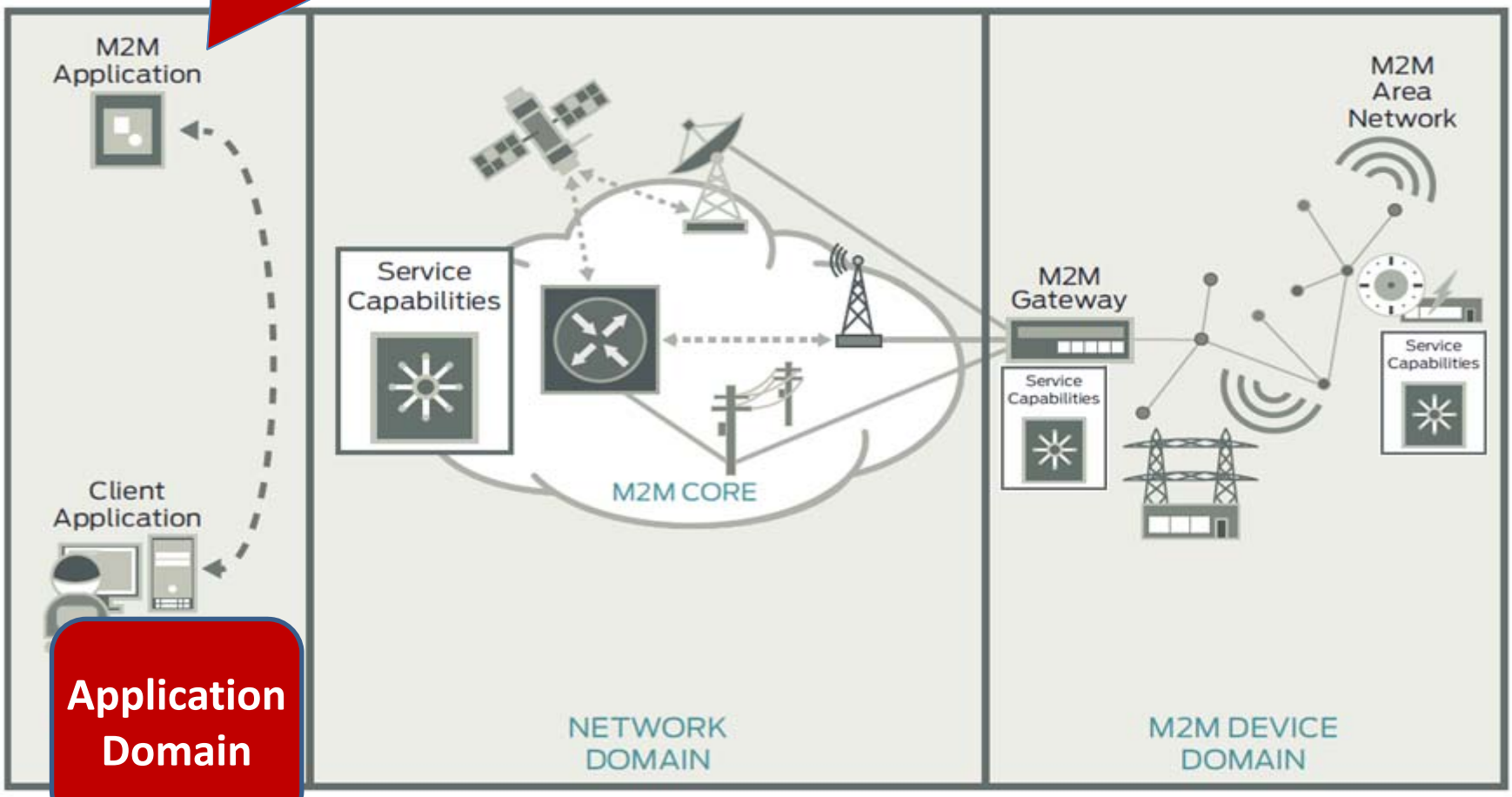
Target: foster use of LAN technology by supporting a diverse ecosystem of service providers and device manufacturers.



