

# From the IoT to the SWoT: definitions, standards and perspectives

ISWC2017 tutorial -

Semantic Web meets Internet of Things and Web of Things

# My teams

## **SARA**, at LAAS-CNRS

- Services and networks



## **MELODI**, at IRIT

- Semantics, logic and discourse

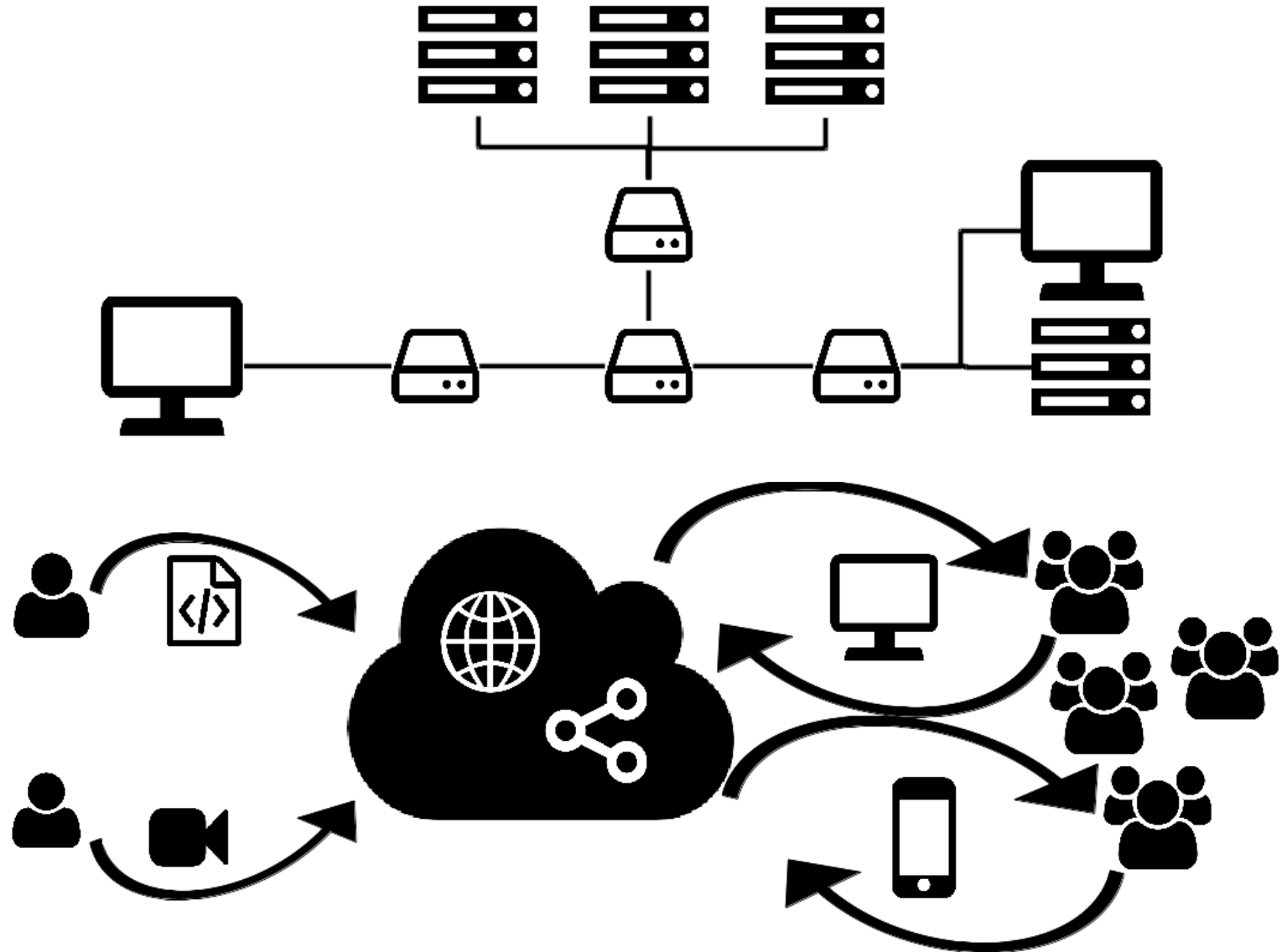


# We discussed internet vs the web...

From the  
pipes...



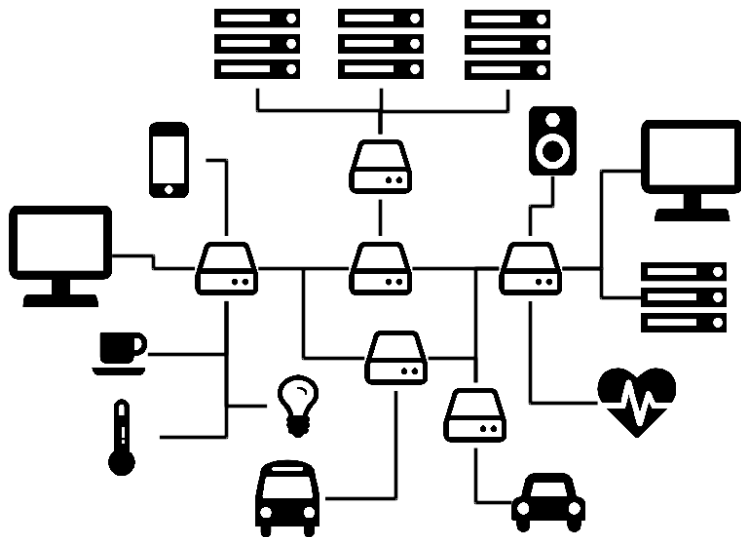
...To the  
information  
space



# ... let's discuss the IoT and the WoT [ITU] !

## On the Internet part

- The pipes are evolving !
- Everyday life devices are being connected [Szilagyi et al.]



## On the web part

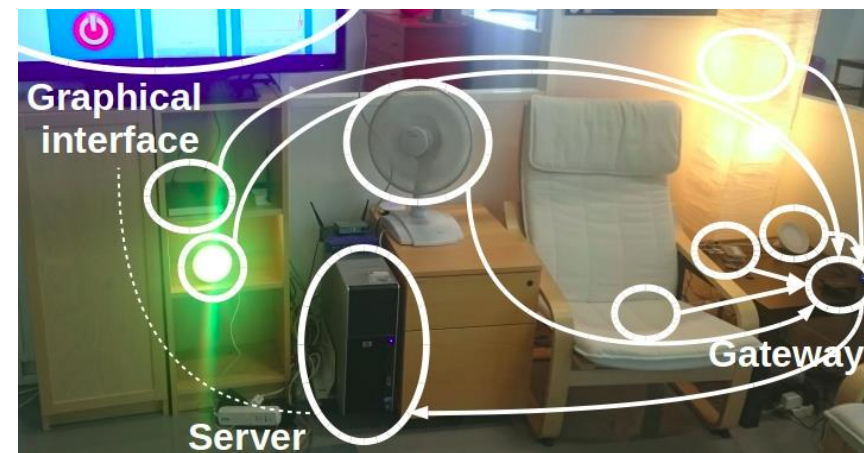
- **Web fundamental principles**
  - Resource identification
  - Resource representation
  - Interaction
- **Paradigm shift**
  - Notification vs Polling
  - REST services

