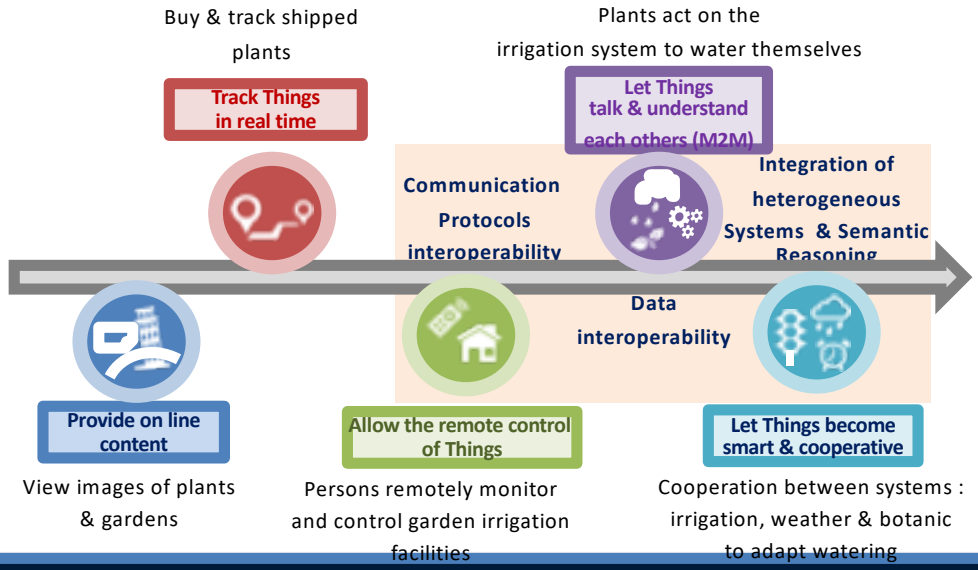
LAAS Days
Research & Technology

Adaptive communication for collaborative interaction in smart environments

Khalil Drira,
Département Réseaux et Communications (RC)
Equipe Services et Architectures pour Réseaux Avancés (SARA)
LAAS-CNRS, Toulouse, France
RT Days, June 21, 2018

LAAS R&T Days

Towards open & cognitive IoT



LAAS/SARA R&D directions for IoT challenges[1]

Vertical Fragmentation

- Common Services & Horizontal Architectures
- Semantic Interoperability:
  - Protocol level
  - Data level

Power Management

- Energy Saving:
  - Protocol-level,
  - Middleware level

LPWAN (LoRA, NB-IoT)

Increasing Complexity

- Autonomic Management:
  - Semantic-enabled Dynamic deployment discovery & integration

Security

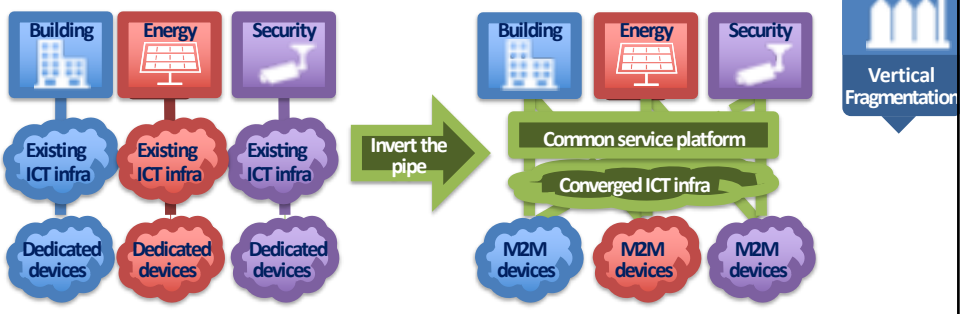
- Detect anomalies & Prevent DoS attacks:
  - *Unsupervised Machine / Reinforcement / Deep Learning*

Network Misalignment

Softwarized & Virtualized Networks: *SDN, NFV, Overlays*

[1] The internet of things: Key applications and protocols O.Hersent, D.Boswarthick, O.Elloumi John Wiley & Sons, 2012

