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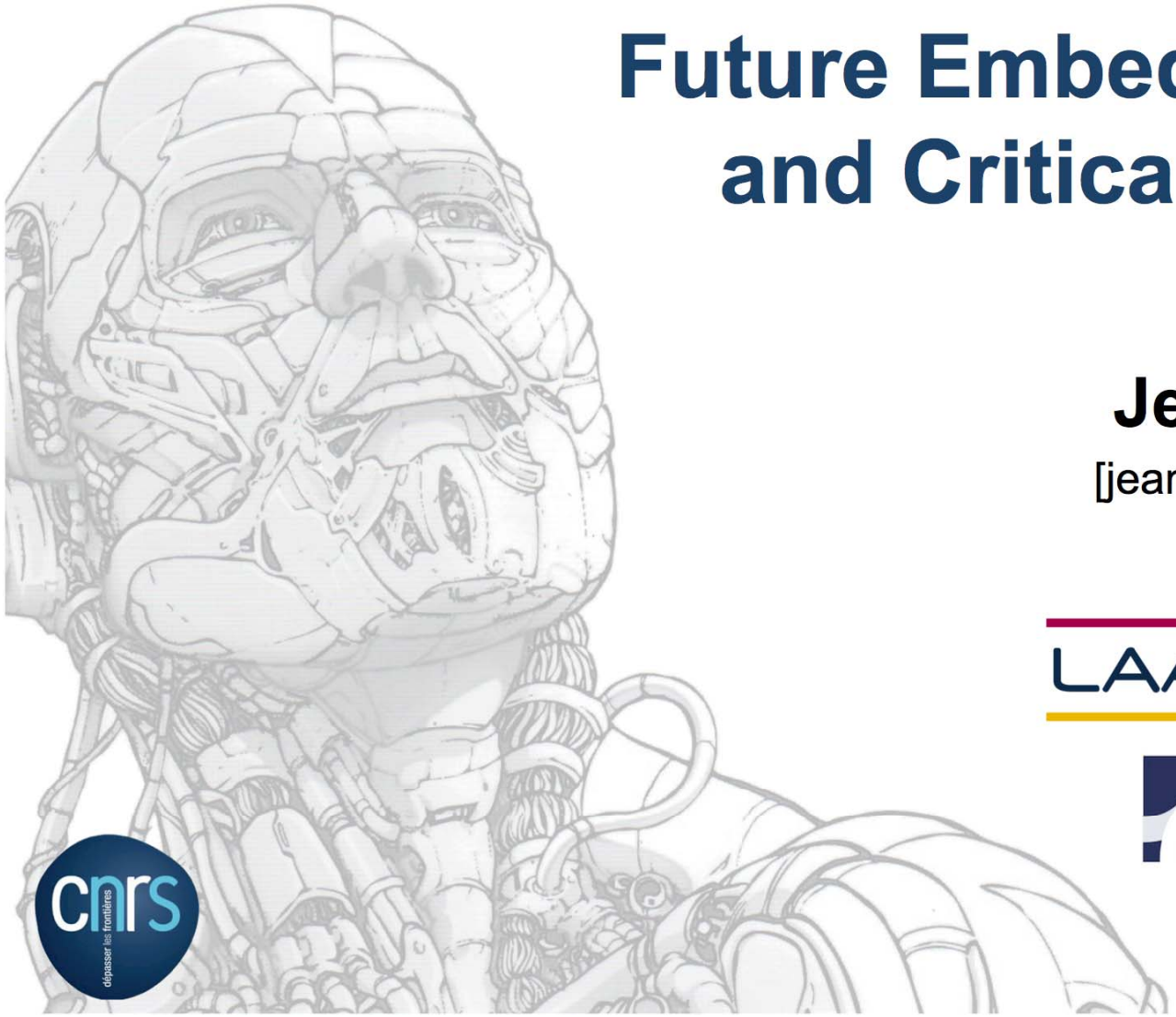
Mr François HOLLANDE
President of the French Republic

Panel

Internet of the Future



Future Embedded Systems and Critical Applications

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cnrs dépasser les frontières

Université de Toulouse

Towards a New Paradigm for Embedded Systems: The Cyber-Physical Systems (CPS)

- **Embedded Systems (SE)**
  - **Computerized system executing specific functions within an host system, generally with stringent non requirements: Real-time, Performance, Resilience,**
  - **Widely deployed in many application domains: Industrial, Transportation, Health-care, Home control, etc.**
- **CPS ≈ "SE" with extensions**
  - **Strong Interaction between information processing level (virtual) and physical resources level (real): Intensive/pervasive deployment of smart objects (e.g., sensors for enhanced context awareness)**
  - **Openness: communication, mobility,…**
  - **Big Data: storage, processing, decision/optimization,…**
  - **Autonomy: All-in-one system** (monitoring-processing-control) **: the Robot**
  - **Dependency, Accepatbility, Trust: Strong requirements in dependability, resilience (cope with changes), security and privacy**

Coping with New Context and Threats

- **Beyond Rigorous Design, Dependability Validation and Achievement is a crucial & comprehensive task:**
  - **Verification (proof, model checking, testing)**
  - **Assessment (stochastic modeling, fault injection- based experimentation, benchmarking)**
  - **Albeit usually of much concern, Safety is not to be accounted for alone: Availability, Security, etc.**
- **Critical systems are increasingly:**
  - **"Open" to outside world and accordingly,**
  - **"Accessible" to malicious attacks.**

