Middleware for Internet of Things (IoT)

<< More than the sum of its devices, the Internet of Things links technologies together to create new services and opportunities. >>

Course (2 ECTS)

For Master II IFI and Ubinet and Polytech-SI5

Video

- Everytime, Everywhere, but also … Everything
- In our everyday life

- Ambient Comp
- http://www.dailymotion.com/video/xqj9gm_ambientcomp-integrateur-gb-hd_tech

- In french … Continuum
- http://www.dailymotion.com/video/x2bnts6_continuum-version-courte_tech

TEST your own Background

MCQ – Multiple-choice questionnaire

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See http://www.tigli.fr/doku.php?id=cours:muc_2016_2017

IoT in a … cloud of keywords

- Ubiquituous Computing
- Pervasive Computing
- Disappearing Computing
- Internet of Things
- Machine to Machine
- Cyber Physical Systems
- Web of Things

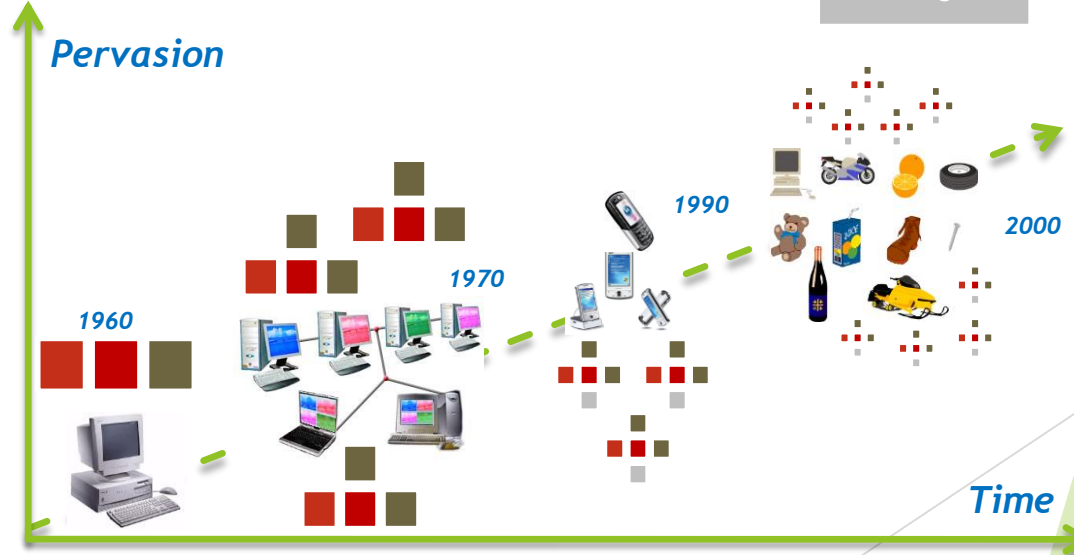# Ubiquitous Computing (1991)

« Silicon-based information technology, is far from having become part of the environment »

Mark D. Weiser (chief scientist at Xerox PARC in the United States) … since 1991 has talked about "the computer for the 21st Century"