# Some IoT usages (according to the semantic web)

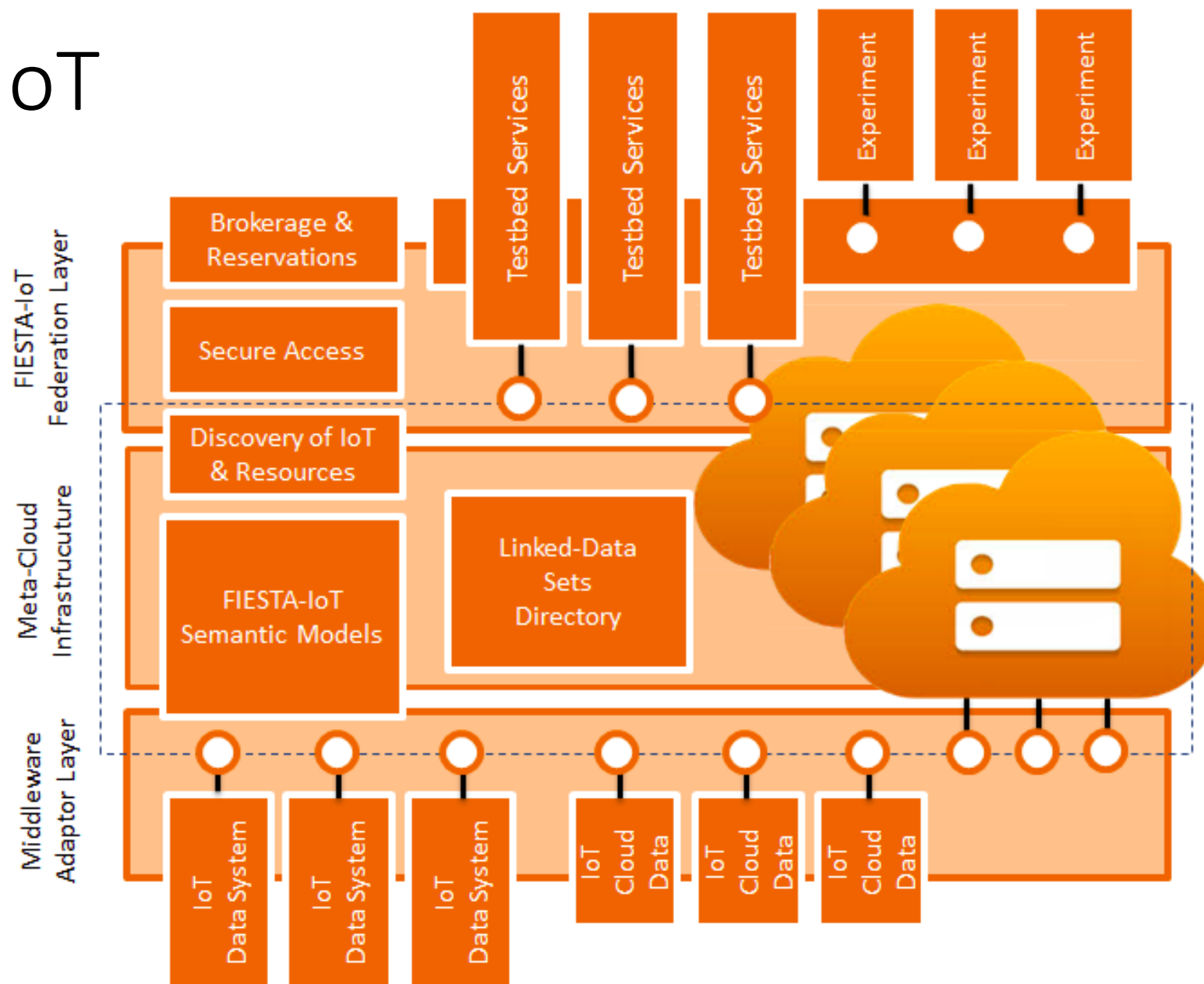
									
Nb onto: 46	Nb onto: 8	Nb onto: 10	Nb onto: 30	Nb onto: 32	Nb onto: 17	Nb onto: 16	Nb onto: 6	Nb onto: 24	Nb onto: 21
									
Nb onto: 55	Nb onto: 30	Nb onto: 6	Nb onto: 6	Nb onto: 9	Nb onto: 7	Nb onto: 30	Nb onto: 5		

[Gyrard et al.]