http://www.etsi.org/technologies-clusters/technologies/m2m

Standards for vertical industries

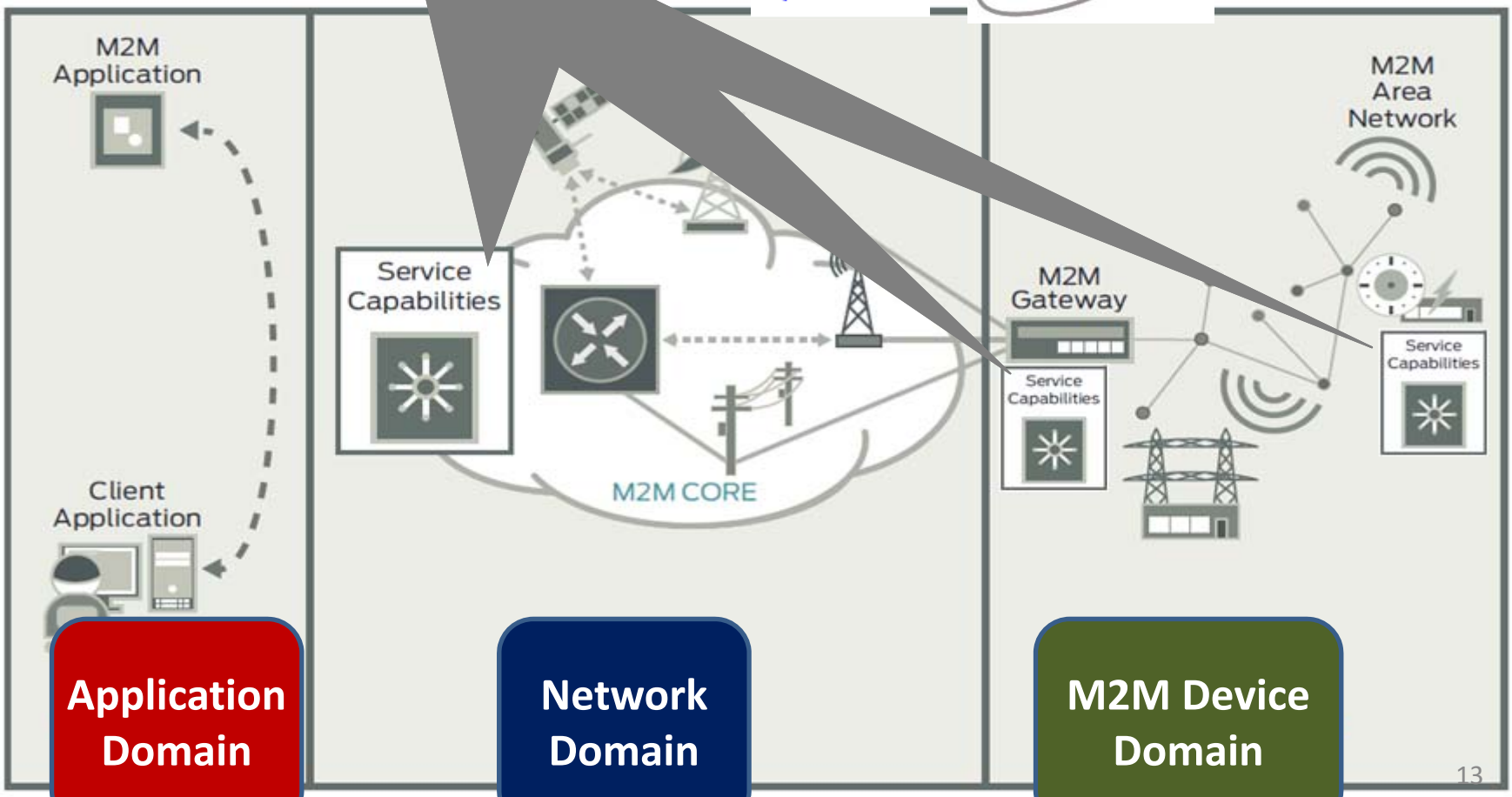
Standards for vertical Industrial applications
Target: enable interoperable, cost-efficient Solutions.



Standards for IoT/M2M service capabilities

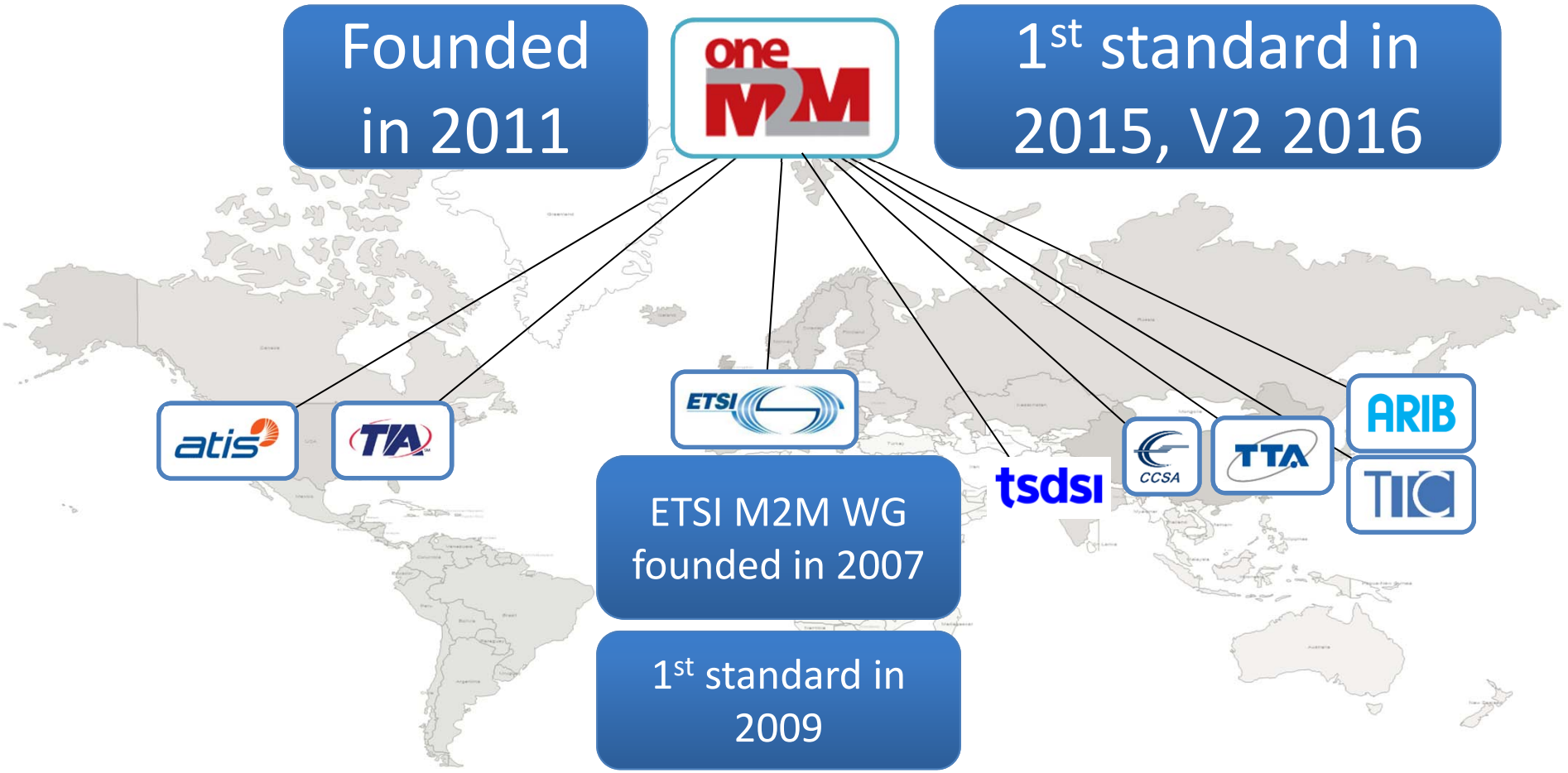
Standards for IoT/M2M Service capabilities:

Target: end-to end enablement across servers, gateways, and devices.
Standardized service interfaces.