- ▶ Everytime, Everywhere, but in Everything

- ▶ Ubiquitous Computing is a Post distributed Distributed Computing

- ▶ After networks of distributed computers, mobiles computers, it's time for distributed things and smart objects
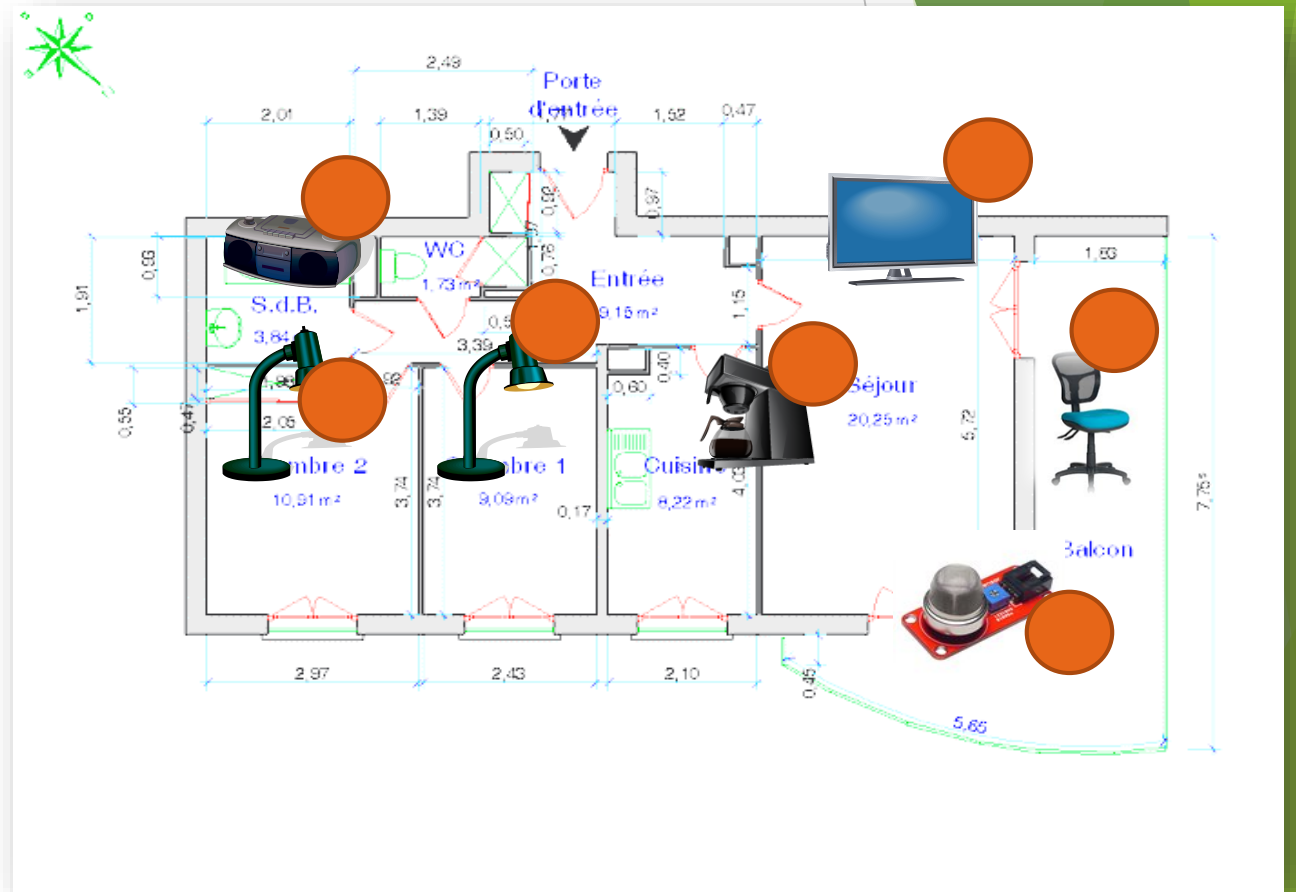
From Von Neumann Computer Model to Smart Objects ....

CPS : Cyber-Physical System

▶ Since less than ten years we talk about CPS …

▶ A **cyber-physical system** (**CPS**) is a system of collaborating computational elements controlling physical entities

▶ Example : Industrial control systems are used in industrial production for controlling equipment or machines.

Khaitan et al., "Design Techniques and Applications of Cyber Physical Systems: A Survey", IEEE Systems Journal, 2014.

CPS (Cyberphysical Systems for physical data)

- IoT and CPS can also be viewed as :

- An Extension of Cyberspace on the physical environment
- **As the connexion of the Physical Environment with the "Cyberspace"** ("the notional environment in which communication over computer networks occurs.")
- Main characteristic : Physical environment is a data provider
  - Well-suited for sensors network and Big Data
  - Sometimes physical data can be modified to act on the physical environment without idea of the physical process beyond.