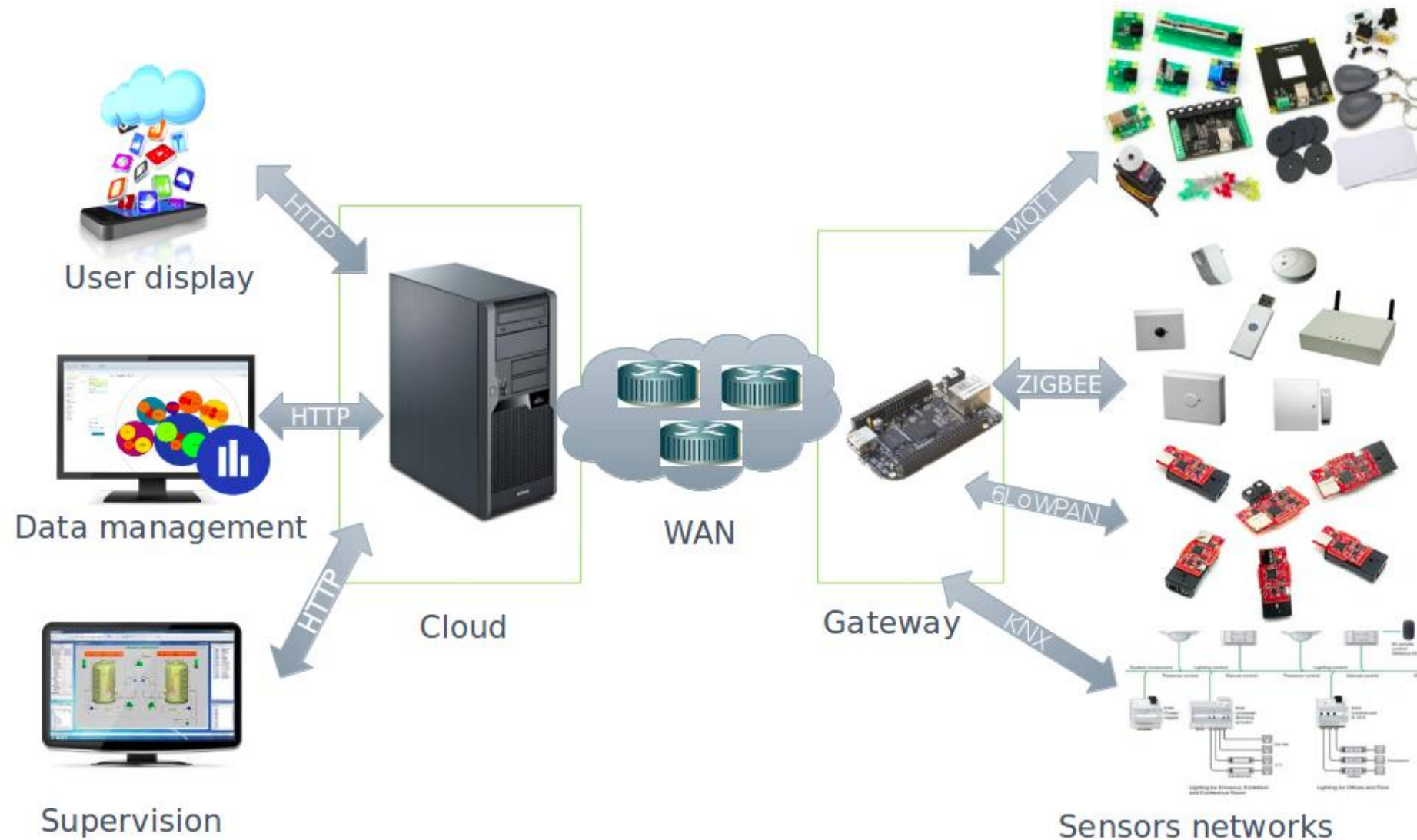
# ADREAM, a smart building



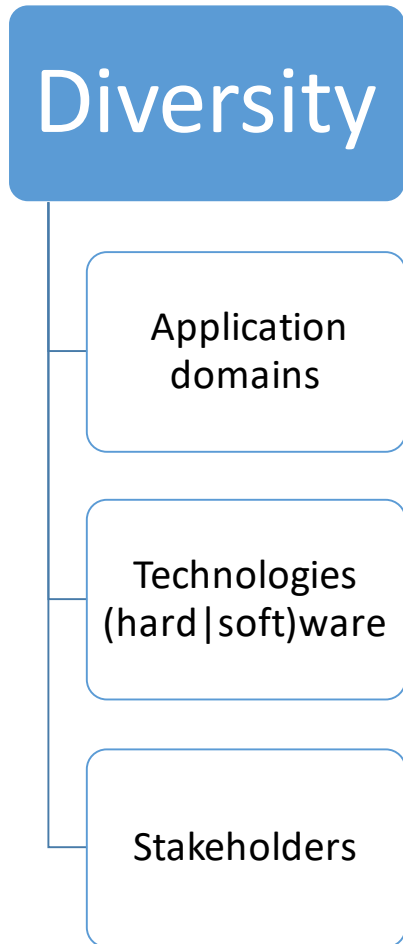
# FIESTA-IoT



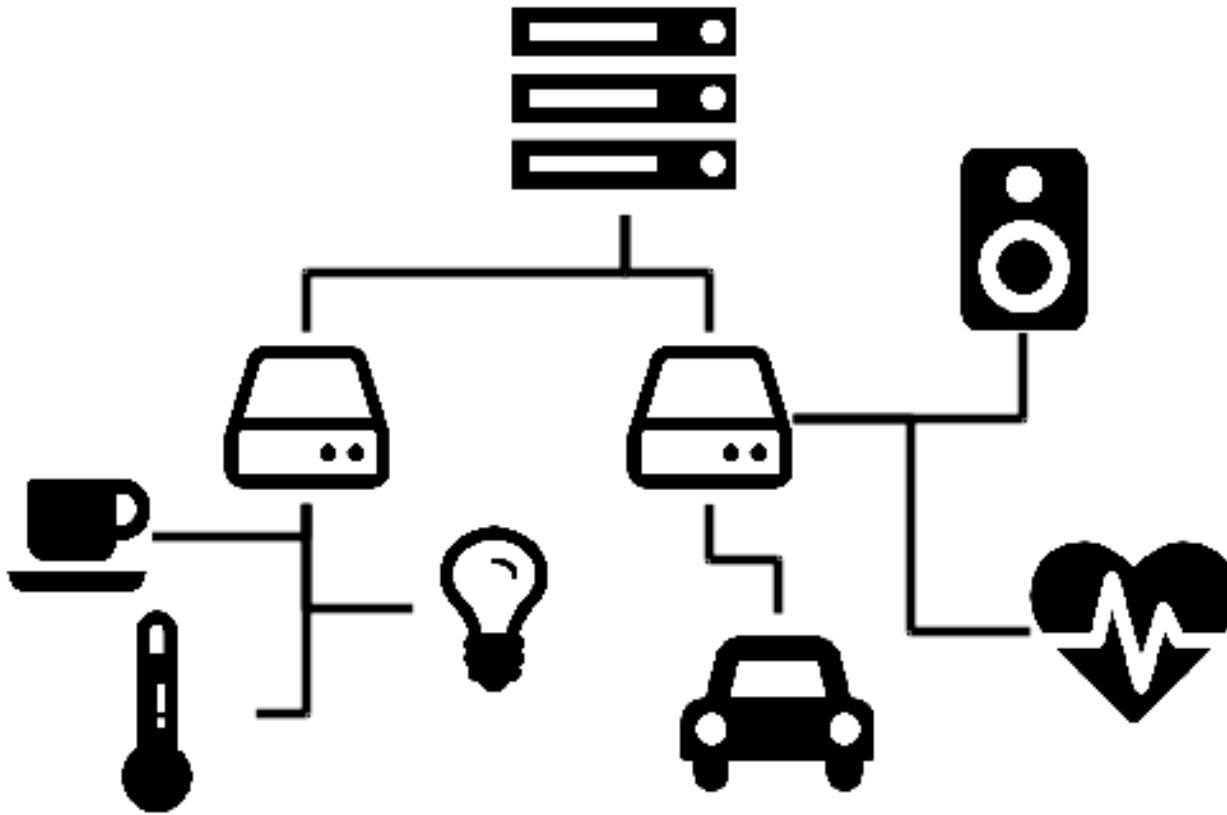
# Generalization of an IoT/WoT architecture



