DESIGN, AUTOMATION & TEST IN EUROPE
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Horizon 2020
European Union funding
for Research & Innovation

CERBERO

Cross-layer modEl-based fRamework for multi-oBjective dEsign of Reconfigurable systems in unceRtain hybRid envirOnments

presented by Michael Masin (IBM Research - Haifa, michaelm@il.ibm.com)

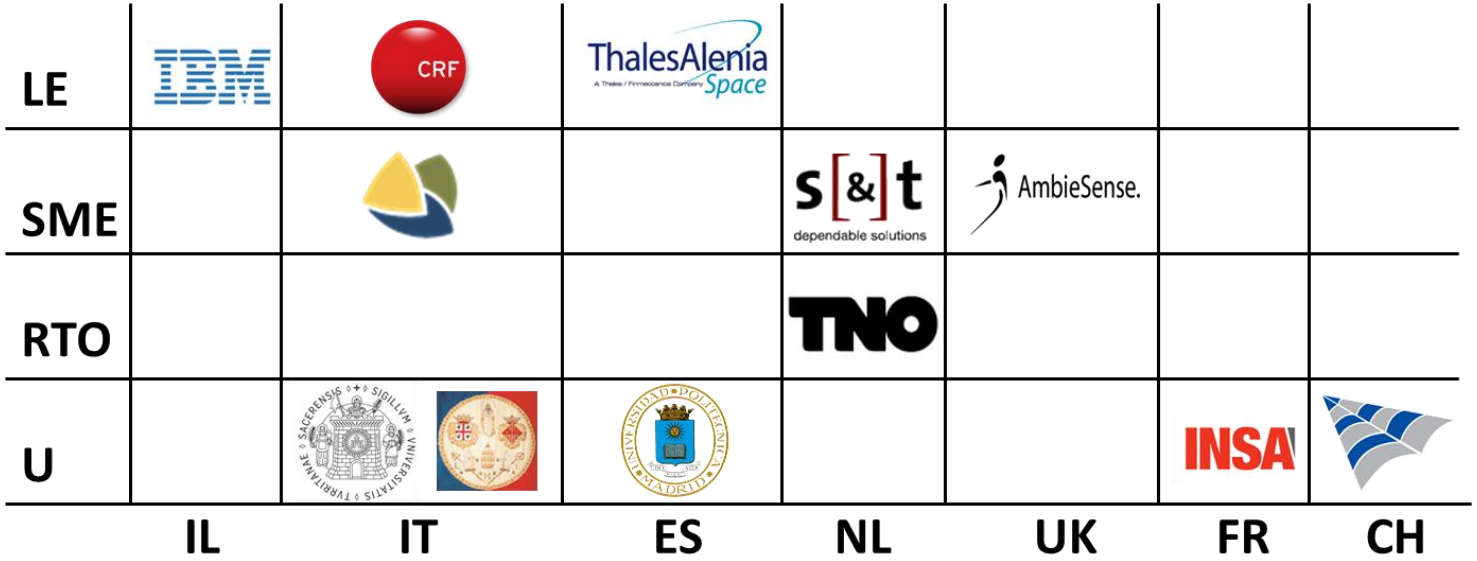
joint work with

F. Palumbo (U. d. Studi di Sassari), **F. Regazzoni** (U. d. Svizzera Italiana), **H. Myrhaug** (Ambiesense), **J. A. de Oliveira Filho** (TNO), **M. Pastena** (S[&]T), **M. Pelcat** (INSA), **L. Raffo** (U. d. Studi di Cagliari), **A. A. Sanchez** (Thales), **A. Toffetti** (CRF), **E. de la Torre** (U. Politecnica de Madrid), **K. Zedda** (Abinsula)

Agenda

- CERBERO consortium in a glance
- Background on Cyber Physical Systems (CPS) and Cognitive CPS
- CERBERO goal (WHAT)
- CERBERO use cases (WHY)
- CERBERO tool chain (HOW)
- Summary of CERBERO approach
- Next steps