- The model of the environment is then a Data Model
- Out of scope for data models are
  - how the sensing/actuating is achieved in the real world,
  - what kind of physical phenomena connect these data

CPS (Cyberphysical Systems for physical process)

- IoT and CPS can also be viewed as :

- An Extension of Cynertics principles on the physical environment
- **From Cybernetics** ("control of any system using technology")
- Main characteristic : Physical environment is a device and service provider
  - Well-suited for ambient computing

- Physical environment is a set of services on devices interacting also through physical phenomena

Internet of Things

Things are mainly based on Inputs / Outputs evolution …

- Things is connected to Device

- Devices can be sensors

- Devices can be actuators

- Devices can be physically coupled sensors and actuators (heater : electrical resistance and temperature sensor)

- Devices can be logically coupled sensors and actuators (electrical switch and controlled light)

Technical view of Internet of Things

- Internet is much more a protocol vision on the OSI/API Stack

- Internet of Things as « Network of networks of Things » (gateways between heterogeneous protocols)

- Internet of Things as « Things over Internet » (gateways toward common internet protocol)

Couches OSI

| Application |
| Présentation |
| Session |
| Transport |
| Réseau |
| Liaison |
| Physique |

Couches TCP/IP

| Application |
| Transport (UDP,TCP) |
| Internet (IP) |
| Interface |
| Matériel (IEEE 802) |

ITU-T Study Group, "New ITU standards define the Internet of Things and provide the blueprints for its development," ITU, 2012. [Online]. Available on http://www.itu.int/en/pages/default.aspx.

Technical limitations

- But Internet is not enough to garantee interoperability

- This is only a common Network and Transport protocol …

- Nothing about syntactic and lexical interoperability
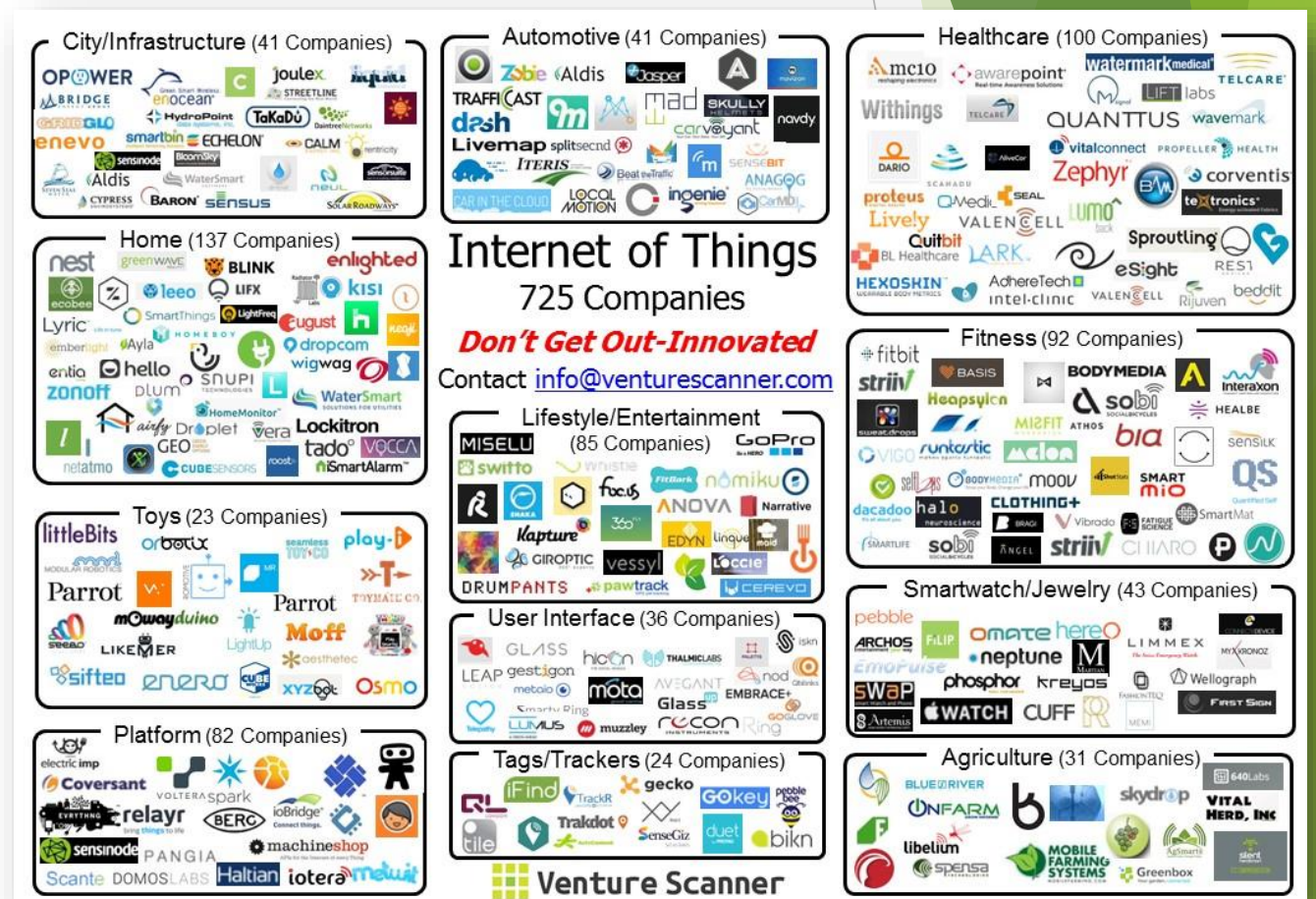
Toward Web of Things with two trends ...