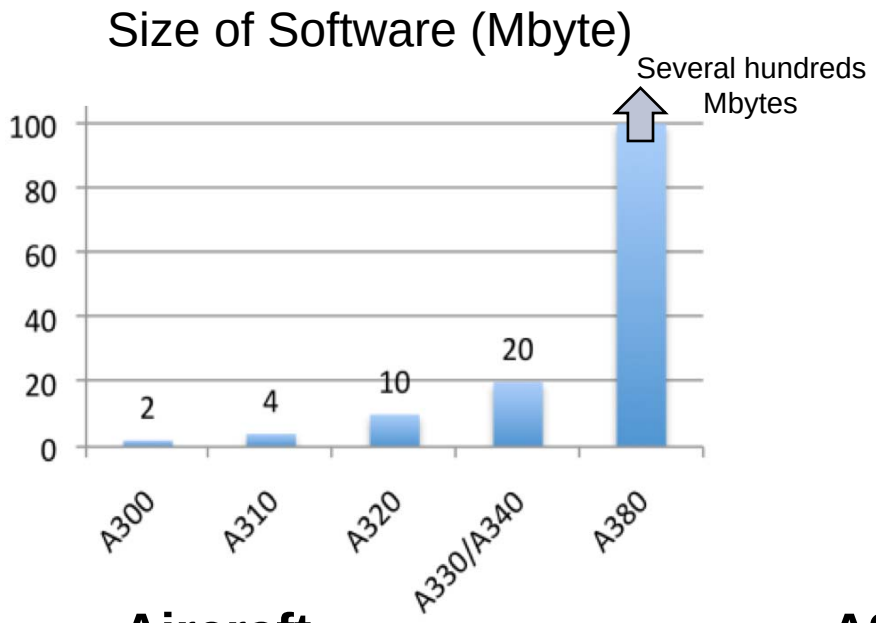
  ➔ **Attacks successfully breaching some security vulnerabilities could jeopardize the ultimate safety requirements.**

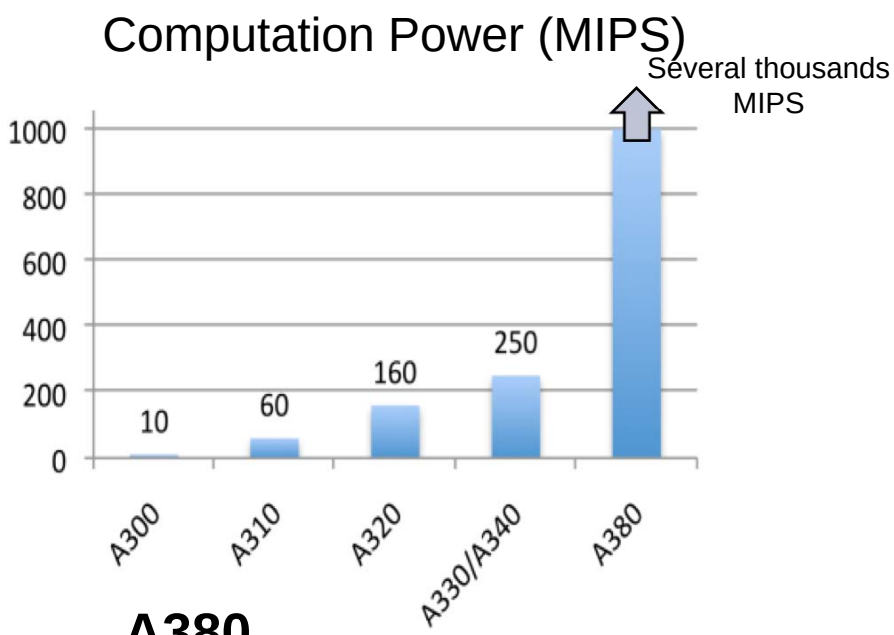
  ➔ **More acute when integrating COTS components (HW or SW)**

  ➔ **Clearly, Security and Safety are intimately linked.**

Increased Functionalities & Complexity of Transportation Systems

- **Current Civil Aircraft**





Aircraft	A320	A380
# messages exchanged among embedded systems	2,000	> 100,000

- **Automotive**
  - **Cost of “electronics” in a vehicule > 30% in 2010**
  - **SW code size: several 10’s of Mbytes by this decade**

Coping with Software (SW)

- **For Certification - Verification is a real concern.**
  - **Limited complexity SW: design and implementation can be automated and the resulting code generated can be considered as "proven-by-design".**
  - **More complex SW: meeting the strong requirements for certification might not be possible. Redundancy and Diversification can be called to the rescue, as well.**
- **Example: Impact on the certification of software for aircraft:**