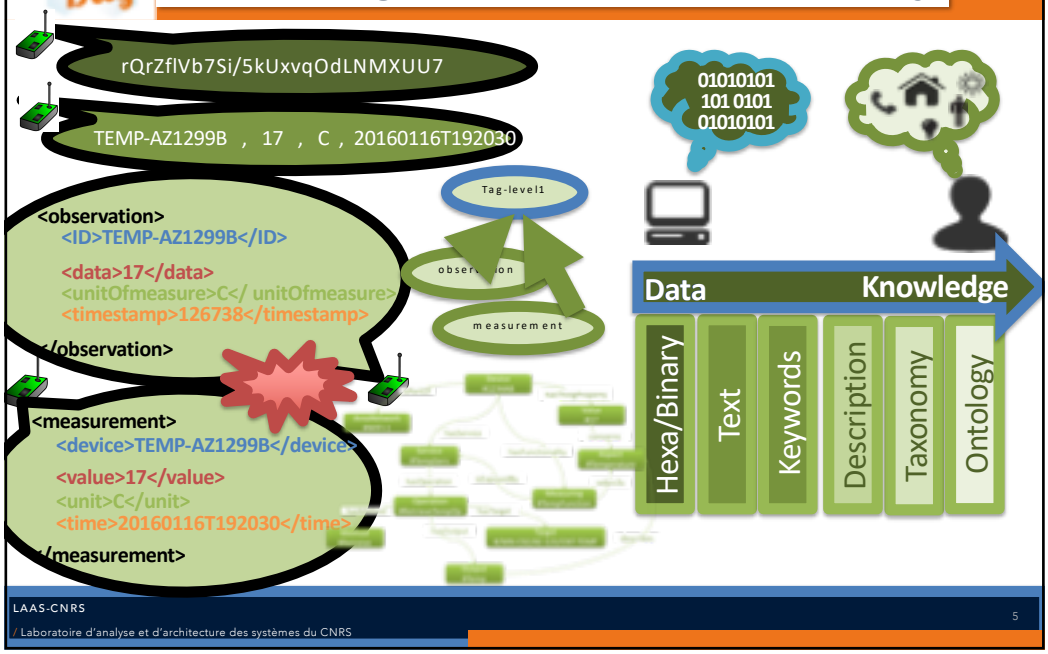
Enabling cross-domain interoperability



> Horizontal Interoperability : International standards oneM2M, ETSI SmartM2M.

> Other initiatives & projects: Allseen, EU projects,etc.

Semantic gap breaks IoT horizontality

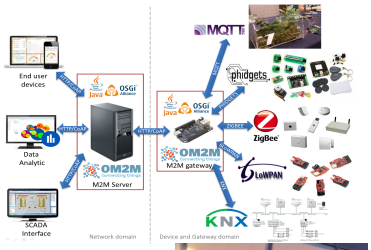


Semantic IoT: The goals

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

LAAS's OM2M: IoT sw service platform

- The reference standard-compliant open source platform : OM2M.org
- Ongoing extensions (+10K lines) by Orange & Deutsche Telekom

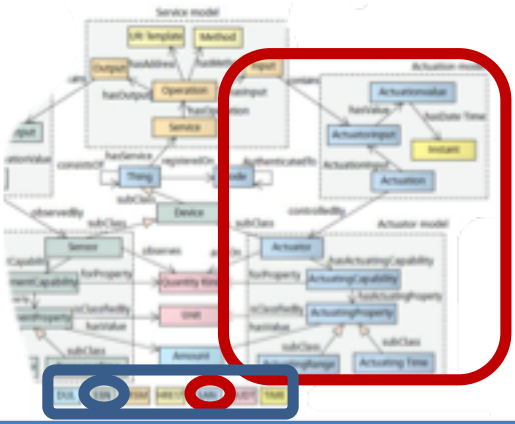


- Experimental deployment at LAAS: ADREAM/Smart Appart/Robots (with DO/RIS)
- Deployed to protect the gateway of the ADREAM building from damage caused twice by oversized trucks

IoT-O: LAAS' ontology for IoT

- Validated and disseminated in "Communication Standards" SI, IEEE Comm. Mag. Dec 2015
- Enhanced, implemented, experimented since 2016 (Wiley ITL 2018)
- Reused for contribution to the international standard oneM2M Base Ontology (LAAS-CNRS/Alcatel-NOKIA) :

OneM2M base ontology proposal
MAS-2015-0564R01, June 2015



Highlights, Deployments, Experiments, Hackathons

2010 — SILVER AWARD — ITEA 2

2012

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-Garonne).
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 BEN 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 présence 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

2014 — 2015

Eclipse OM2M V1, V2

2016

sensinov
Global IoT Platform

Startup hosted by IoT Valley Toulouse

oneM2M Tutorial & Hackathon, March 9 - 10, 2018
by oneM2M.org - Standards for M2M
2018

Aujourd'hui en France

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.