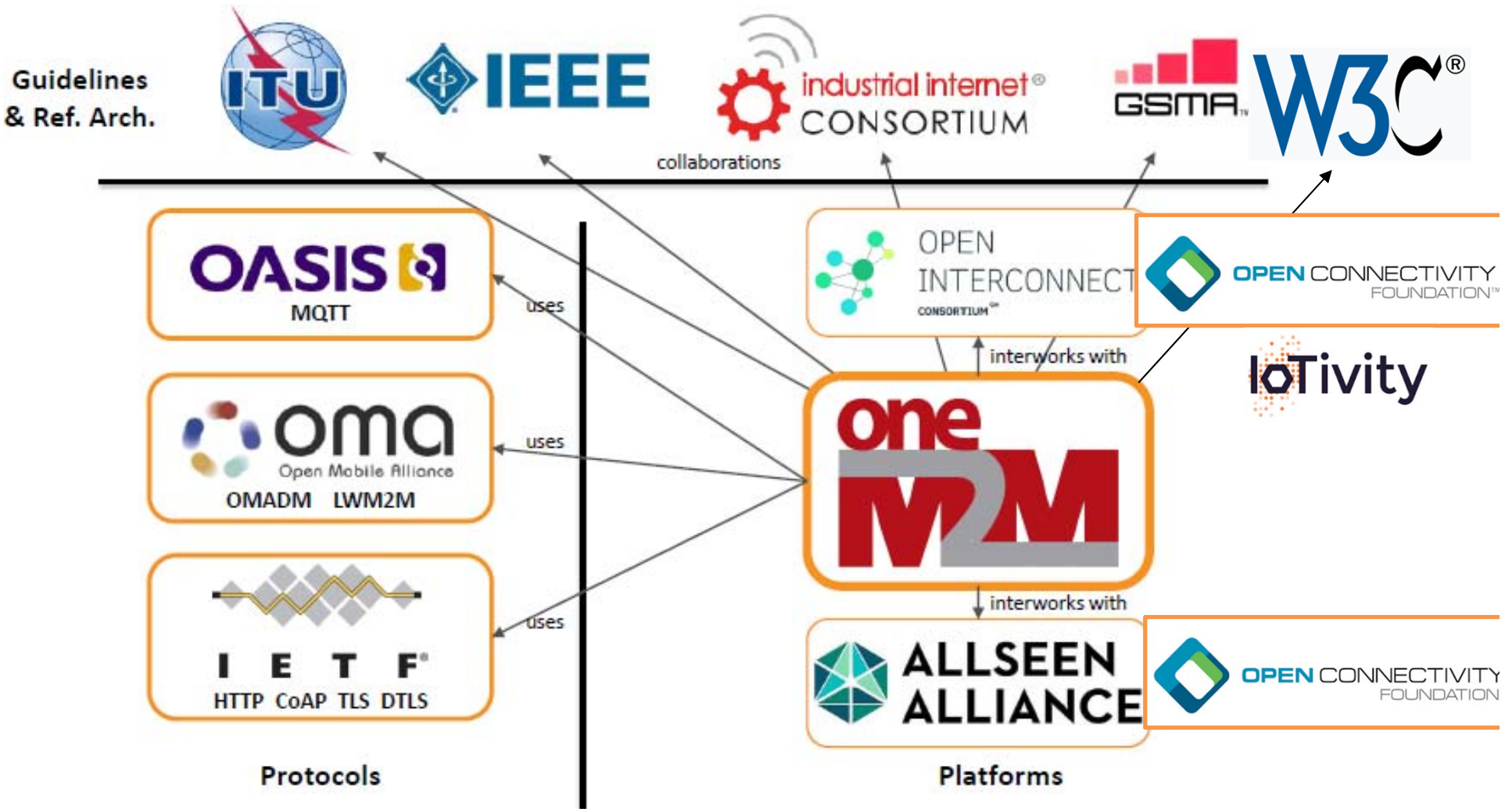


http://www.etsi.org/technologies-clusters/technologies/m2m

The international standardization initiatives



oneM2M liaisons



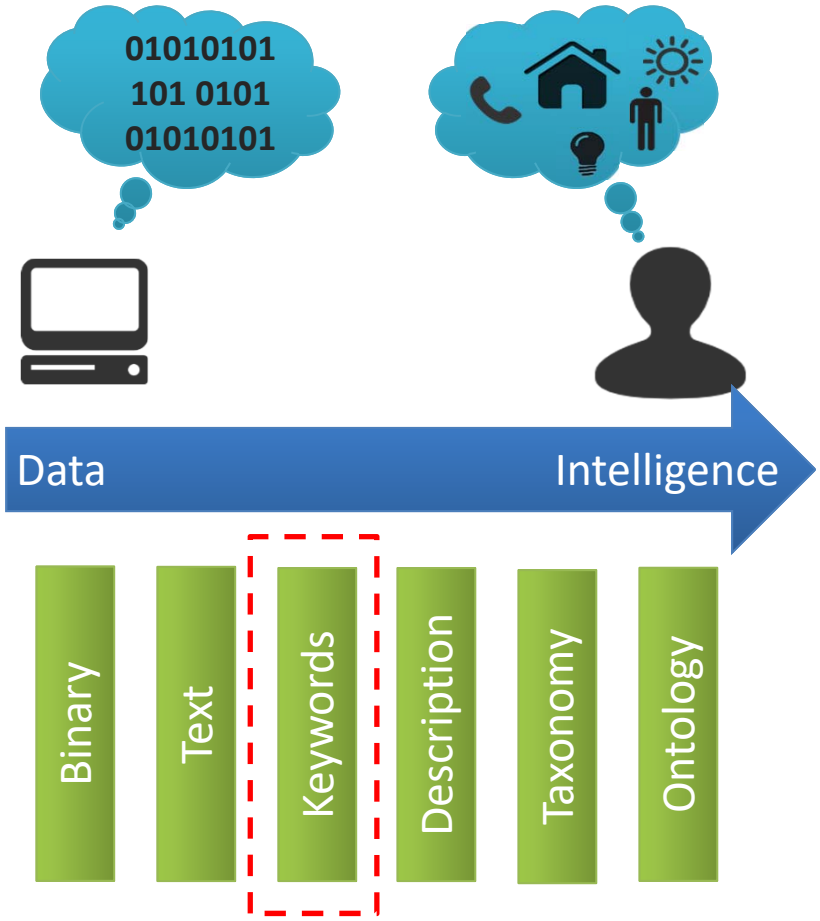
Semantic gap breaks IoT horizontality

Interoperability in IoT standards:

- Resources **description** and **discovery** are based on **keywords** (labels).
- Applications use their **own vocabulary** (beforehand agreement between designers).
- **Limited interworking** to some use cases (based on specific formats).