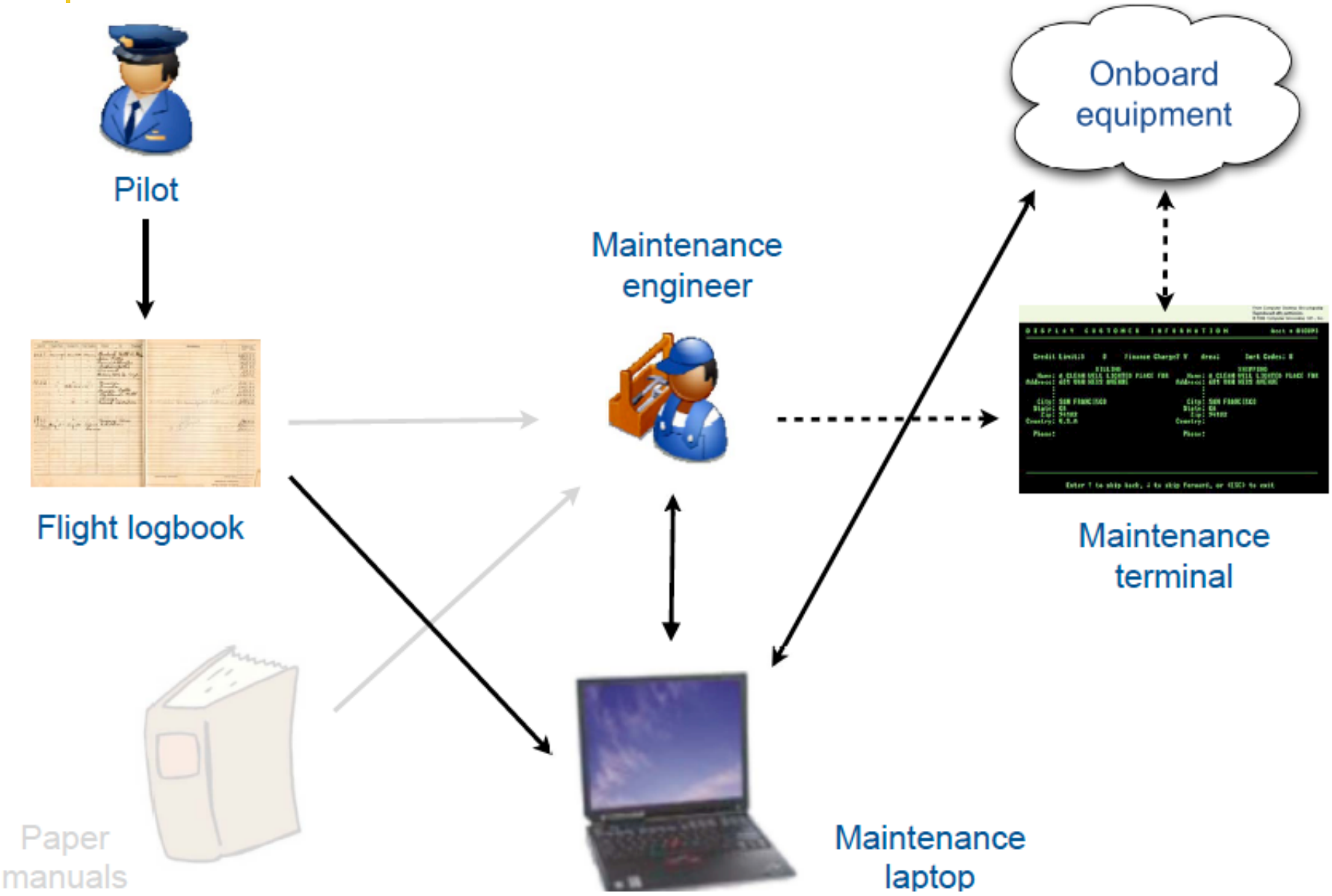
> DO-178B : "Dissimilar software verification methods may be reduced from those used to verify single version software if it can be shown that the resulting potential loss of system function is acceptable as determined by the system safety assessment process."