Semantic models: 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.*

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

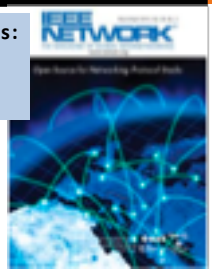
Contribution to OneM2M Standard, Mar. 2015 *"OneM2M base ontology proposal".*

ACM Transactions on Internet Technology

IEEE TRANSACTIONS ON
EMERGING TOPICS IN
COMPUTATIONAL INTELLIGENCE
A PUBLICATION OF THE IEEE COMPUTATIONAL INTELLIGENCE SOCIETY

Machine Learning: Recent Publications

"**Unsupervised Network Intrusion Detection Systems: Detecting the Unknown without Knowledge**", IEEE Network, 26 (1), 2012.



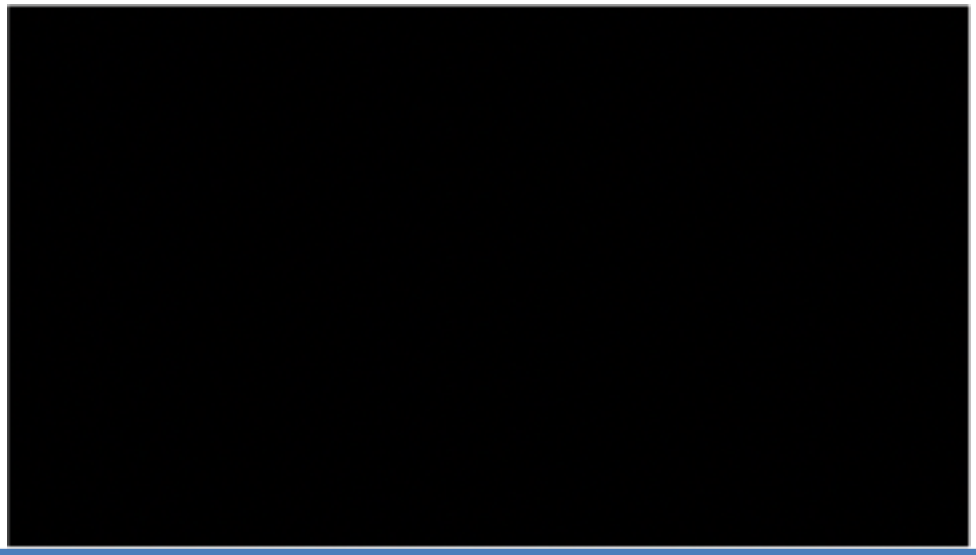
"**IoT Attack Detection with Deep Learning**'', ISCIS Security Workshop 2018.

IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS

"**Big Data for Autonomic Intercontinental Overlays**". IEEE JSAC, 34(3), 2016.

Scalable, Self-healing and Self-optimizing Routing Overlays, IFIP Networking 2016.

Implementation scenario



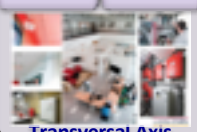
LAAS R&T Days

Thanks

LAAS R&T Days

Related activities of SARA: executive summary

AI | SYNERGY



Transversal Axis

Recent Projects

CNES	TOUIX	e-Horizon	S2C2	DGA
Orange	RTRA/ CYPHYS	LAAS/OPA	IDEX/Chair	Endeavor
Panacea	A2NETS	AATAC	ROSACE	IMAGINE

Theories &Techniques

- Reinforcement Learning
- Unsupervised learning
- Game Theory
- Semantic & Ontologies
- FM, Graphs & G. Grammars

Software-Defined Networks

Network Virtualisation

Open Interoperable IoT Architectures

E-health (with LIST/LU)
Fleet Management (with ATOS)
Smart Metering (with VTT/FI)
Robotics (with RO/RIS)
Dynamic Manufacturing Networks (with Airbus group)
Rescue Systems (with RO/RIS, [illegible] ONERA)

Traffic Management & Optimization

Scalability Management

Platforms

Tools & FW

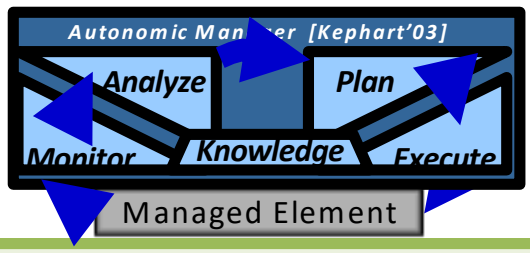
Semantic IoT vs Semantic Web

> Semantic IoT has more **requirements** and **constraints** than Semantic Web.