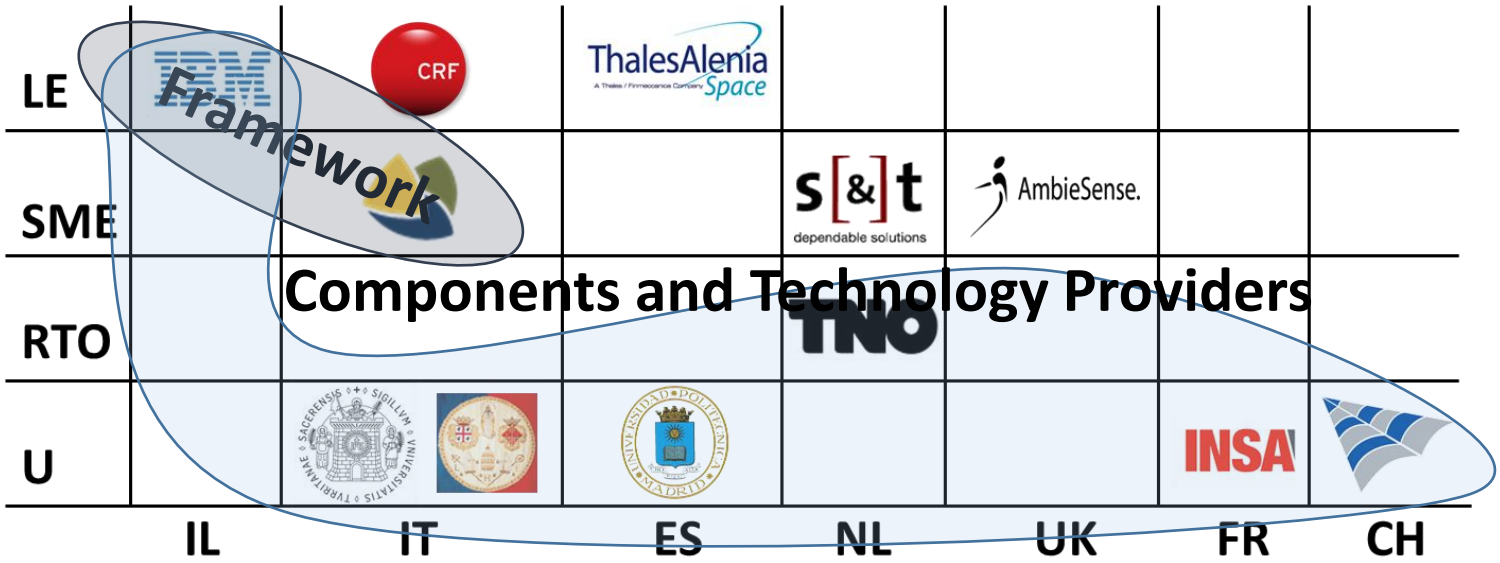
Consortium: 12 partners from 7 countries



Started: January 1, 2017

Duration: 36 months

To build Cognitive Cyber Physical Systems



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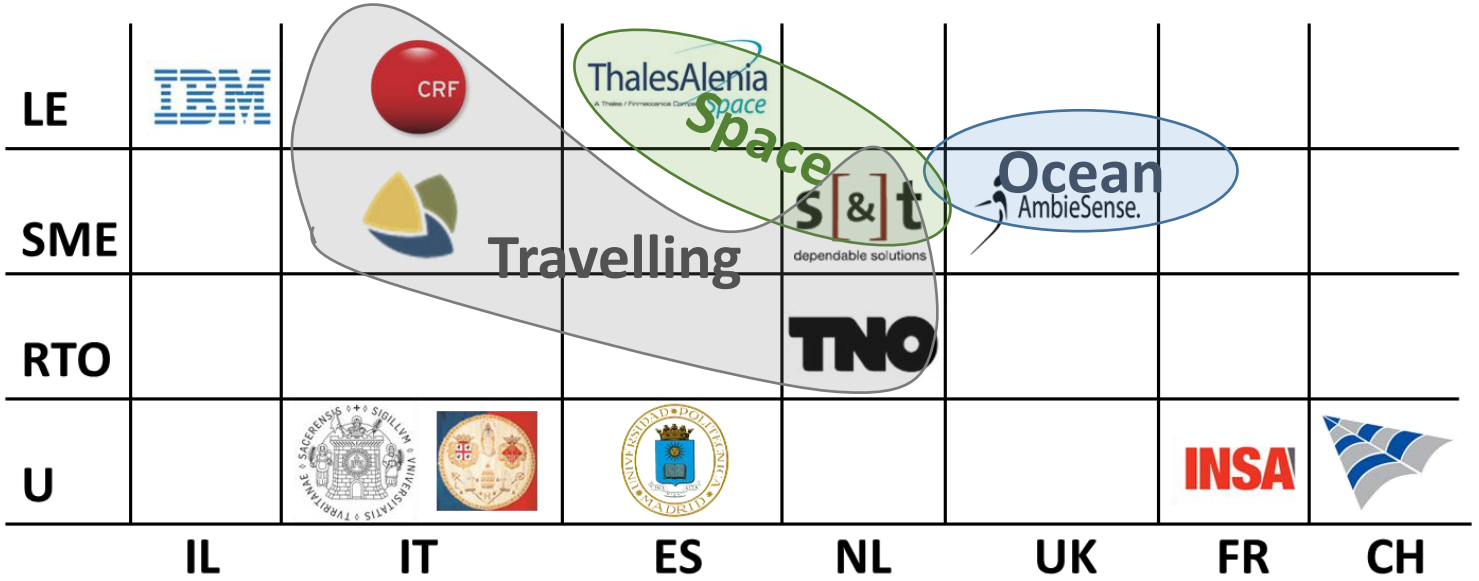
and evaluate by 3 use cases