A Large Spectrum of Threats

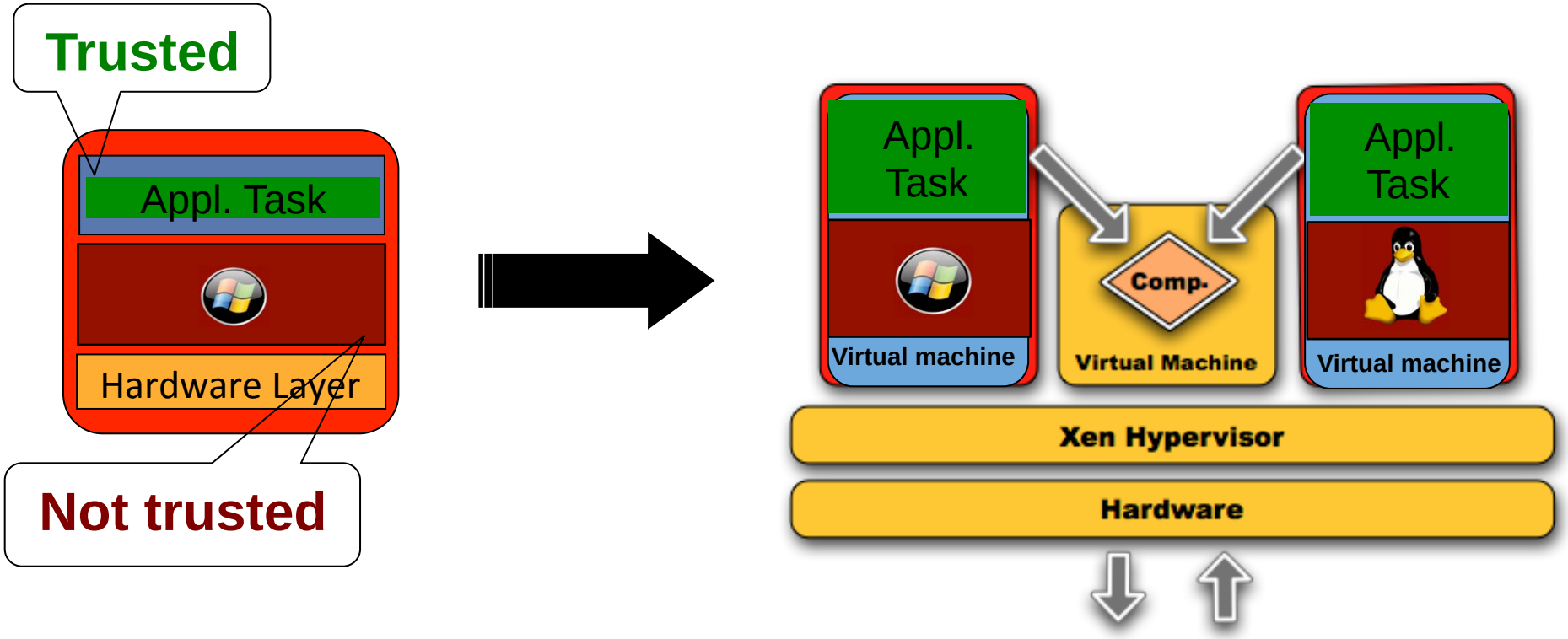
- Various types of faults (HW, SW, malicious) are to be considered
- The design should rely on fault-tolerant computing architectures concepts, at system-level as well.
- Among various possible approaches, once again, redundancy and diversification is one generic approach to help cope with various types of faults (accidental and malicious)

- A Kind of "*Swiss-Knife*" Solution … ☺

Aircraft Maintenance: Laptop Scenario



Trustable Implementation: Diversified Duplex — Principles



Y. Laarouchi, Y. Deswarte, D. Powell, J. Arlat; E. De Nadaï (Airbus)
Connecting Commercial Computers to Avionics Systems
28th IEEE/AIAA Digital Avionics Systems Conference (DASC), pp. 6D1.1-6D1.9, October 2009.

Some Challenges and Trends

- **Reliance on fault-tolerant computing principles should be more widespread:**
  - **New paradigms for managing task-scheduling and WCET assessment (less pessimistic estimates): probabilistic assessment could be a way forward?**
  - **Coping with non-deterministic behavior of elementary components of HW chips (Moore Law limitation)**
  - **Trade-off between requirements for openness and flexibility (system operation, maintenance, etc.) and requirements for protection against risks caused by malicious faults to fulfill the safety constraints**
  - **Moving from a process-oriented certification to a product-based certification**

CPS @ LAAS-CNRS

- **ADREAM : Architectures for Dynamic Resilient Embedded Autonomous Mobile systems**
- **Ambient Intelligence, Internet of Things, CPS**
  - **Open and Pervasive Digital Systems, Sensor Networks, Companion Robots,…**
  - **Modeling, Simulation, Verification, Optimization, Control, QoS, Dependability, Security, Privacy**
  - **Assistance : Health, Public Space, Factory of the Future, Rescue, Agriculture,…**

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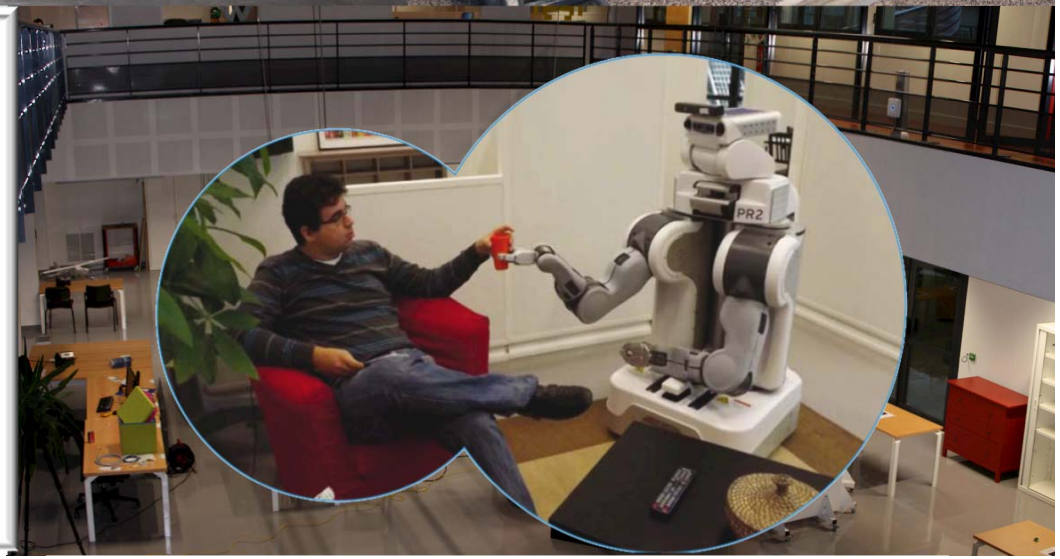
Research Program ADREAM