Towards a common vocabulary for IoT

- Managing devices with high degree of **autonomy**.
- The **need for semantic** to describe specific domains.
- Easily **discover, interpret and share data** between vertical applications.



IoT Standards interoperability is based on keywords

Semantic Web vs. Semantic IoT

- *Semantic Web*:
  - Relatively **static content**.
  - e.g. Semantic Wikipedia (dbpedia), annotated pages, etc.
- *Semantic IoT*:
  - Highly **dynamic environment**.
  - Data **annotations can change** frequently over time/space.
  - e.g. fleet tracking, patient monitoring, etc.

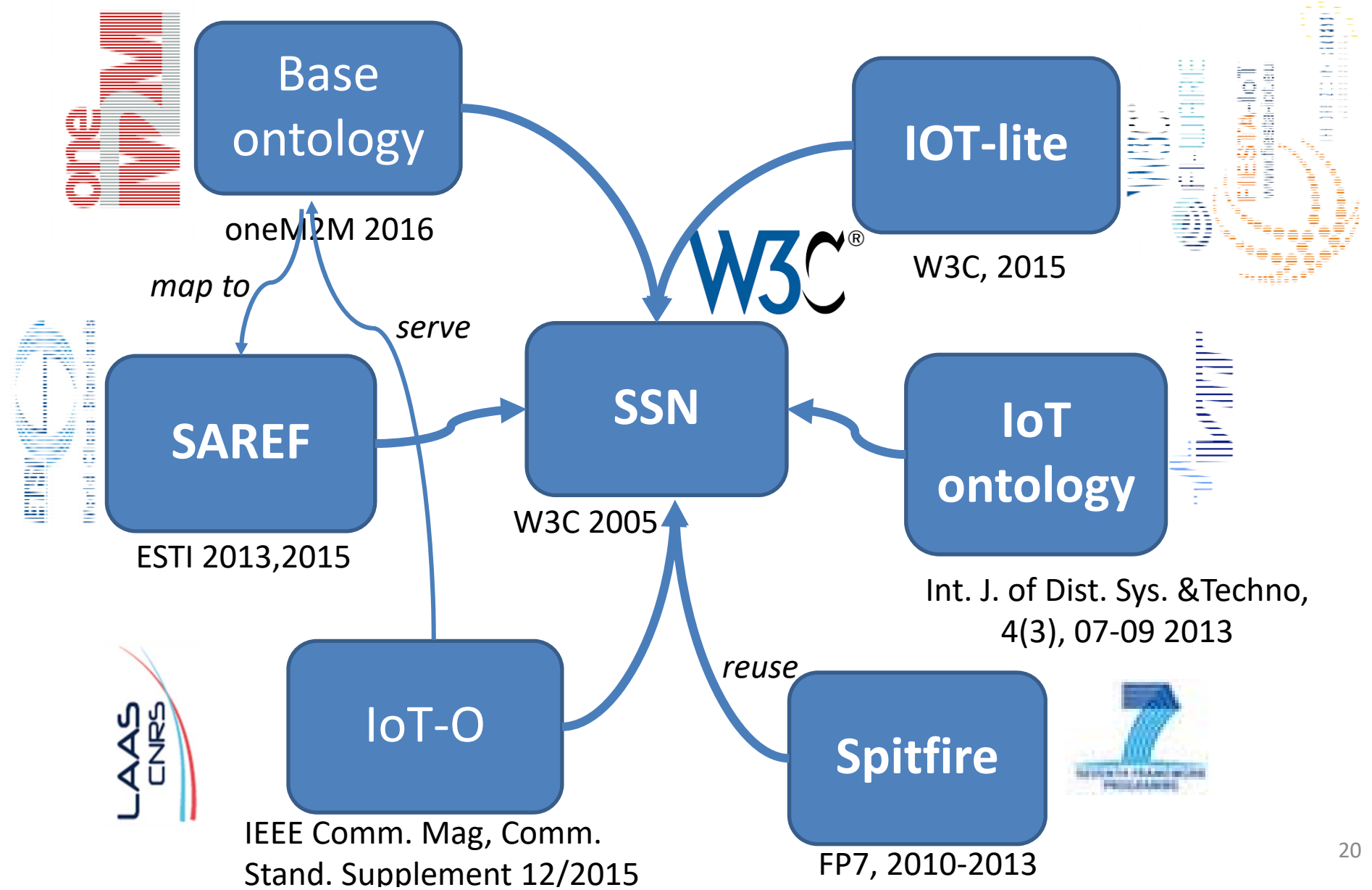
Semantic IoT vs Semantic Web

- Semantic IoT has more **requirements** and **constraints** than semantic web.
- It requires continuous:
  - *monitoring*,
  - *pre-processing*,
  - *filtering*,
  - *aggregation*,
  - *annotation*, and
  - *integration*.