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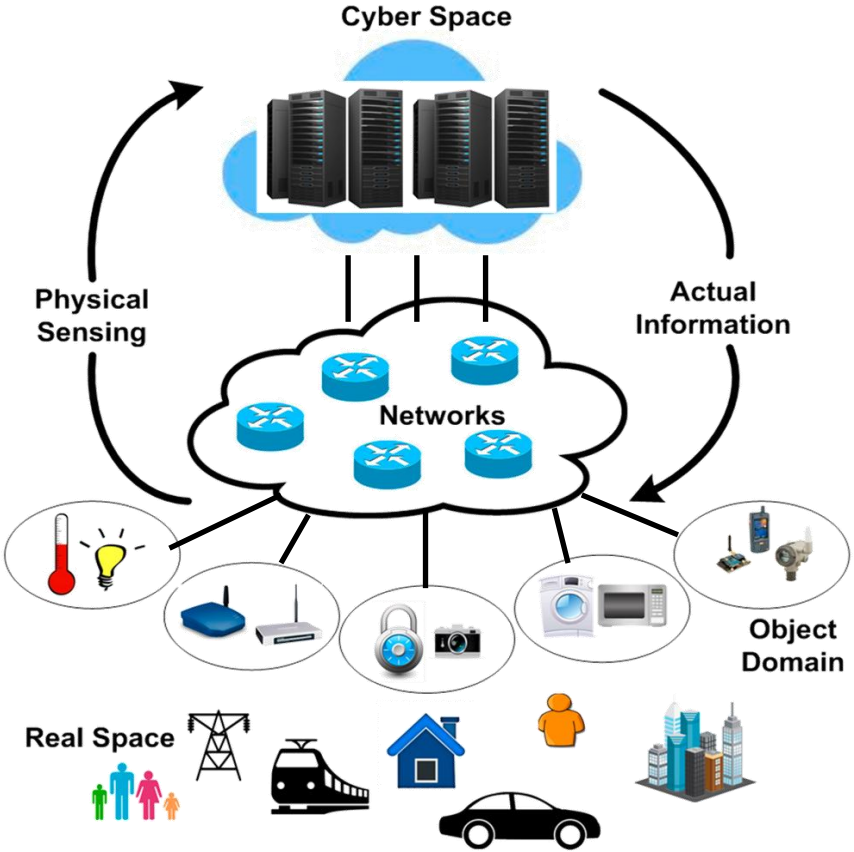
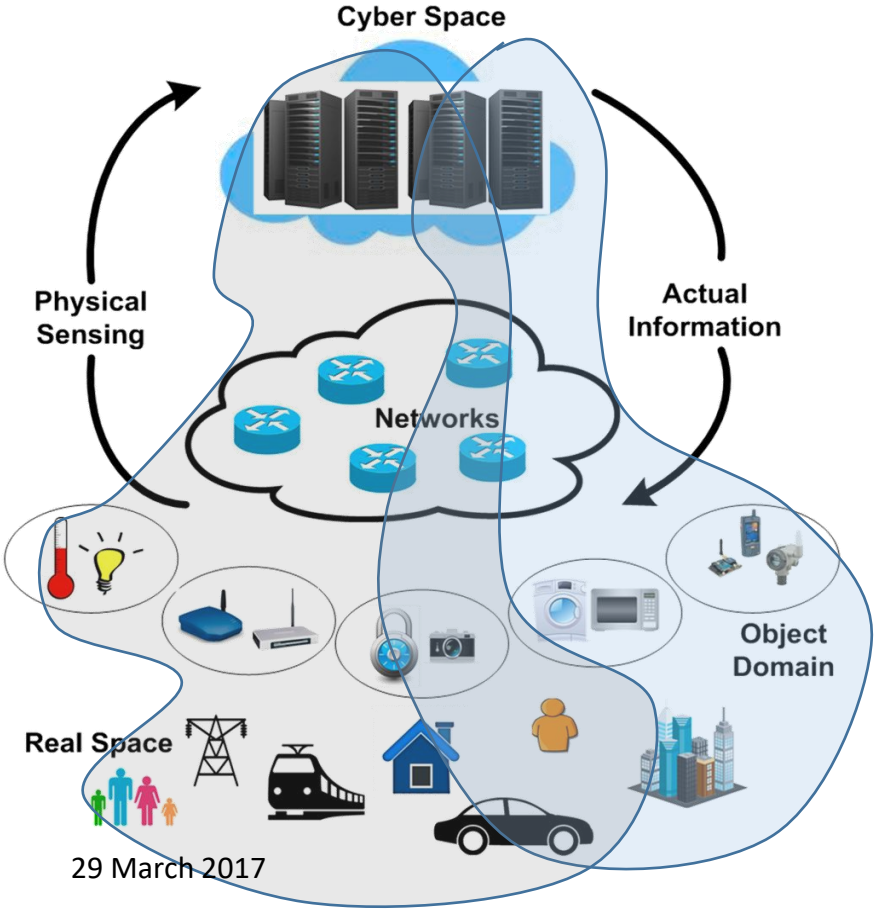
Cyber Physical Systems (CPS)