> It requires continuous:

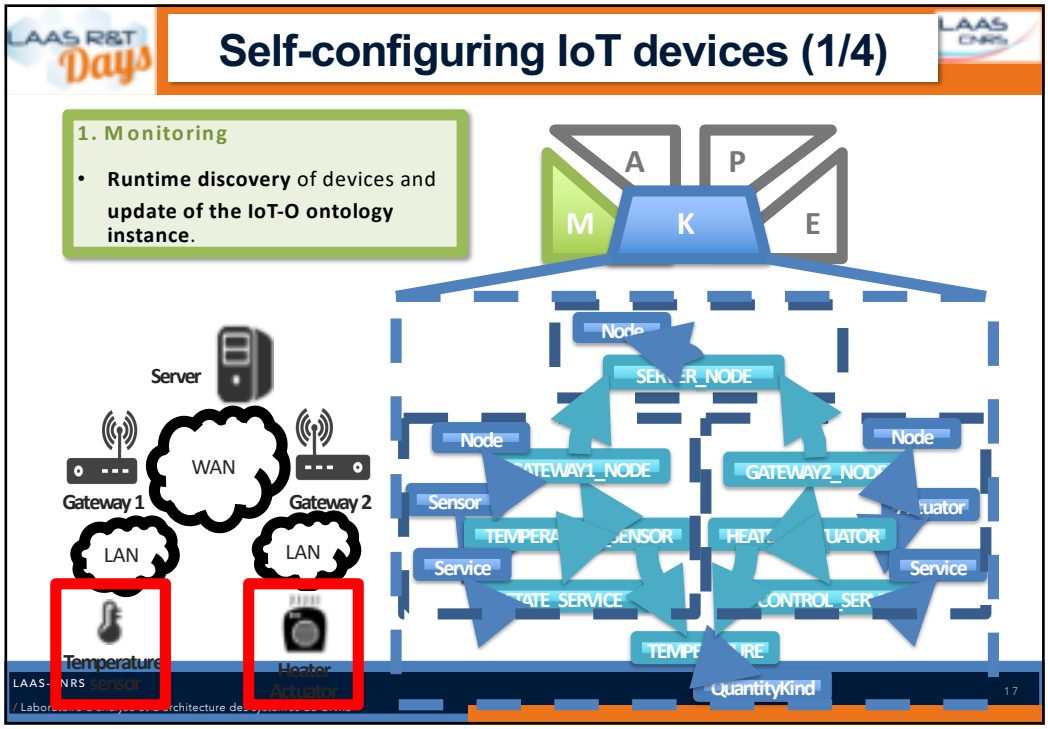
- ***monitoring***,
- ***pre-processing***,
- ***filtering***,
- ***aggregation***,
- ***annotation***, and
- ***integration***.