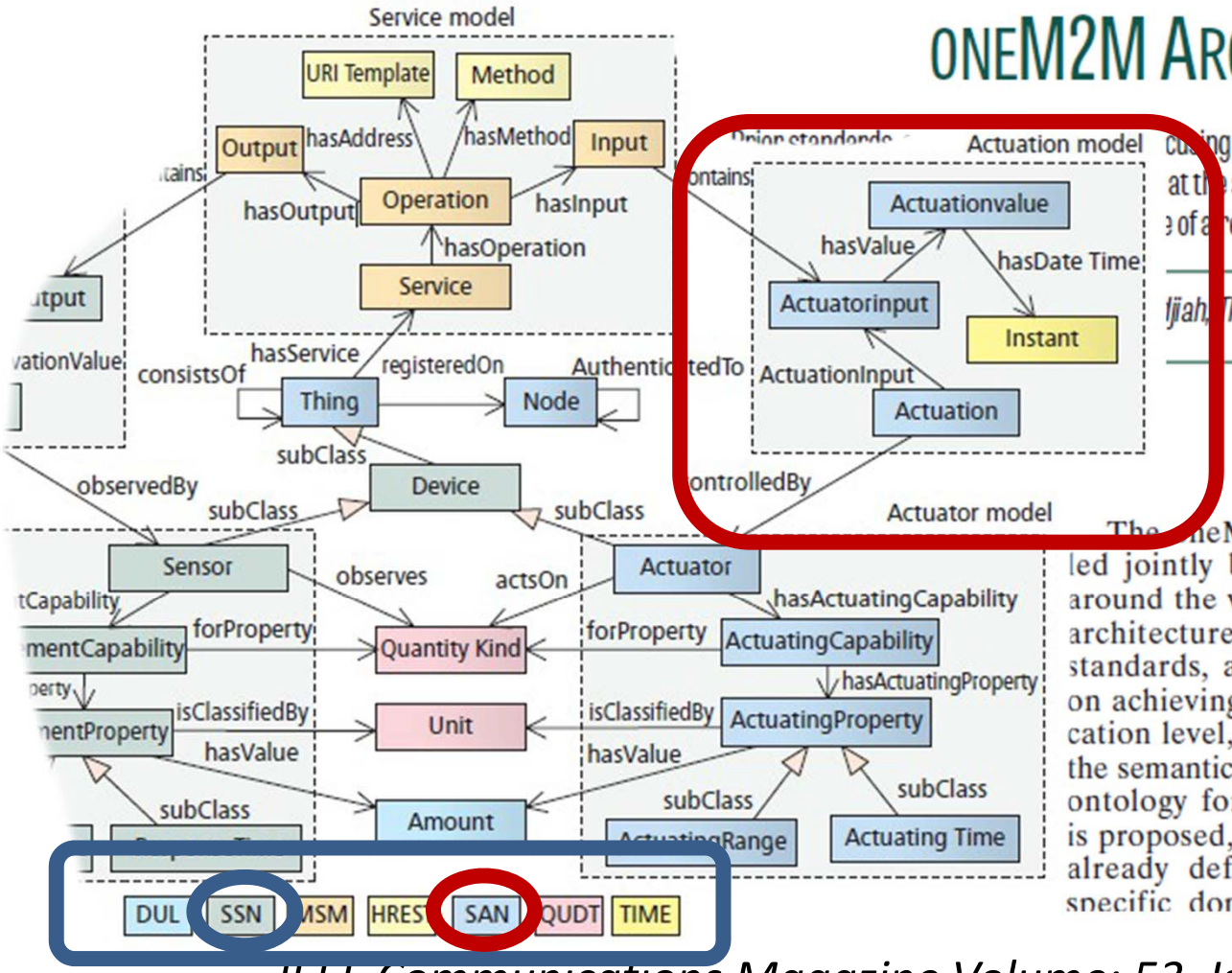
Semantic IoT goals

- Effective **data interoperability** between devices and applications without any prior agreement.
- **Generic *interworking*** and automated management of resources.
- **Semantic discovery** and data **querying**.
- Semantic **matching** and **binding** of devices and applications.
- Semantic **reasoning** to infer **new knowledge** from a set of asserted facts.
- Better monitoring and **understanding** of the surrounding **environment**.
- Make smart **decisions** and dynamically **adapt** to environment changes.

Reference Ontologies for IoT



IoT-O: LAAS' ontology for IoT/M2M



TOWARD SEMANTIC INTEROPERABILITY IN ONEM2M ARCHITECTURE

...on achieving interoperability at the communi-
...at the semantic level. An expressive ontology for IoT
...of already defined ontologies in specific domains.

...ijah, Thierry Monteil, and Khalil Drira

ABSTRACT

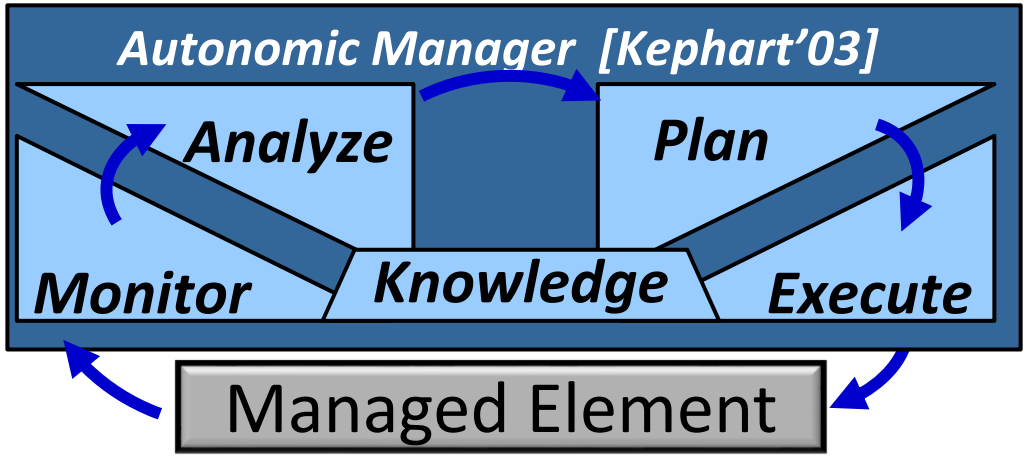
The ...neM2M standard is a global initiative led jointly by major standards organizations around the world in order to develop a unique architecture for M2M communications. Prior standards, and also oneM2M, while focusing on achieving interoperability at the communication level, do not achieve interoperability at the semantic level. An expressive ontology for IoT called IoT-O is proposed, making best use of already defined ontologies in specific domains such as sen-