- **Autonomous cyber** systems communicating with **physical** environment
- Examples
  - **embedded controllers**
  - **home appliances and cars communicated with cloud**
  - **industrial controllers, SCADA**
- Usually **small** System of Systems (SoS) or **star** topology of similar devices connected to cloud
- **Main challenge:** Combine Cyber and Physical Models for design, analysis and operation
- **Established** technologies for design and operation

Cognitive CPS

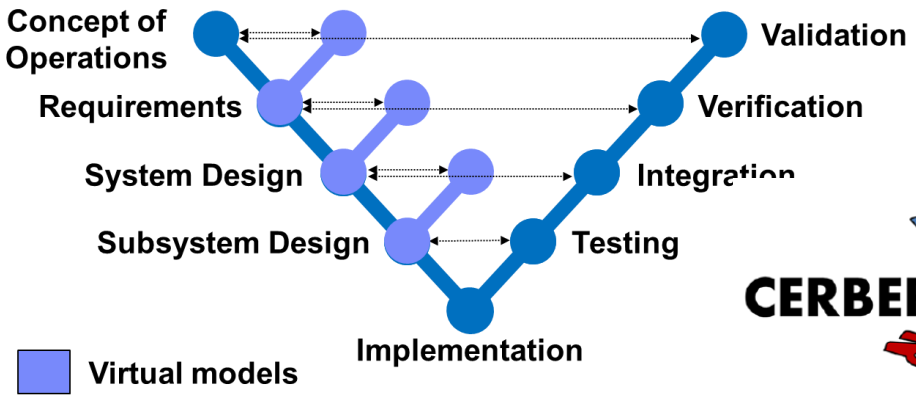


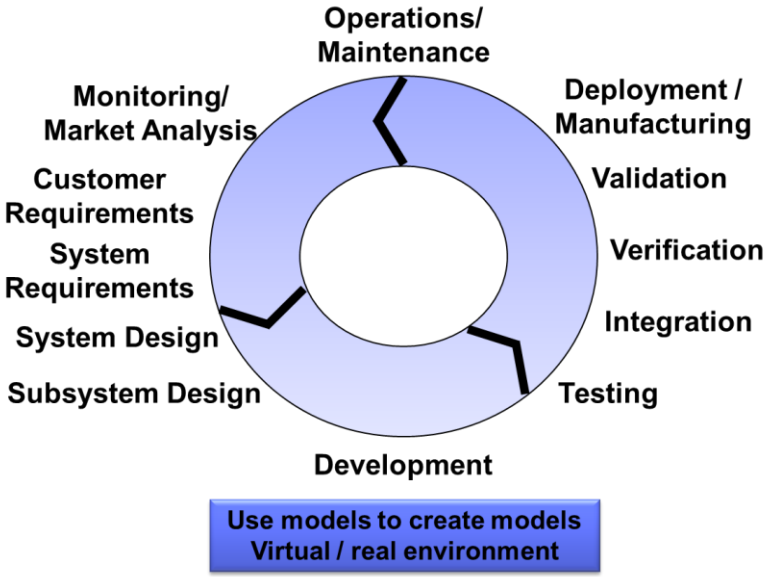
- **Reconfigurable** CPS that understand operational **context** in real time, especially with **humans** or **teams** of machines and humans
- Examples
  - **mars rover**
  - **autonomous vehicles**
  - **autonomous vessel fleets**
  - **self healing appliance**
  - **self adaptive manufacturing**
- Usually **large** SoS and **fog** topology between hybrid devices
- **Main challenge:** Reconfigurable "Smart" Cyber Systems in Uncertain Hybrid Environments
- **Emerging** design and operation methodologies

CERBERO Goal

- **Integrated model-based framework for multi-objective design, fast prototyping and continuous DevOps of Cognitive Cyber Physical Systems**
  - *From* (User Requirements)
  - SoS and System level
  - Application / Service level
  - Real Time Manager level
  - *To* Real Time Software and Hardware implementation