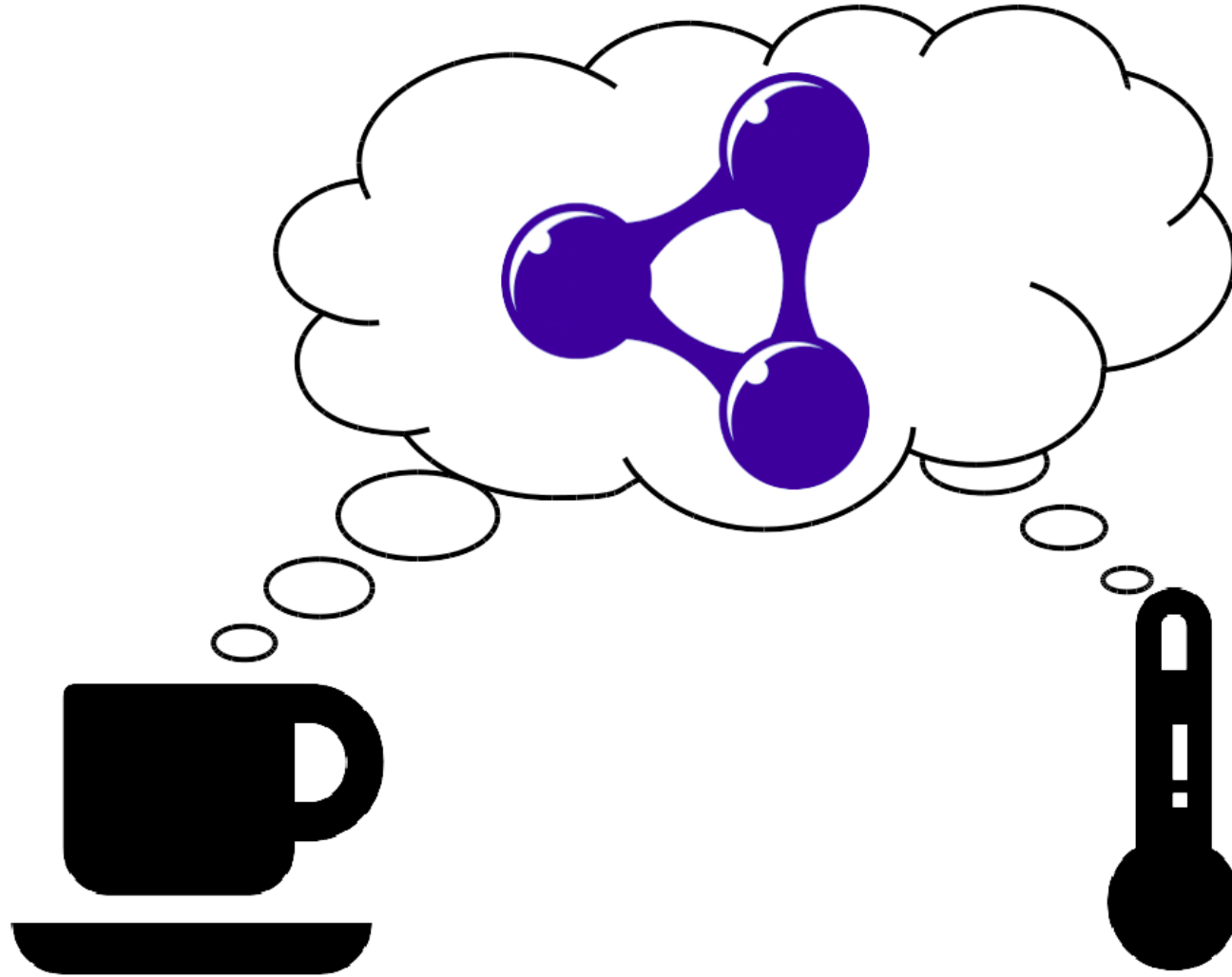
# Heterogeneity and verticality



# Horizontality requires understandability

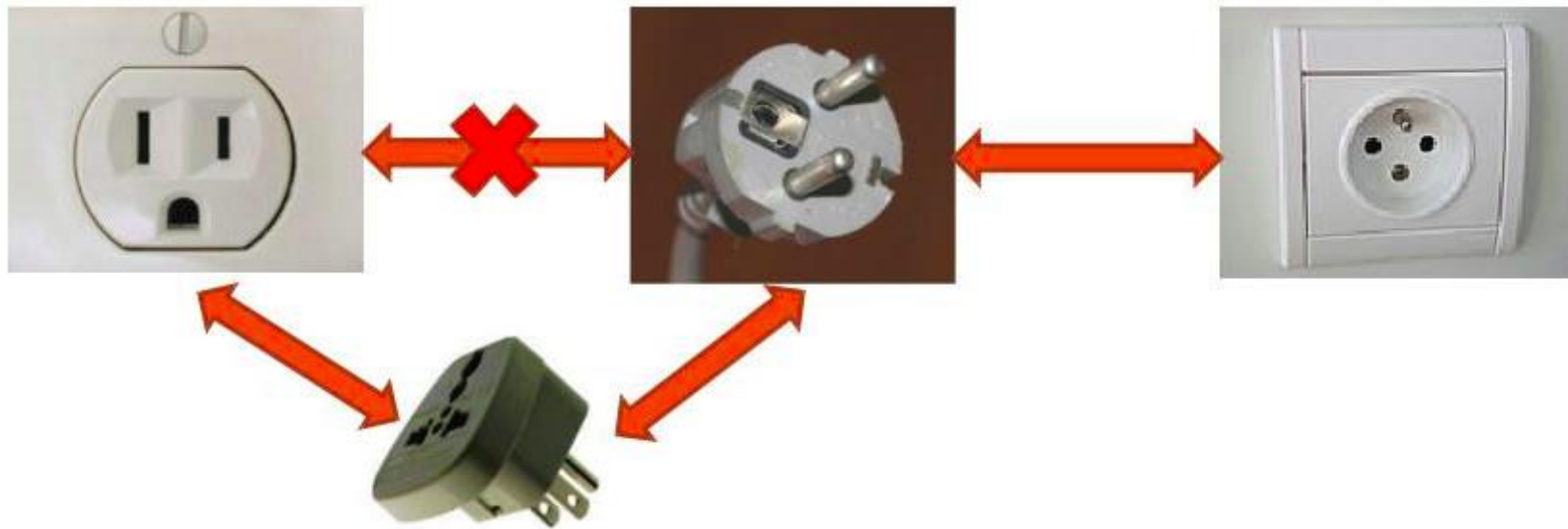


That is where the semantic web comes in !



# Interoperability...

Ability of two systems or more to interact and exchange data successfully [Serrano et al.]



# ... or interoperabilities ?

Technical

- Interaction at the hardware and protocols level

Syntactical

- Interaction at the data scheme level

Semantic

- Shared understanding of the meaning of exchanged data

# On the road to interoperability...

The past

- Non-semantic standards
- Semantic prooves of concept

The present

- Semantization of standards

The future

- Machine-understandable standards for architectures
- Semantic data

... but with roadblocks

Why isn't the WoT  
semantic already ?

# Dynamicity

## The IoT is volatile

- Knowledge representation was historically dedicated to **static data**
- IoT data is **timely and spacially** bound
- The network itself evolves

# Constrained devices

The IoT is made of field devices

- Memory/processing power constraints
- Communication capabilities
- Battery powered