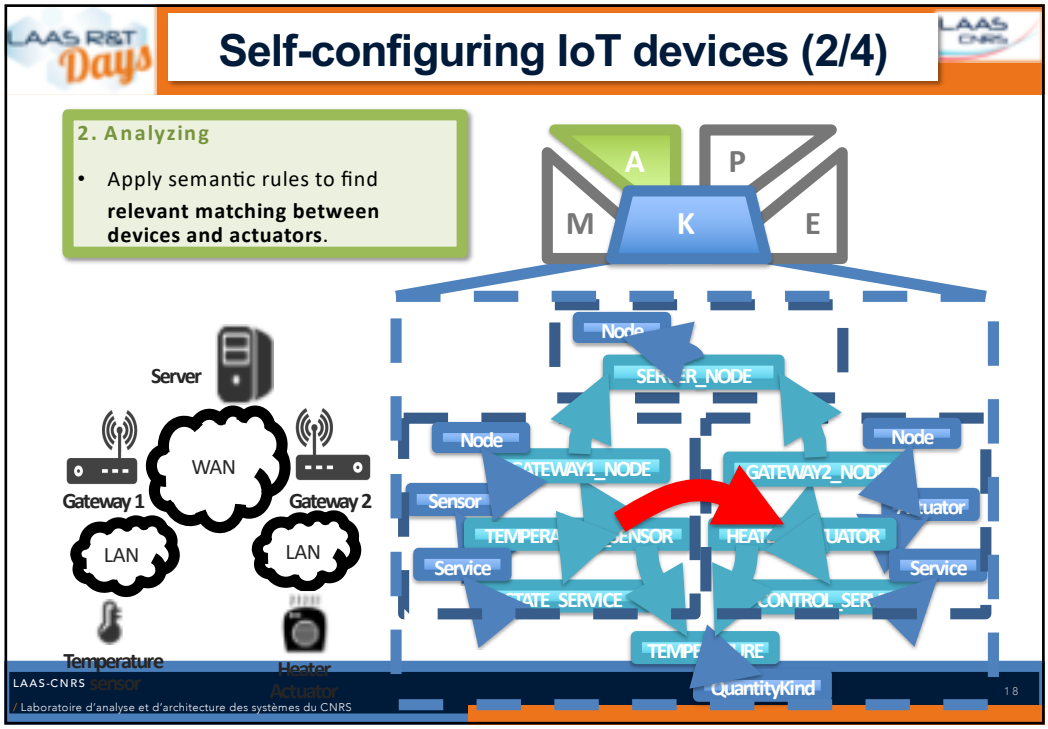
Mastering complexity by semantic reasoning