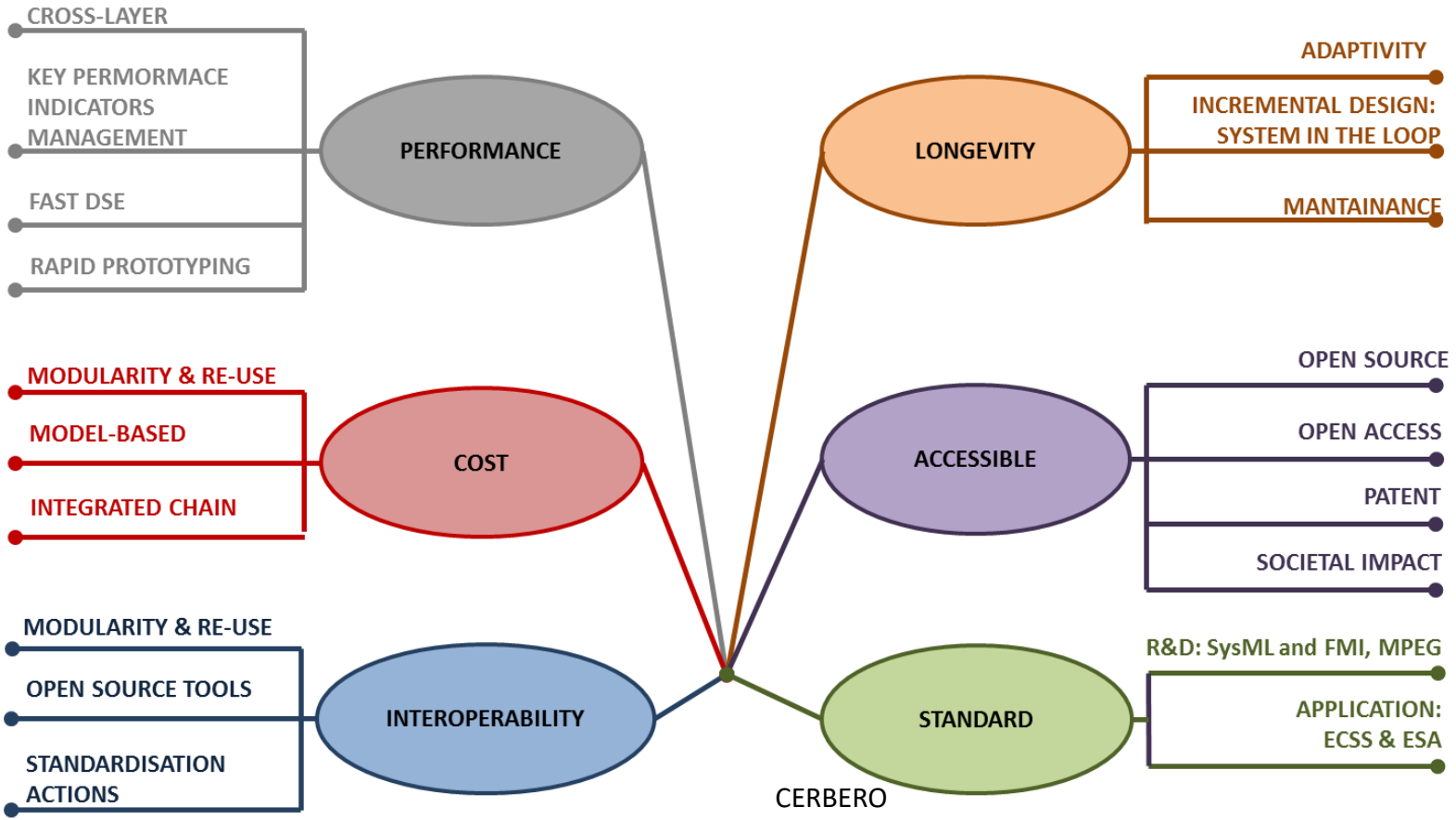
CERBERO Expected Impact





- **Collection of partially integrated toolchains and methodologies for CPS that**
  - collect data usage
  - apply predefined control
  - find shortest path navigation
- **Integrated modelling and design environment for Cognitive CPS with**
  - self adaptation and self healing capabilities
  - adaptive control based on global objectives
  - congestion, accident (and other risks) avoidance

CERBERO Drivers



CERBERO Use Cases

Self-Healing System for Planetary Exploration:

- **Self-healing** and **self-adaptive** embedded CPS processing systems capable of operating in such a critical environment