# Challenges due to the evolution of IoT

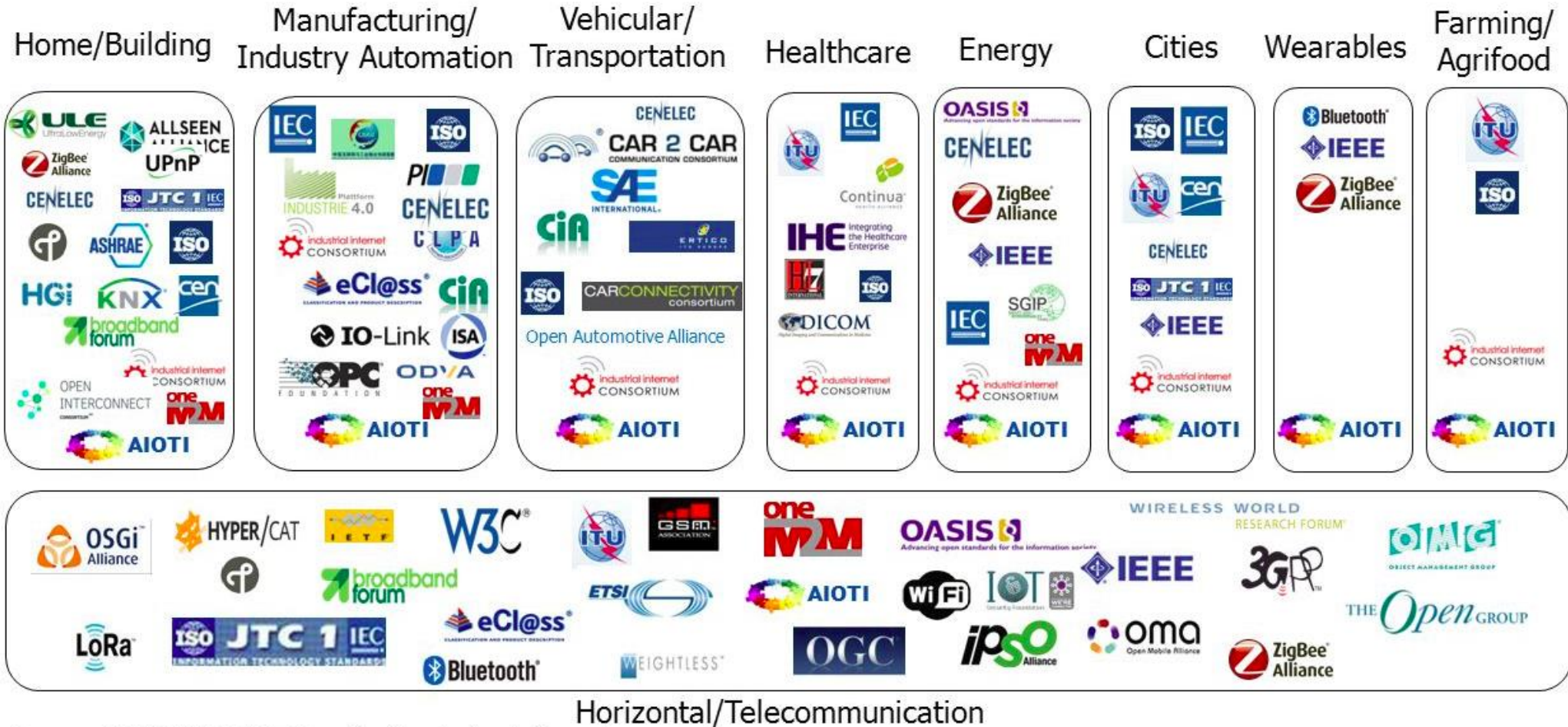
## Scalability

- (much) More devices [Desai et al.], more data
- Reasoning and processing complexity