COMMUNICAT
STANDAR

IEEE Communications Magazine Volume: 53, Issue: 12, Dec 2015

Mastering IoT complexity by semantic reasoning

The autonomic management aproach



Challenges for Autonomic Mgt in IoT:

- **Generic solutions** for autonomic management of **IoT systems**.
- **Ontology for semantic reasoning**: self-configuration of devices

Standards and Reference platforms

Main driving projects

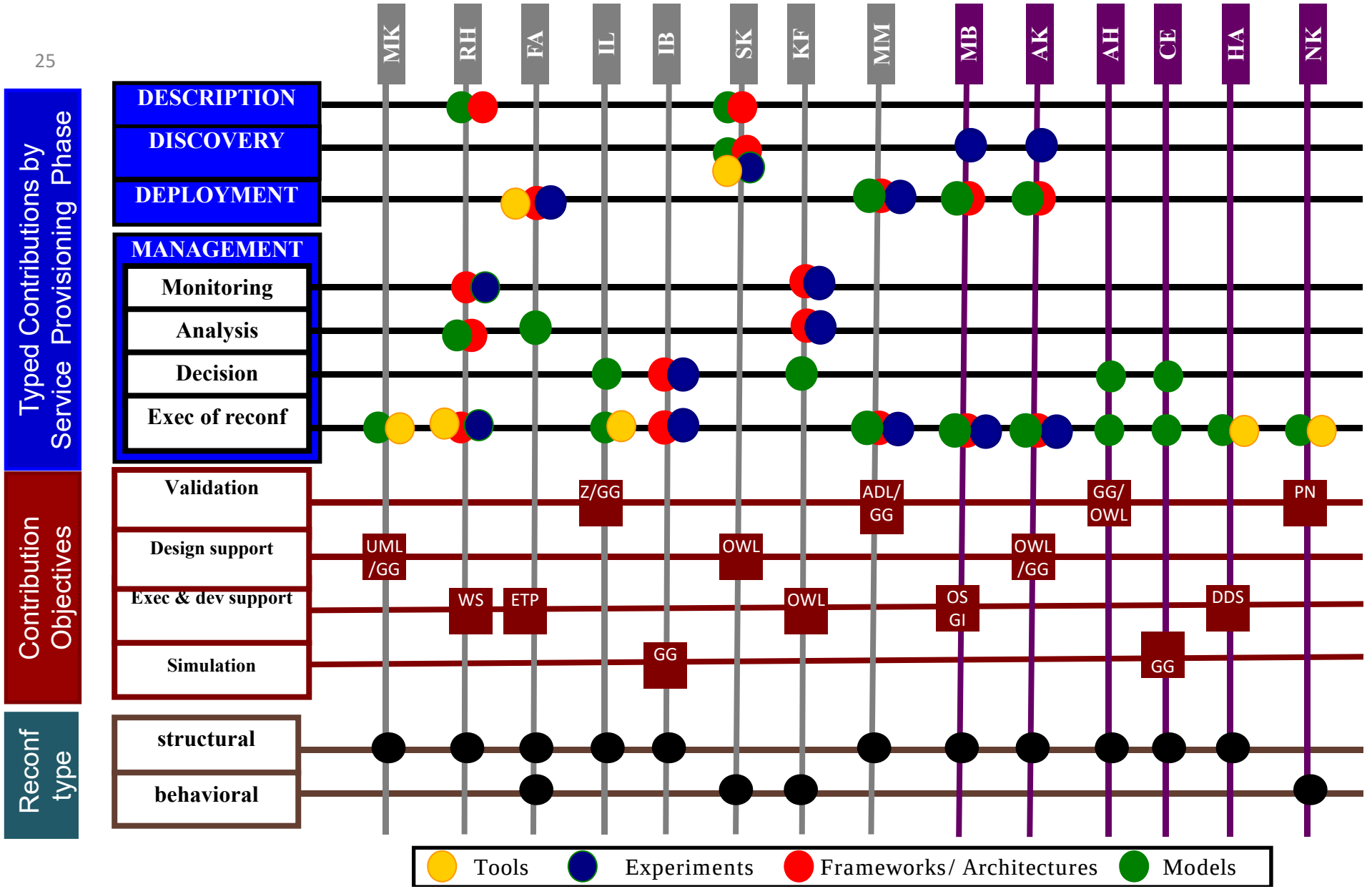
ITEA 2

INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

USENET: Ubiquitous M2M Service Networks 2007-2010

A2NETS: Autonomic services in M2M Networks 2010-2014

Related Recent PhD thesis



Related Recent outputs

ADREAM | SYNERGY

Transversal Axis

Starting Projects — Ongoing&continu.

IMAP	WS-DIAMOND	Tenemo	PIA/M2M	DGA
CIFREs	RTRA/CYPHYS	Usenet	IDEX/CLOUD	AMIC-TCP
Grants	A2NETS	MOSAIC	ROSACE	IMAGINE

Theories & Methods

- Syst of Syst
- Multi-scale Models
- UML/SysML
- Semantic & Ontologies
- Graphs & G. Grammars