Architectures for Dynamic Resilient Embedded Autonomous Mobile systems

- **≈ 200 m2 of Modular Space for Experimentation**
- **Smart and Networked Sensors in Building** (movement, localization,…)
- **Communication Protocols (*M2M*)**
- **Autonomous *Robots*** *(companions, service, drones)*
- ***Resilience, QoS, Security & Privacy***



On Smart Objects…

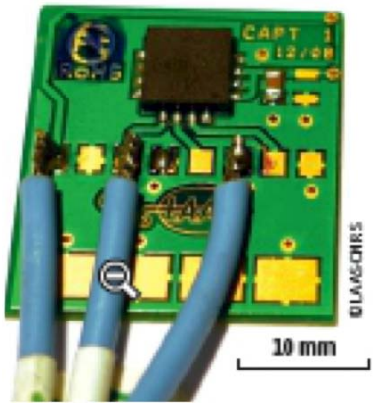
- **Smart Sensors: Integrated Devices, Autonomous, Communicating,…**

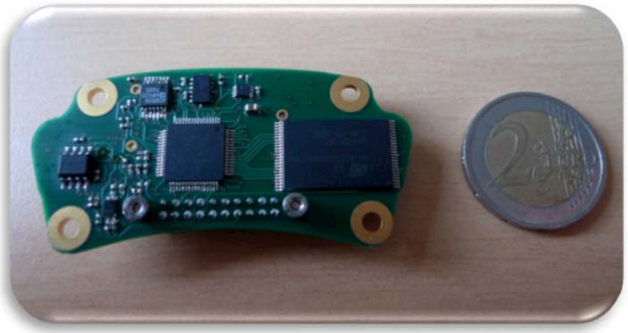
- **Some Examples:**
  - **Transports**
  - **Frailities,**
  - **Environment**
  - **Vulnerabilities of Domestic Appliances**
  - **…**

Smart Objects & Transport: Stuctural Health - diagnosis et supervision of the Integrity

<u>Microsystème Enregistreur de Paramètres de Pales</u>

- **Diagnosis of Defects, Impacts, Over-speeding in Blades**
- **Vibration analysis**
- **Collaboration:**





Smart Object and “Fraility” Monitoring

Instrumented Sole « Foot-Test »

Collaboration:

medicapteurs
PODOLOGIE, POSTUROLOGIE ET RÉÉDUCATION

intesens
TELEDIAGNOSTIC SOLUTIONS

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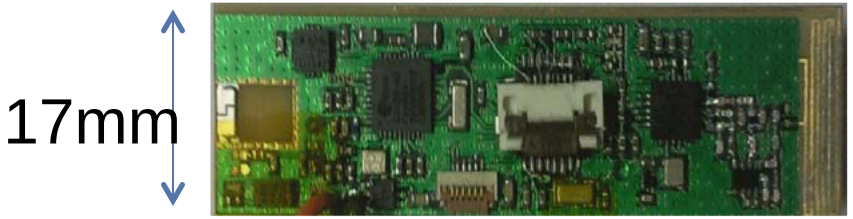
Smart Objects and Coping with “Fraility”



SACHA
SEARCH AND COMPUTERIZE HUMAN ACTS

centre esanté

Le centre hospitalier du val d'Ariège

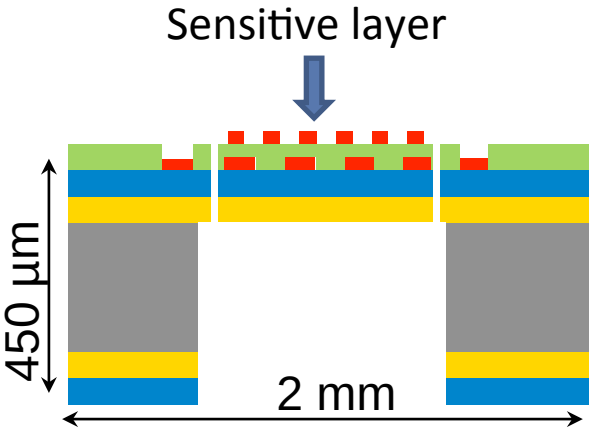
SIGFOX
One network A billion dreams

TELECOM DESIGN

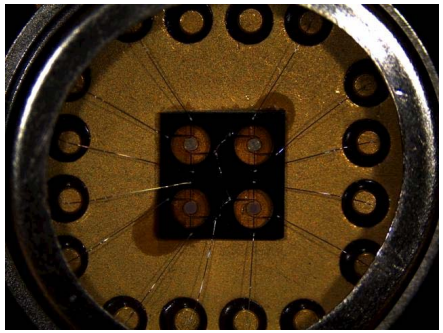
axible technologies

Smart Objects and “Virtual Nose”