## Consistency in heterogeneity

- Data manipulated in heterogeneous contexts

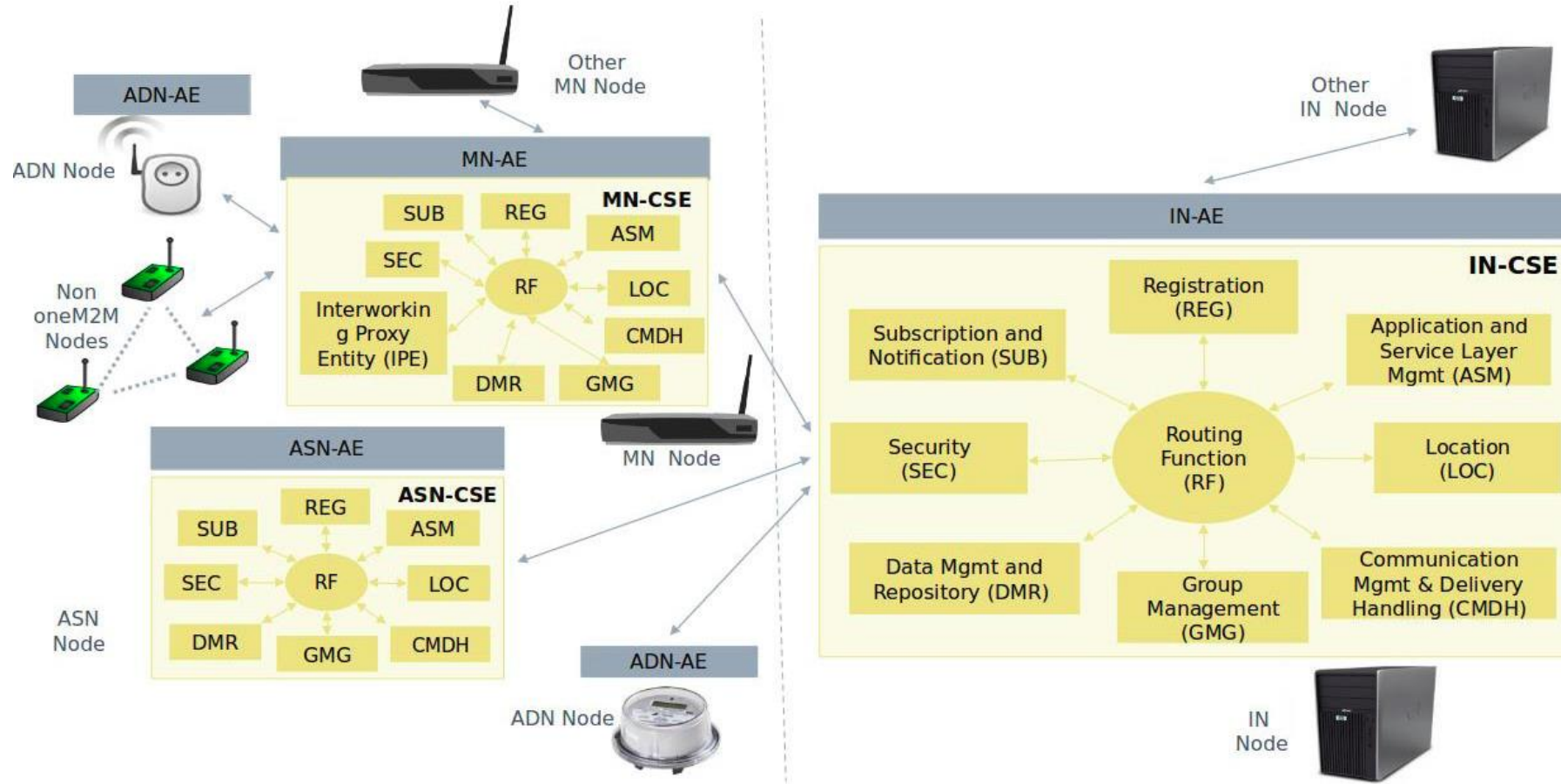
# Standards, as easy as ABC



Horizontal/Telecommunication

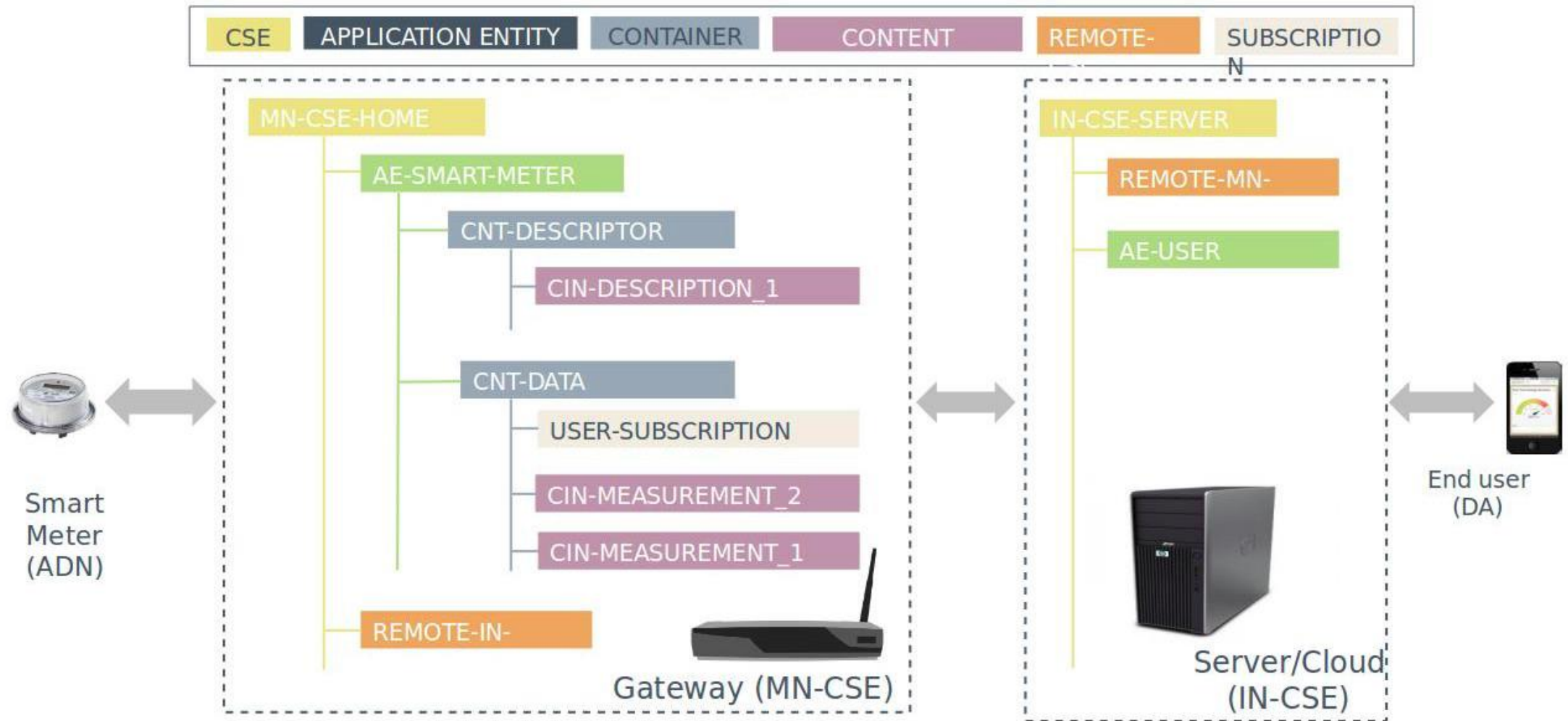
Source: AIOTI WG3 (IoT Standardisation) – Release 1