- ▶ First Trend is « Web of Physical Data »
  - ▶ How to integrate Things in the Web
  - ▶ How to add physical data as physical hyperlink
  - ▶ In a ROA (Resource oriented Architecture) style
  - ▶ Well adapted for CPS

- ▶ Second Trend is « Web of Physical Devices »
  - ▶ How to over overcome the limitation of the specificity of API
  - ▶ How to explicitly describe the API of a Service
  - ▶ In a SOA (Service oriented Architecture) style

Technologicaly : Web of Things to bypass the Technological Heterogeneity in IoT ...

▶ WoT are Web-based solutions

▶ Web Services a good way to solve IoT heterogeneity through Gateways (or any other federative protocol with same properties)

▶ RESTFul, WS-SOAP, CoAP ...

▶ If alternative solutions exist, they depend on the popularity of the standard of the communication protocol that they adopt
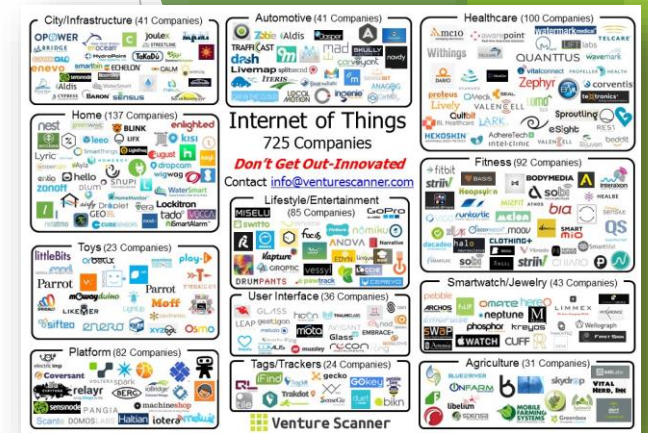
Web of Things WoT	HTTP, REST,...