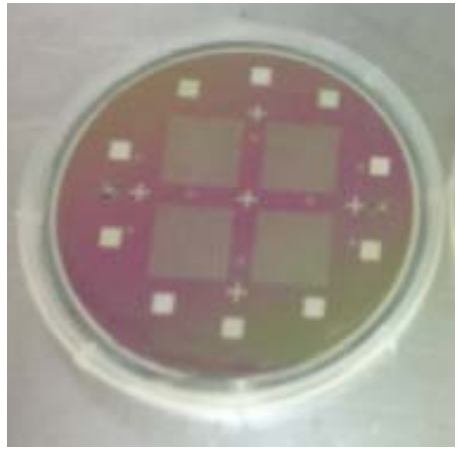
- **Design and development of communicating “electronic noses”**
  - **Detection of specific gas**
    (Indoor, Outdoor, Electricity Tranrformer Station),
    and communication of data via a Sigfox module (low rate, low power)



Chemically sensitive Layer:
ZnO stone



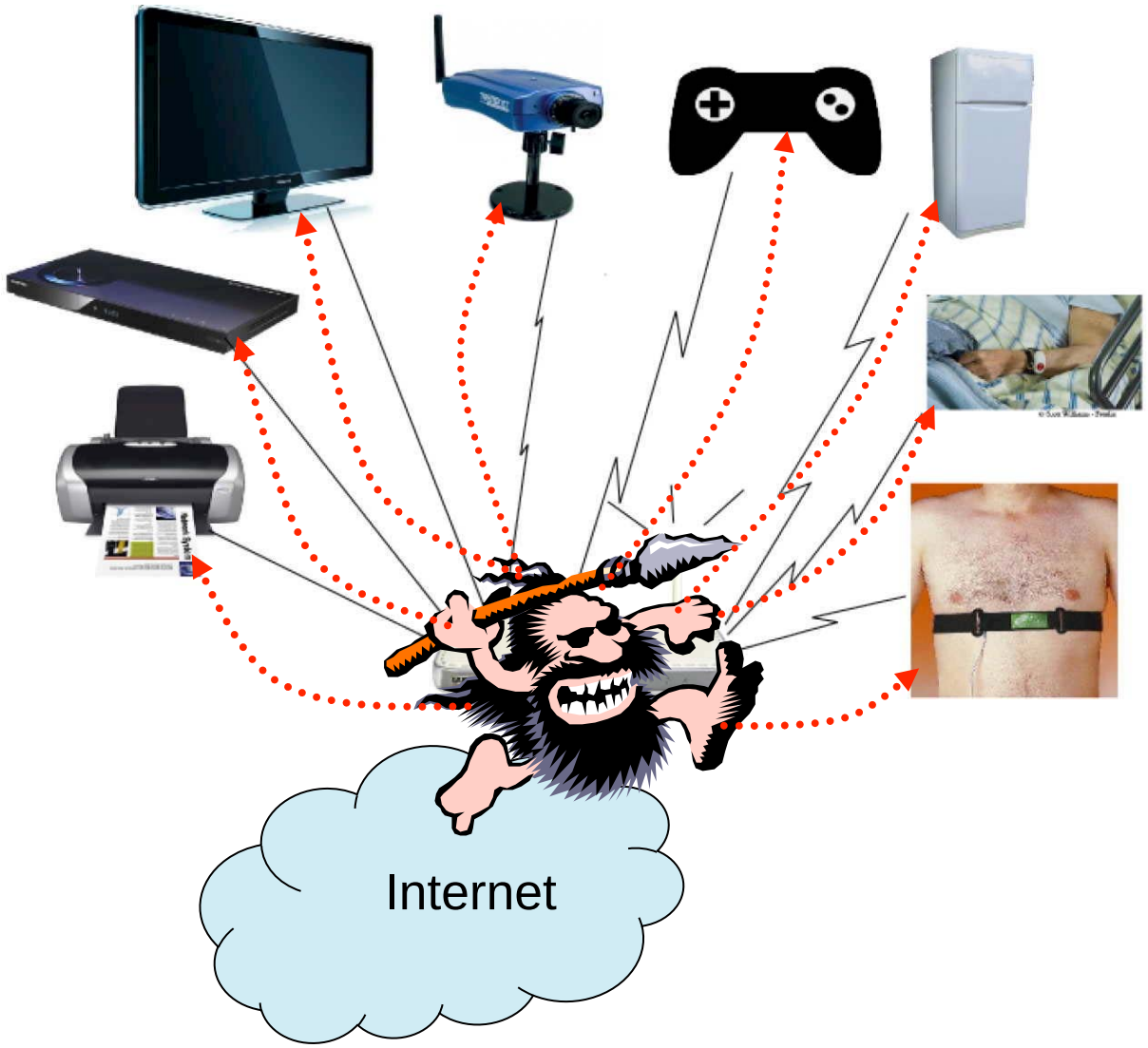
Multi with 4 cells



Wafer with 400 cells

OBJECT’S WORLD

Domestic Networked Appliances and Attacks



On-going Work

- **ADSL “Boxes” are vulnerables**
  - Privileges Extensions
  - Reprogramming — via Telecommand — for proceeding with hidden functions
- **Targeted Equipment**
  - Smart (connected) TV Sets and DVD Players — *Thales Security*
  - Avionics (Avions, Satellites) — *Airbus, Astrium (A D & S)*
  - Automotive vehicles — *Renault*
  - *…*