# OneM2M main features

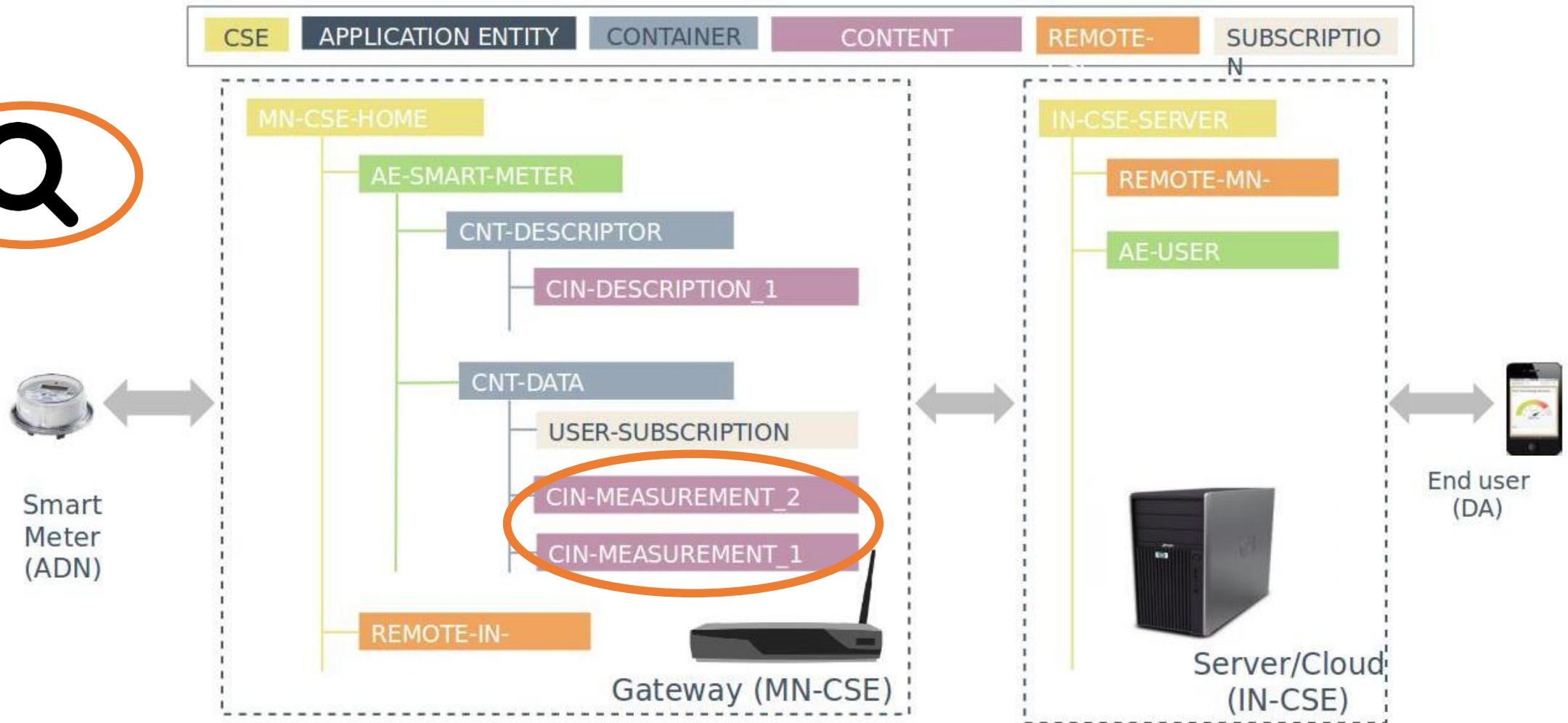


Full specification : <http://onem2m.org>

# Example instantiation



# Where the standard end(ed)...



... the semantics begins

## Semantic descriptors

- RDF/XML-based

## Semantic discovery

- Sparql

## OneM2M base ontology

- <http://www.onem2m.org/ontology/>

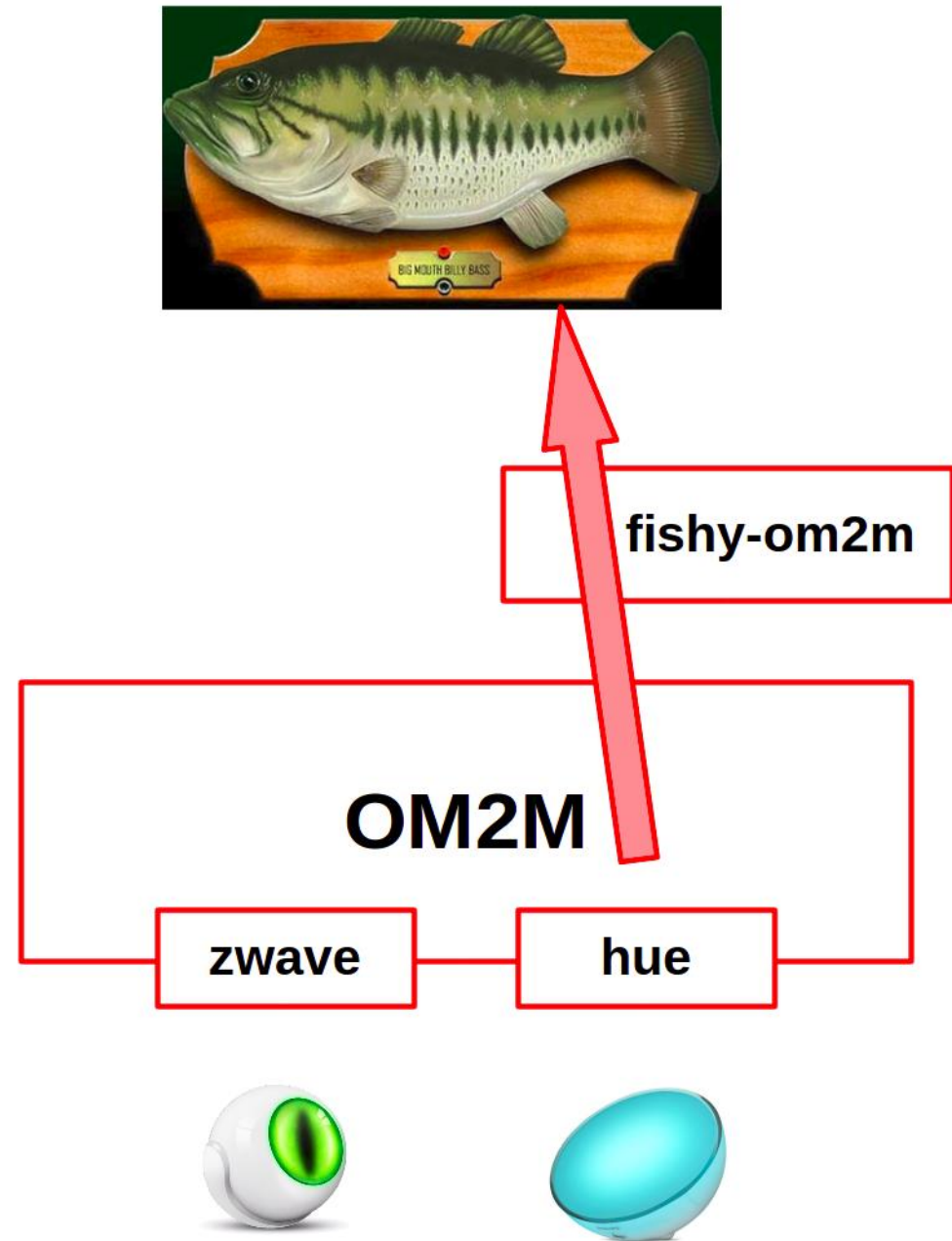
# Eclipse OM2M



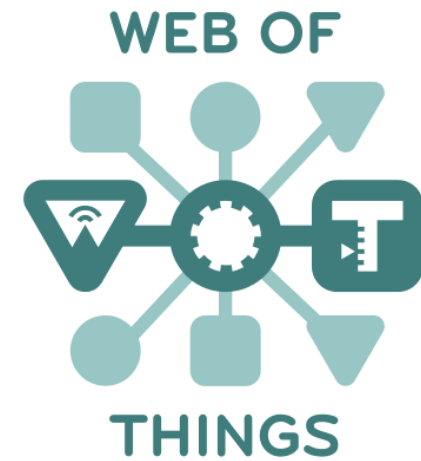
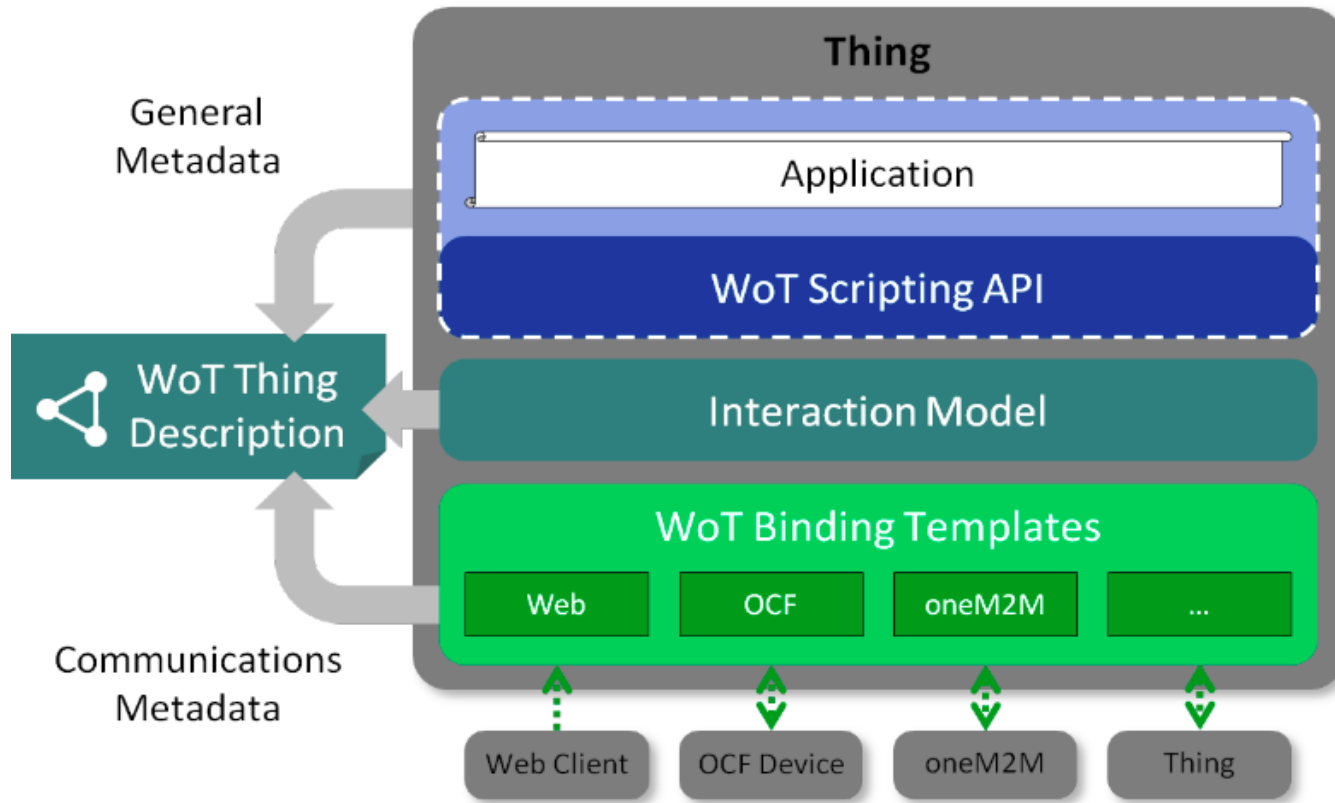
- **Project page** : <http://eclipse.org/om2m>
- **Wiki** : <https://wiki.eclipse.org/OM2M/one>
- **Source code** : <https://git.eclipse.org/r/om2m/org.eclipse.om2m>