Need to manage Technological Heterogeneity for communicating with devices

IoT	BT, ZigBee, 6LoWPAN,...

Things are ....

Web of Things for Physical Data or Physical Process

▶ The Web of Things (WoT) is a term used to describe approaches, software architectural styles and programming patterns that allow real-world objects to be part of the World Wide Web.

▶ WoT based on Resource oriented Architecture for CPS (Cyberphysical Systems for physical data)

    ▶ RESTFul services to get Physical data with URI

▶ WoT based on Service oriented Architecture for CPS (Cyberphysical Systems for physical process)

   ▶ SOAP services to access to physical devices functionalities

6th International Workshop on the Web of Things: WoT 2015, collocated with IoT 2015 and will take place at the COEX Center in Seoul, South Korea on October 2015 – http://webofthings.org/

Guinard, Dominique; Trifa, Vlad; Mattern, Friedemann; Wilde, Erik (2011). From the Internet of Things to the Web of Things: Resource Oriented Architecture and Best Practices. Springer. pp. 97–129. ISBN 978-3-642-19156-5.
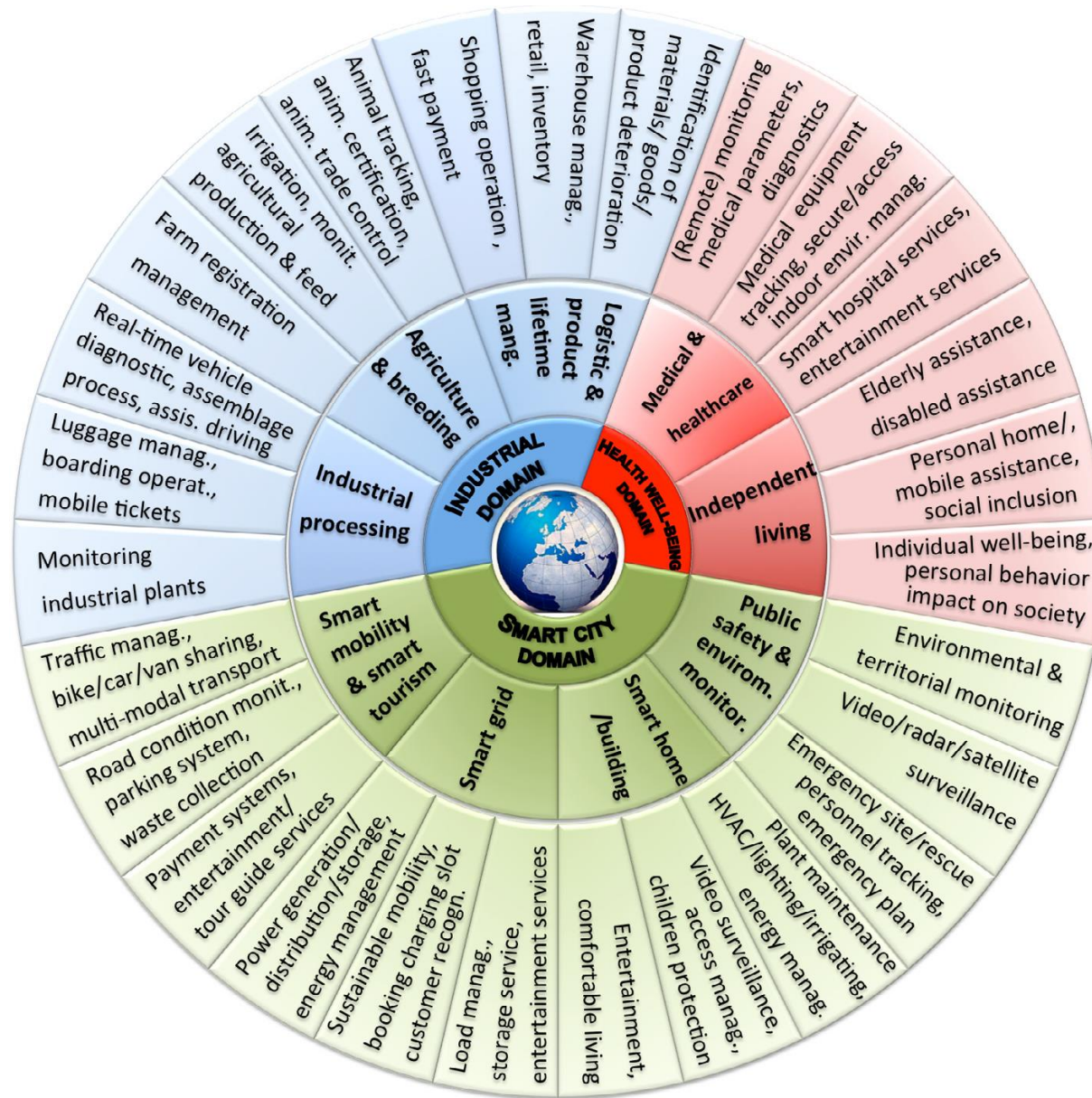
IoT application domains