Adaptive Protocols & Services

Dynamic Architectures

Distributed Algorithms and Applications

E-health

Connected Vehicles

Smart Metering

Smart Grids

Dynamic Manufacturing Networks

Emergency Management Systems

Deployment & Planning

Context Monitoring & Analysis

OM2M V0.8 | OM2M V1.0

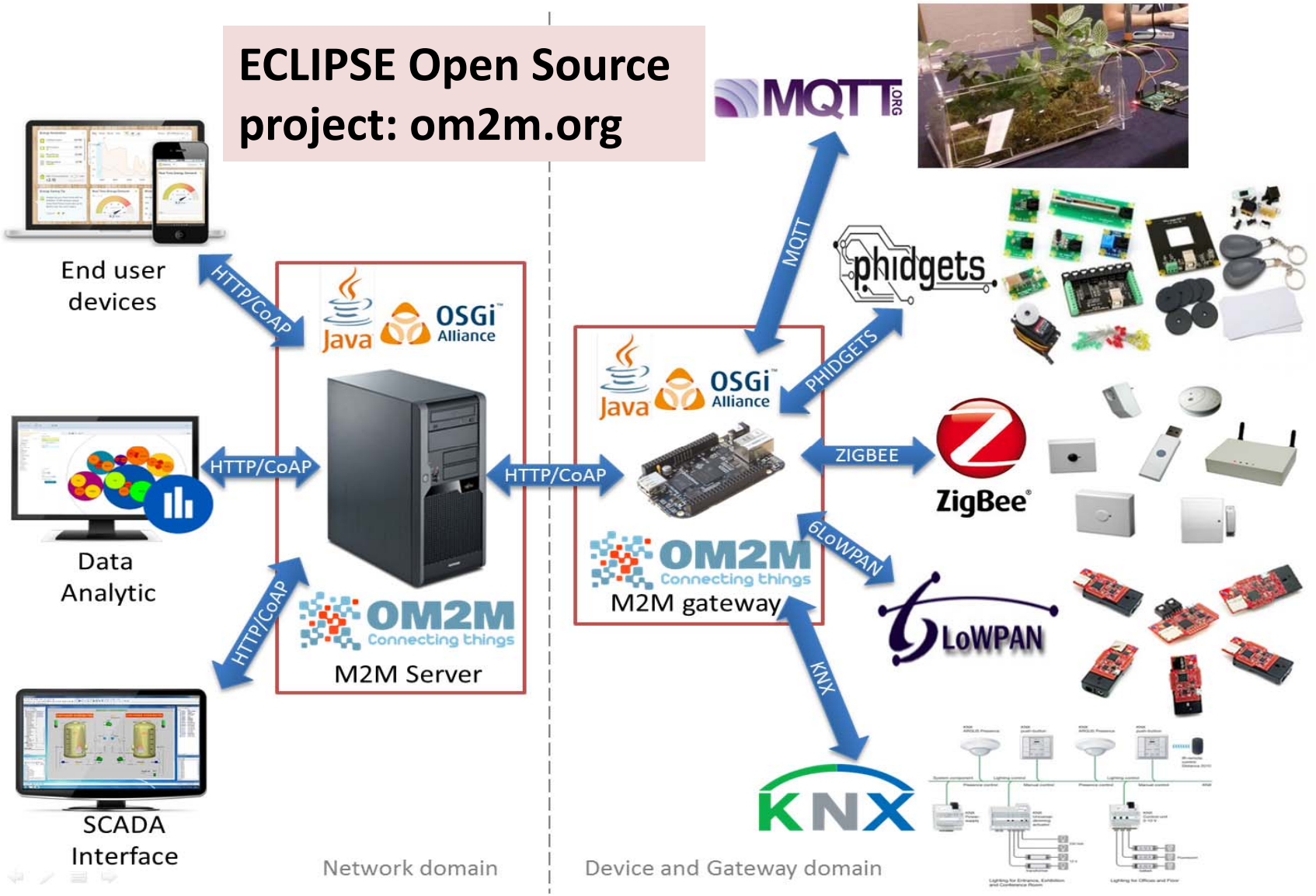
Experimental Platforms

Learning PF for FoF & Living Labs

Tools & FW

GMTE | FrameSelf | FACUS

OM2M: horizontal IoT service platform (om2m.org)



Deployments, Experiments, Hackathons

2010

SILVER AWARD

ITEA 2

Des caméras et des capteurs partout

TOULOUSE (HAUTE-GARONNE)
DE NOTRE CORRESPONDANTE

La lampe s'allume alors que la nuit tombe, le ventilateur se met en route car la température a augmenté, puis tout s'éteint quand il n'y a plus personne dans la pièce. Cette salle à manger intelligente est au beau milieu d'un laboratoire de recherche du Laas (laboratoire d'analyse et d'architecture des systèmes) du CNRS à Toulouse (Haute-Garonnel.
Ce nouveau bâtiment tout juste inauguré et unique en son genre est dédié au projet Adream (Architectures dynamiques reconfigurables pour systèmes embarqués autonomes mobiles), qui vise à développer « l'intelligence ambiante », comme par exemple la communication entre les objets.

« Ces objets nous permettront d'économiser de l'énergie… et de l'argent »
MAHDI IBEN ALAYA, DOCTORANT AU CNRS

Au centre du laboratoire de 1 700 m², un appartement a été recréé. Ici, les fauteuils ne sont pas seulement là pour que l'on s'y repose. Ils sont aussi équipés de capteurs pour détecter la présence humaine. « Nous testons dans des conditions réelles les systèmes que l'on développe, c'est plus concret qu'en laboratoire », explique Mahdi Ben Alaya, doctorant en informatique qui travaille sur l'Internet des objets. Des caméras et des capteurs ont été disposés un peu partout. Ce sont eux qui envoient les principales informations. Ils surveillent la luminosité, la température, la pression ou encore la consommation d'électricité. Et tout est interconnecté : l'idée, c'est que les objets soient intelligents et communiquent entre eux afin de nous faciliter la vie.
« Et ils nous permettront d'économiser de l'énergie… et de l'argent ! ajoute le jeune chercheur. Comme un chauffage qui se met en route

2012

2014

2015

Eclipse OM2M V1 | V2

Date : 18/07/2012
Pays : FRANCE
Page(s) : 1-3
Rubrique : Le fait du jour
Diffusion : (190688)
Périodicité : Quotidien

Aujourd'hui en France

2016

sensinov
Global IoT Platform

Startup hosted by
IoT Valley Toulouse

VOITURE, MAISON, LOISIRS

Les innovations qui vont changer notre quotidien

Un réfrigérateur qui actualise seul la liste des courses, une penderie qui gère votre look, une voiture qui permet d'envoyer des mails sans lâcher son volant… Les nouvelles technologies vont transformer notre quotidien. PAGES 2 ET 3