Security, Confidentiality, Privacy,…

LE FIGARO

« Sans la liberté de blâmer, il n'est point d'éloge flatteur » Beaumarchais

5 mai 2014

- **The car, the new target for hakkers**

  Principale « porte d'entrée » des voleurs : la prise OBD (*On-Board Diagnostics*) : connecteur utilisé pour procéder au diagnostic de la voiture

- **Plus que l'électronique embarquée, ce sont les connexions sans fil entre les fonctions multimédias, services en ligne et outils de diagnostic qui faciliteraient le piratage à distance d'une automobile… ☹**

Le Point.fr

9 mai 2014

- **The iPhone "cookie"**
- **Une fonctionnalité de l'iPhone (optionnelle, mais activée par défaut) vous suit désormais à la trace …**
- **Vous êtes donc probablement traqué à votre insu… ☹**

How Hackable Is Your Car? Consult This Handy Chart… ☺

Car	Attack Surface	Network Architecture	Cyber Physical
	++	--	+
	-	+	+
	++	+	+
	-	++	+
	++	++	++
	++	++	--
	++	-	++
	++	-	--
	++	+	+
	--	--	--
	++	-	++
	++	--	+
	++	--	++
	++	--	+

Blackhat Security Conference
Las Vegas, NV, USA — 14/08/2-7
(www.blackhat.com/us-14)

The Criteria

Attack Surface: Radio connection links: Bluetooth, Wi-Fi, cellular network connections, keyless entry systems, radio-readable tire pressure monitoring systems,…

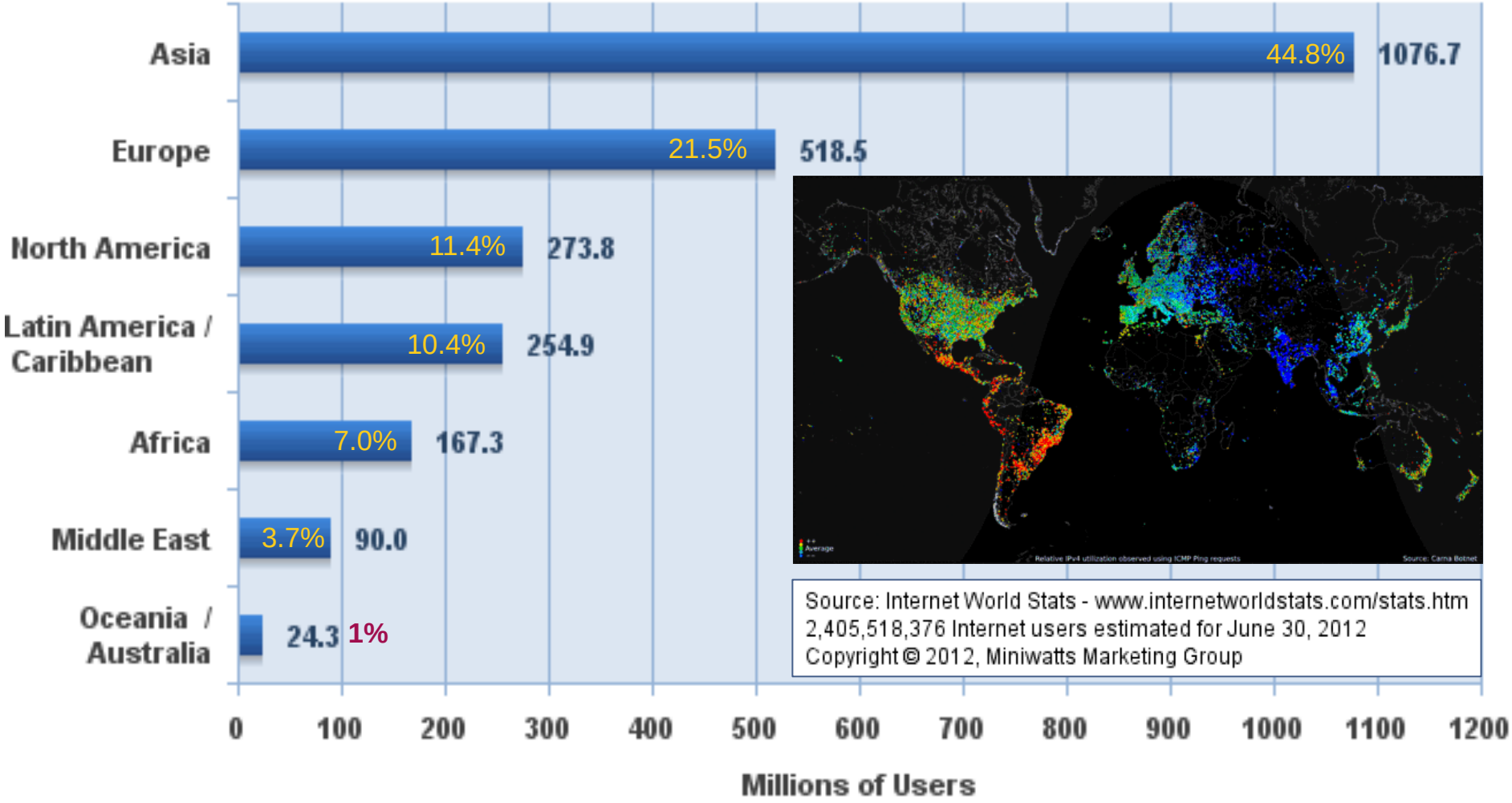
Network Architecture: To what extent those connections allow access to vehicles' core architecture controlling critical functions: steering and brakes.