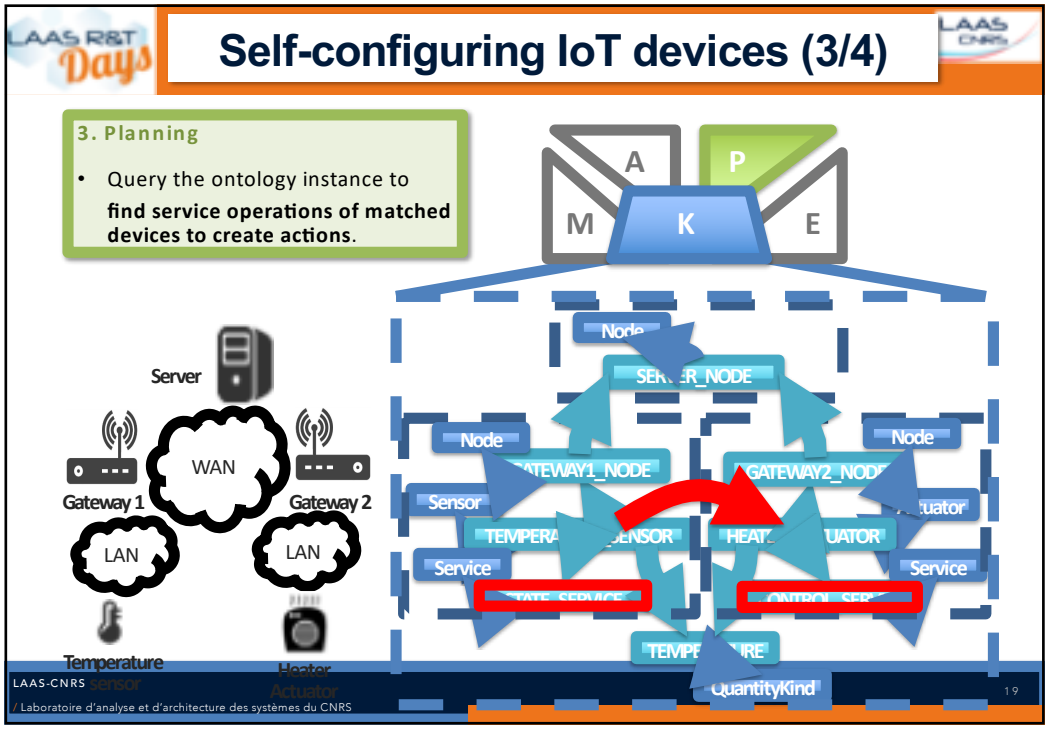


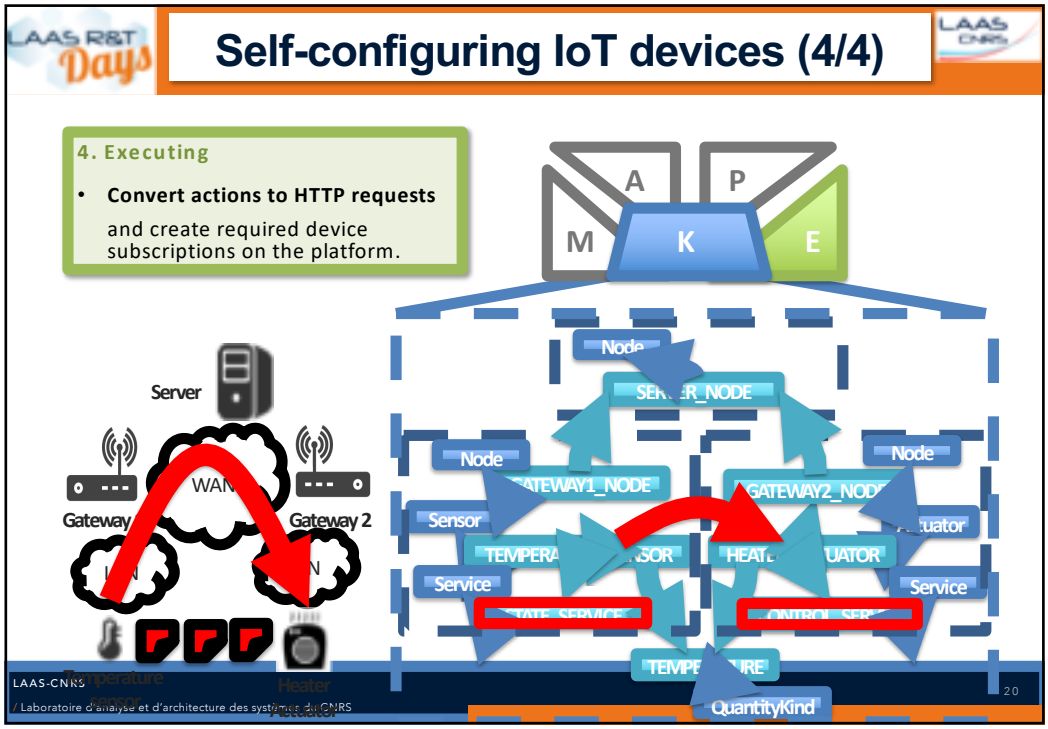
Challenges for Autonomic Mgt in IoT:

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


LAAS R&T Days
Self-configuring IoT devices (1/4)
1. Monitoring
• Runtime discovery of devices and update of the IoT-O ontology instance.
A
P
M
K
E
Server
WAN
Gateway 1
Gateway 2
LAN
LAN
Temperature Sensor
Heater Actuator
Node
Node
Node
Sensor
Service
Service
QuantityKind
LAAS-CNRS
17


LAAS R&T Days
Self-configuring IoT devices (2/4)
2. Analyzing
• Apply semantic rules to find relevant matching between devices and actuators.
A
P
M
K
E
Server
WAN
Gateway 1
Gateway 2
LAN
LAN
Temperature Sensor
Heater Actuator
Node
Node
Node
Sensor
Service
Service
QuantityKind
LAAS-CNRS
/ Laboratoire d'analyse et d'architecture des systèmes du CNRS
18


Self-configuring IoT devices (3/4)
3. Planning
• Query the ontology instance to find service operations of matched devices to create actions.
A
P
M
K
E
Server
WAN
Gateway 1
Gateway 2
LAN
LAN
Temperature sensor
Heater Actuator
Node
Node
Node
Sensor
Service
Service
QuantityKind
LAAS-CNRS
/ Laboratoire d'analyse et d'architecture des systèmes du CNRS
19


Self-configuring IoT devices (4/4)
4. Executing
• Convert actions to HTTP requests and create required device subscriptions on the platform.
A
P
M
K
E
Server
Gateway 2
Node
Node
Node
Sensor
Service
Service
QuantityKind
LAAS-CNRS
/ Laboratoire d'analyse et d'architecture des systèmes du CNRS
20

Ambient Intelligence: the scope of challenges