IoT application domains and related applications
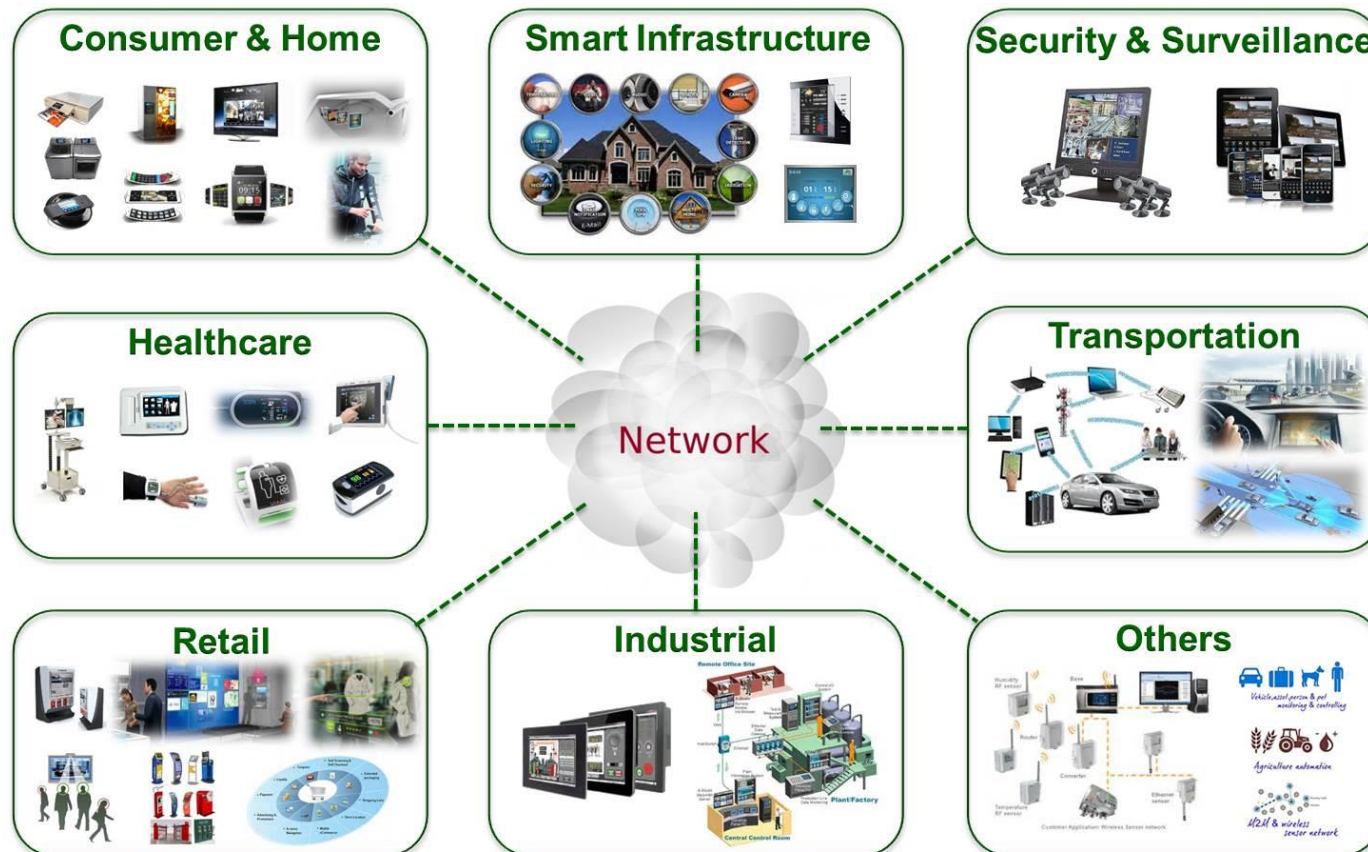
And more …