"Cyber-physical" features: Advanced capabilities (automated braking, parking & lane assist) that if targeted by spoofed digital commands could be prone to lead to an "out-of-control car".

http://www.wired.com/2014/08/car-hacking-chart

Deployment of the Internet And Beyond…

Worldwide population: **7,017,846,922**
Users: **2,405,518,376**
% Penétration: 34.3 %
% Increase / 2000 : 566.4 %
June 30, 2012



- IoT would connect **50 to 100 billions** of objects et trace their movements
- In an urban environment: each person surrounded by **≈ 1000-5000** smart objects

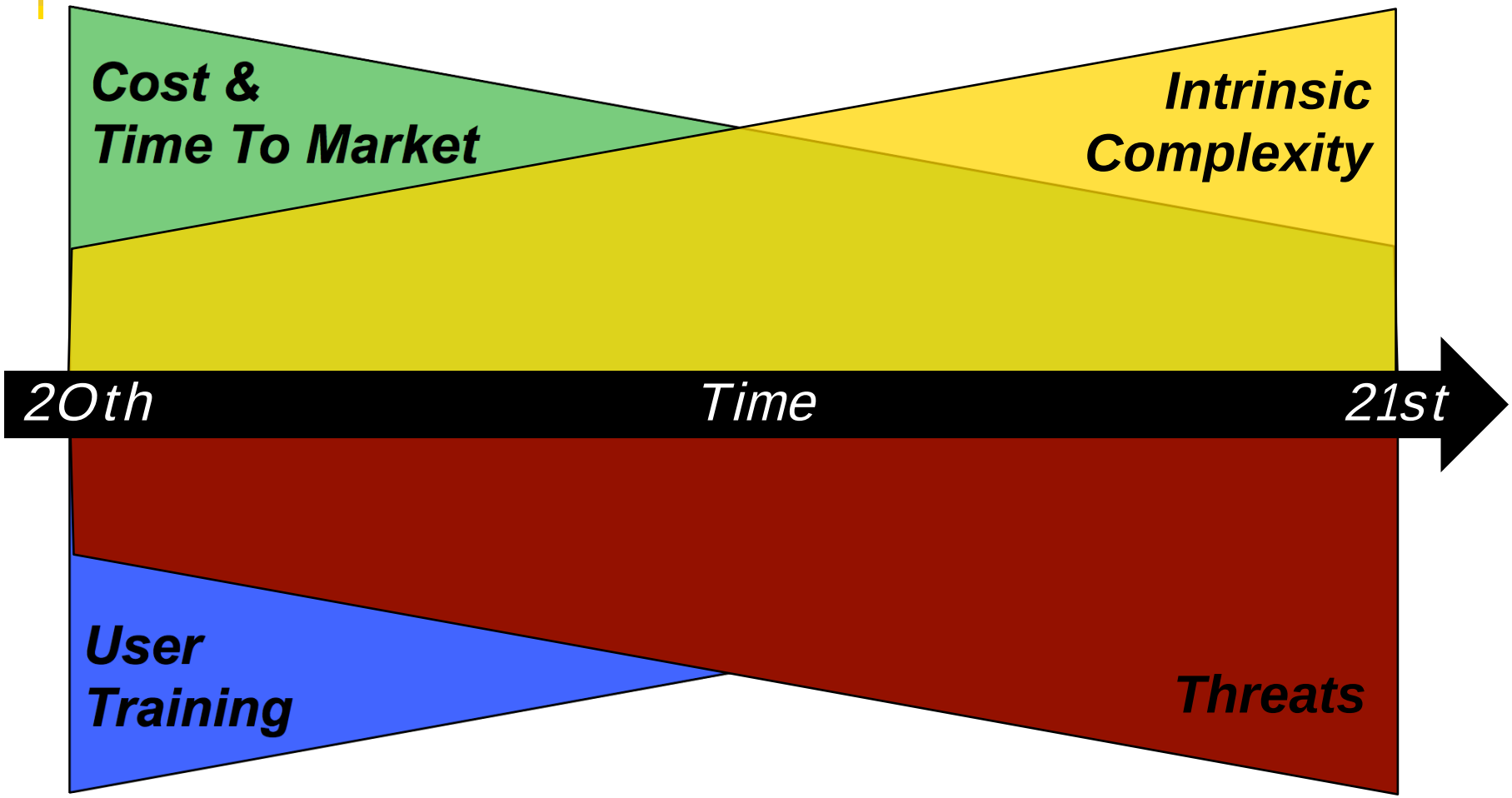
On the implementation of the Internet of Things

New paradigms and models for the Communications

- **Reconfigurability**
- **Networks of Dedicated Operators,…**
- **Interoperability**:
  Standardization of M2M protocols ➔ OM2M Connecting things
  [http://om2m.org]

➔ **LAAS-CNRS: First *Open Source* platform compliant with the emerging standard**
— under ECLIPSE license ECLIPSE

Looking Ahead: An Ever Moving Target



Panel

Internet of the Future

Merci !

Thanks!

Danke!

Gracias!

Grazie!

Obrigado!

Questions ?

Takk!

ありがとう

謝謝

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