- Adaptive **System of Systems** for planetary exploration mission

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Ocean Monitoring:

- Smart video-sensing unmanned vehicles with **immersive environmental monitoring** capabilities
- **Individual** and **fleet self-operation, power management** and **navigation**
- Data analysis and information fusion to enable **smart adaptation** strategies to address rapidly changing environment conditions in order to obtain or maintain positions on sea and other missions objectives

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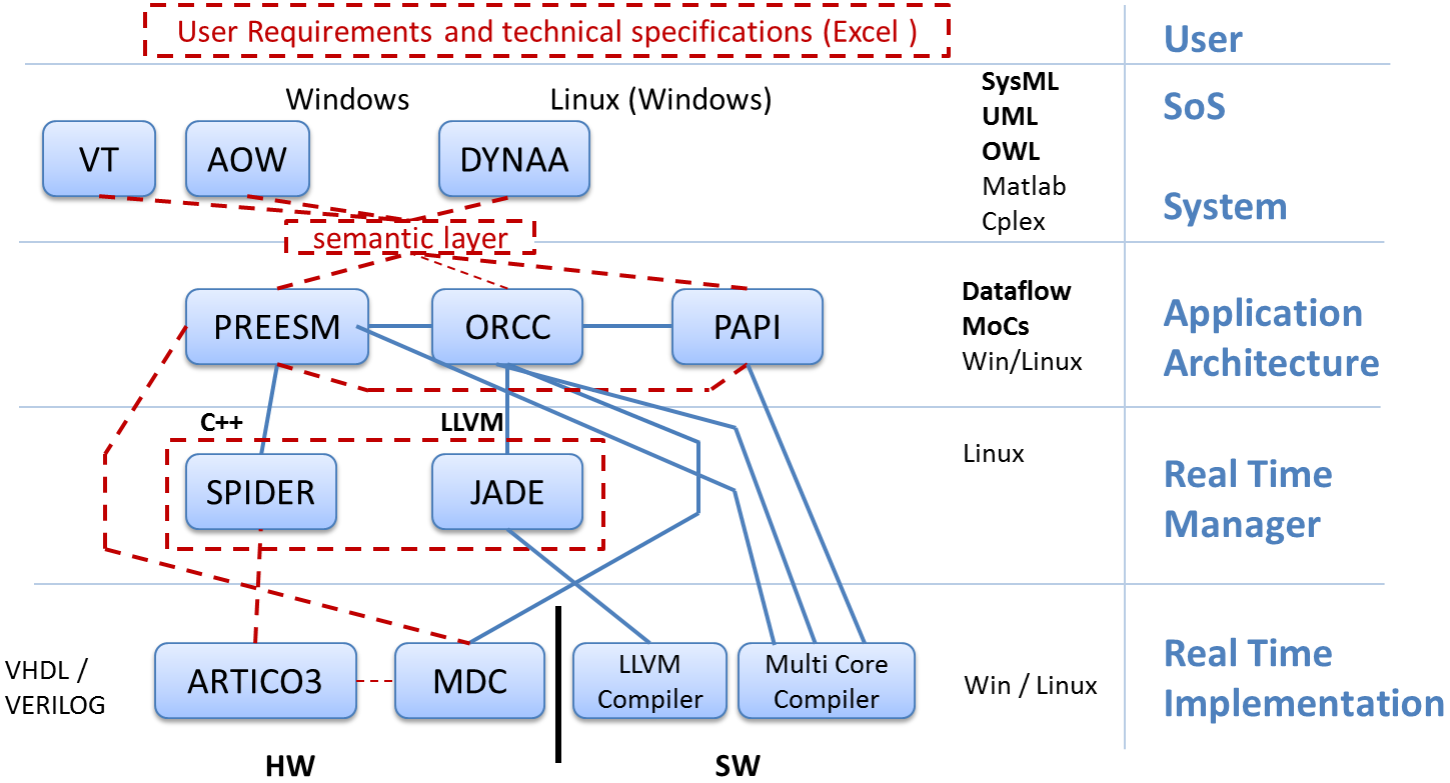
Smart Travelling for Electric Vehicle:

- **Highly networked** scenario composed of heterogeneous concurrent subsystems
  - **Electric Vehicle**, **Person** possessing a only partially observable personal agenda, the **Smart Energy Grid** and the **Smart Mobility** that provides mobility-aware functionality (e.g. parking places, charge points, smart home, smart office, etc.)
- High degree of **autonomy** and support for **adaptability,** plus modelling and managing the distributed communication layers.
- **Virtual Reality** simulated environment

CERBERO Toolchain v0.1



CERBERO Approach

- **BEYOND SEPARATION OF CONCERNS:**
  - **Modeling, optimization and analysis of hybrid systems with *continuous* physical and human behavior and *discrete* cyber models of computation and communication**
  - **Many layers of abstraction with unique models and tools**

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  - **High level functional and non-functional (i.e. security, sustainability, usability) requirements analysis and continuous verification**
  - **Generalization of requirements by means of common Key Performance Indicators**

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  - Methodology for designing cognitive system architectures
  - Autonomous and sensor-based hardware/software reconfiguration
  - Multi-layer runtime adaptation approach by means of a high-level self-adaptation engine

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- **BEYOND TOOL INTEGRATION:**
  - Semantic integration of different design automation components
  - Incremental prototyping and verification, with system-in-the-loop co-simulation capabilities

Current status and next steps

- **Elaboration of use cases**
- **Requirements for the tools and integration platform**

- **Initial methodology, framework, and toolchains**
- **Building CERBERO users community**
  - **CERBERO Summer School – Alghero (Italy), September 25-30, 2017**
    http://www.cerbero-h2020.eu/summer-school

- **Iteration cycles based on feedback from use case providers and users community**

Thank you for your attention! Any questions?

Designing Cyber-Physical Systems
From concepts to implementation

Multi-objective Methodologies and Tools for Self-healing and Adaptive Systems

http://www.cerbero-h2020.eu/summer-school

Cyber-physical systems (CPS) are complex and autonomous ensembles of different components that interact to offer smart and adaptive functionalities. These systems are increasingly used in a variety of applications with a growing market, potentially bringing about significant social benefits. However, there is no such thing as a free lunch, and there area several new challenges and trade-offs to face when designing CPS, especially since they should be able to adapt to the changing environments, or heal themselves. Uncertain operation environments and interactions with humans as users and/or as operators complicate the scenarios of these ever increasingly pervasive systems.

The CPS summer school is targeted at students, research scientists, and R&D experts from academia and industry, who want to learn about CPS engineering and applications. The program is composed of both lectures and practical sessions, covering all the design phases of CPS (i.e., from concept to the definition of the final system and the discussion of the key challenges.