# Demonstration

- From the IoT to the WoT
- Semantic discovery

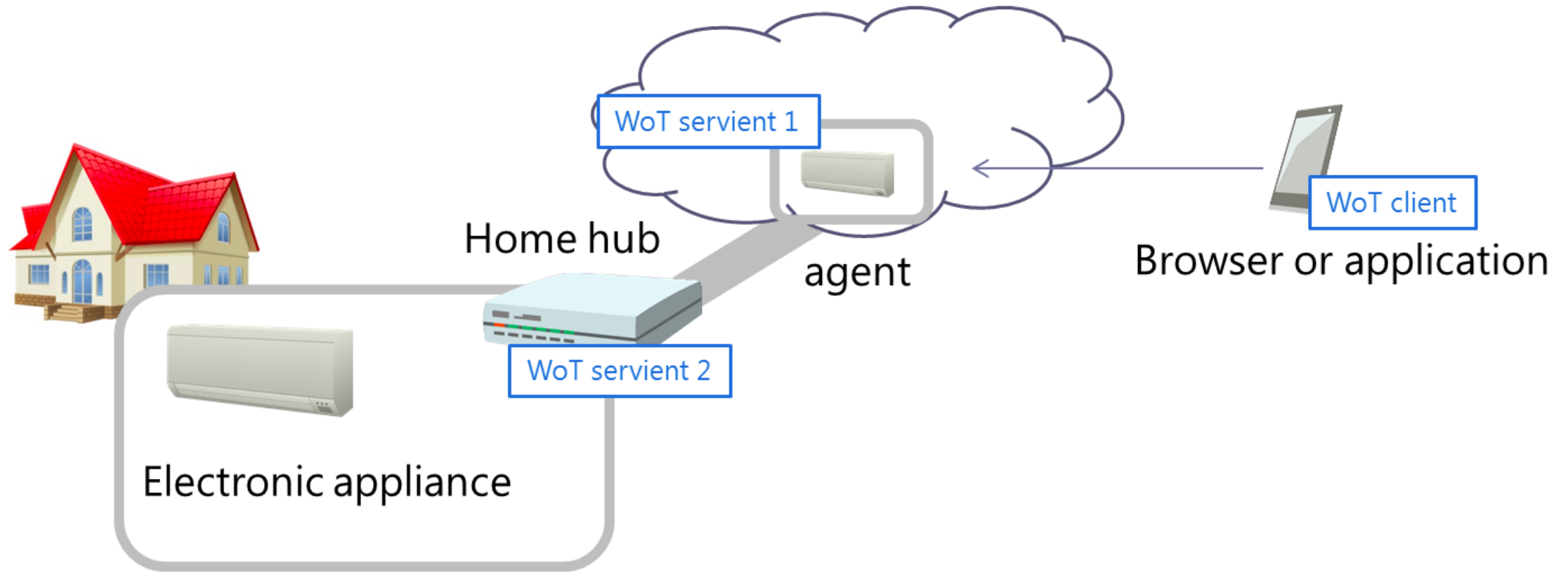


# W3C WoT WG main features

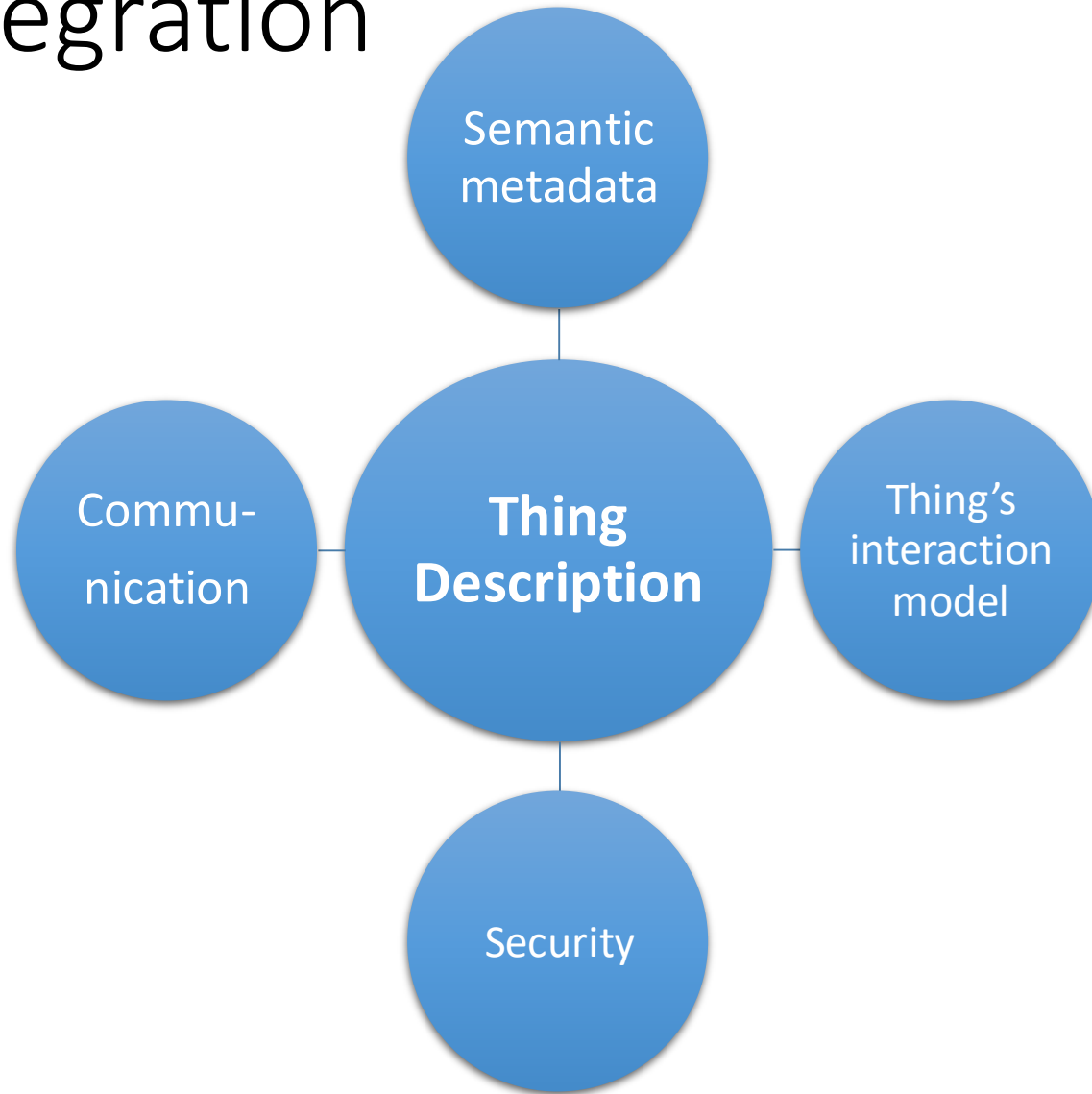


Full specification:  
<https://w3c.github.io/wot-architecture/>

# Example instantiation



# Semantic integration



# Conclusion

There are still challenges...

- Scalability
- IoT constraints
- « Semantic culture »

- Semantic interoperability
- Integration to standards
- Multiplication of initiatives

But the SWoT is coming !

# References

- I. Szilagyi and P. Wira, "Ontologies and Semantic Web for the Internet of Things - a survey," in IECON, IEEE, 2016
- ITU, "Framework of the web of things," tech. rep., International Telecommunication Union, 2012
- Amelie Gyrard, Christian Bonnet, Karima Boudaoud, Martin Serrano, "LOV4IoT: A second life for ontology-based domain knowledge to build Semantic Web of Things applications", FiCloud 2016
- M. Serrano, P. Barnaghi, F. Carrez, P. Cousin, O. Vermesan, and P. Friess, "Internet of Things IoT Semantic Interoperability: Research Challenges, Best Practices, Recommendations and Next Steps, EUROPEAN RESEARCH CLUSTER ON THE INTERNET OF THINGS," 2015
- Desai, A. Sheth, and P. Anantharam, "Semantic Gateway as a Service architecture for IoT Interoperability," in Kno.e.sis Publications, 2015