The Internet of Things vision: Key features, applications and open issues
Eleonora Borgia
Institute of Informatics and Telematics (IIT), Italian National Research Council (CNR), via G. Moruzzi 1, 56124 Pisa, Italy
Computer Communications 54 (2014) 1–31, paper

MIT Agenda

2016 - 2017

Main structure of the course

Middleware for IoT provide solutions

▶ For Interoperability challenges at different levels for IoT

▶ To Give answers to specific IoT constrains :

　　▶ Low power

　　▶ Limited Bandwith

　　▶ Large Area

　　▶ …

Main structure of the course

IoT Interoperability levels in the course
Advanced IoT : Semantic Web of Things (SWoT) and opportunistic composition
WoT and WSD : Web of Things and Web Service on Device – Tutorials : REST over Device and WoT and WSD composition
IoT : Network of Networks of Things – Tutorials : Things over IP (MQTT standard) and Complex Event Processing
Local and Personal Area Networks but also Body and Low Power Wild Area Networks – Tutorial LoRa

MIT Agenda and Lecturers

mardi 06 Décembre 2016		
09:00-12:15	J.-Y. Tigli	Middleware for Internet of Things, a survey on the interoperability challenge and communications patterns
mardi 13 Décembre 2016		
08:00 - 10:00, 10:15 - 12:15	Laurent Gomez - SAP	LPWA networks - Tutorial LoRa
Vendredi 16 Décembre 2016		
13:30 - 15:30, 15:45 - 17:45	Laurent Gomez - SAP	LPWA networks - Tutorial LoRa
mardi 03 Janvier 2017		
08:00 - 10:00, 10:15 - 12:15	J.-Y. Tigli	IoT : MQTT - OASIS standard / Tutorial MQTT

MIT Agenda and Lecturers

mardi 10 Janvier 2017		
08:00 - 10:00, 10:15 - 12:15	I. Sarray	Synchronous language for formal validation - application to CEP (complex event processing)
mardi 17 Janvier 2017		
08:00 - 10:00, 10:15 - 12:15	J.-Y. Tigli	From IoT to WoT/WSD - Tutorial HTTP/CoAP - WS/REST - WSD
mardi 24 Janvier 2017		
08:00 - 10:00, 10:15 - 12:15	S. Lavirotte	WSD and WSD composition in the cloud - tutorial Ubiquaria
mardi 31 Janvier 2017		
08:00 - 10:00, 10:15 - 12:15	G. Rocher puis J.Y. Tigli	Advanced MIT : SWoT & Semantic Interoperability (G. Rocher) - Opportunistic Composition (J.Y. Tigli)

What about your computer and software environment for MIT ?

For tutorials, we need :

- Linux

- Windows

Use Vmware to install them on the same machine at the same time

Don't forget to configure :

- IP network

- Shared directory between virtual machine and your computer