Topics:
- Market trends for cyber-physical systems
- Applications of CPS, including wearable, biomedical, Industry 4.0, cognitive, and automotive systems
- Hardware/software co-design, adaptivity and multi-view modeling
- Low power design of heterogeneous systems
- Tools for dataflow design, high-level synthesis, hardware/software co-design, and coarse/fine reconfiguration
- Security in adaptive and interconnected systems

Confirmed speakers:
- Alberto Sangiovanni-Vincentelli, *University of California, Berkeley*
- Hironori Kasahara, *Waseda University* and *IEEE Computer Society*
- Armando Tacchella, *Università di Genova*
- Eduardo de la Torre, *Universidad Politécnica de Madrid*
- Muhammad Shafique, *Vienna University of Technology*

Tool references:
- Preesm (INSA) (http://preesm.sourceforge.net/website/)
- Multi Dataflow Composer MDC (UniCA, UniSS) (http://sites.unica.it/rpct)
- Architecture Optimization Workbench – AOW (IBM)
- Analysis and Design of Large, Distributed Systems – DynAA (TNO)
- FPGA Reconfigurable Architecture – ARTICo^3 (UPM)

Visit the website for more information and pre-registration.

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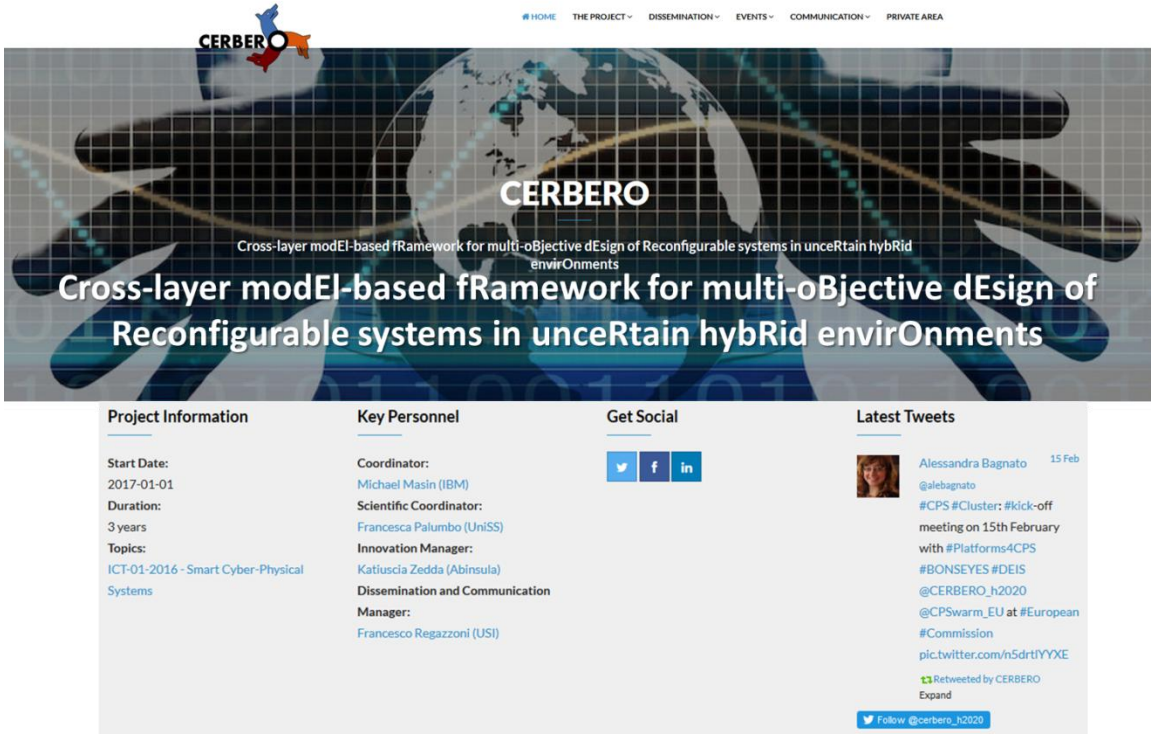
H2020-732105: CERBERO (Cross-layer modEl-based fRamework for multi-oBjective dEsign of Reconfigurable systems in unceRtain hybrid envirOnments)
Coordinator: M. Masin (IBM); Scientific Coordinator: F. Palumbo (UniSS)

CERBERO



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CERBERO Use Cases

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Self-Healing System for Planetary Exploration: The objective of this use case is twofold. On one side it focusses on a single unique **embedded CPS**; while, on the other, it focusses on its integration with other systems of a **planetary exploration mission**. CERBERO is mainly conceived to define **self-healing** and **self-adaptive** processing systems capable of operating in such a critical environment.

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