Votre quotidien bientôt 100 % high-tech

INNOVATIONS. Dicter ses courriels en conduisant, vivre dans une maison intelligente, payer avec son portable, ce n'est plus de la science-fiction. Tour d'horizon des inventions qui vont révolutionner la vie de tous les jours.

oneM2M

Join us to learn, create and compete using oneM2M, a global standard for the Internet of Things (IoT)

Hackaton @UT DALLAS

oneM2M Tutorial & Hackathon, March 9 - 10, 2018

by oneM2M.org - Standards for M2M

2018

Related Recent Publications

"**An Autonomic Cognitive Pattern for Smart IoT-based System Manageability: Application to Comorbidity Management** ", *ACM TOIT to appear in 2018*,

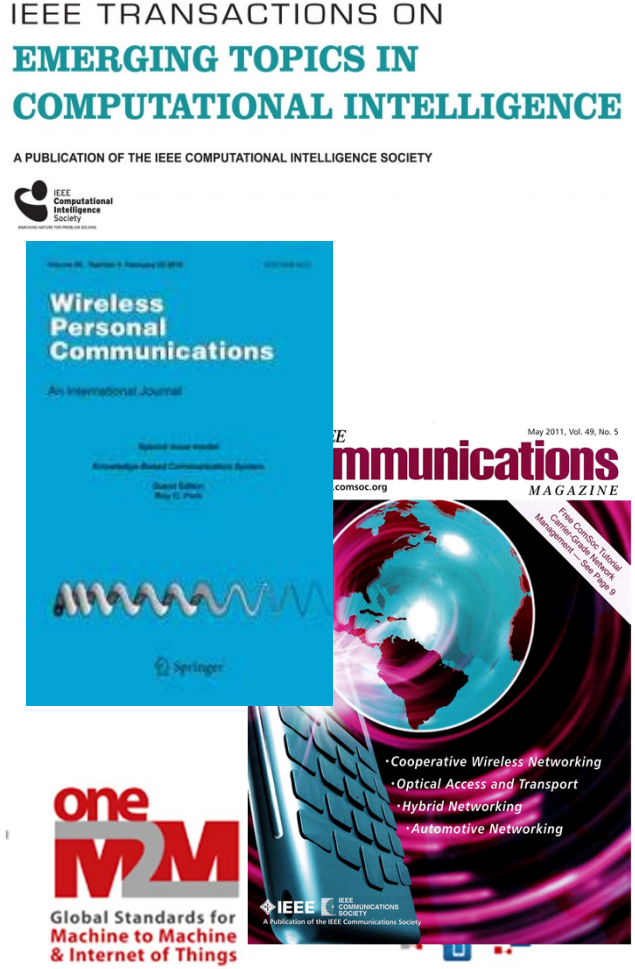
"A model-driven methodology for the design of autonomic and cognitive IoT-based systems: application to healthcare". *IEEE Transactions on Emerging Topics in Computational Intelligence, Vol.1, N°3, Jun. 2017.*

"Wireless sensor network based smart grid communications: challenges, protocol optimizations, and validation platforms", *Wireless Personal Communications, Vol.95, N°4, Aug. 2017*

"Towards semantic data interoperability in oneM2M standard". *Communication Standards SI. IEEE Communications Magazine, Dec. 2015*

Contribution to OneM2M Standard, Mar. 2015 *"OneM2M base ontology proposal".*

ACM Transactions on Internet Technology



Final thoughts

The statement (1/2)

- **Semantic interoperability: ripe standards:**
  - *Communication level:* converging initiatives:
    - WW SDOs have merged their efforts in **a unique international standard: oneM2M**
    - Main alliances and foundations: Allseen/Alljoin and OpenConnectivity/Iotivity have also merged
    - Interworking between initiatives started
  - *Data level:* ontology now considered in international standards: oneM2M base ontology, ETSI SAREF ontology

The statement (2/2)

- **Design Complexity:**
  - Efforts still required:
    - Autonomic and Cognitive IoT:
      - Machine Learning,
      - Semantic and automated reasoning,
      - Dynamic reconfiguration
  - Needs for appropriate solutions:
    - Model-Driven Engineering for IoT services & applications

The requirements (1/3)

- **Non-Functional properties**: critical open issues for real deployment of IoT platforms & **big scale** use-cases like smart cities:
  - Scalability
  - Resistance to outages
  - Security: Authentication, Authorization, Accounting & Privacy

The requirements (2/3)

- Ease of development : Need for solutions of model-based design and management:
  - Inspiration from/adaptation of recent cloud solutions: e.g.
  - Cloud Foundry Deployment Tool: BOSH
  - Ubunto Juju Charms
  - and cloud evolution: edge/fog computing

The requirements (3/3)

- Devops solutions based on open source tools:
  - Provisioning: Vagrant (config mgt), Packer (image creation), Terraform (infras mgt)
  - Service security mgt (AAA): Vault (hashicorp), Keywhiz
  - service discovery, configuration and orchestration: Consul, Eureka (Netflix), kubernetes
  - Cluster management for application deployment: Nomad, Swarm (Docker), kubernetes

Emerging Directions (1/3)

- New Technologies can leverage IoT mass deployment:
  - Towards secure, decentralized, efficient, transparent IoT platforms based on blockchain technology (e.g. platforms: ethereum, distributed block-chain based cloud storage: storj.io)

Emerging Directions (2/3)

- We can anticipate the emergence of new extended IoT applications:
  - New Blockchains-IoT smart applications: "from self-driving to self- renting cars" (ride sharing and private transportation platforms e.g. Slock.it)

Emerging Directions (3/3)

- Expected Social & economic impact:
  - Automated management with smart contracts : Democratization of IoT-based individual economic activities: No need for third party (Banks) nor Middlemen (Amazon, AirB&B, Drivy) in distributed transactions.

For more questions and interaction: khalil@laas.fr

Resources available under: om2m.org

Publications available under: www.laas.fr

https://education.open-platforms.eu/

THANKS