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

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

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<tr>
<th>LE</th>
<th>IBM</th>
<th>CRF</th>
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<th>Space</th>
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Started: January 1, 2017
Duration: 36 months
To build Cognitive Cyber Physical Systems

Components and Technology Providers

Started: January 1, 2017
Duration: 36 months
and evaluate by 3 use cases

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Duration: 36 months
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.

- **Big challenge**: Reconfigurable “Smart” Cyber Systems in Uncertain Hybrid Environments.

- **Emerging** design and operation methodologies.
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 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

• **BEYOND REQUIREMENTS ANALYSIS:**
  • 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

• **BEYOND SCENARIO AWARENESS:**
  • 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

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

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25 September 2017
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
• Robotic arm and motors control for space vessel

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

Smart Travelling for Electric Vehicle:
• Virtual Reality simulated environment
• 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.

25 September 2017
CERBERO Toolchain v0.1

User Requirements and technical specifications (Excel)

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<tr>
<th>User</th>
<th>SoS</th>
<th>System</th>
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Existing interface: solid line
Planned integration: dashed line
Elaboration of use cases

Requirements for the tools and integration platform

Initial methodology, integration framework, and sub-toolchains

Review in Brussels on October 24

General Assembly in Haifa, Israel
Thank you for your attention!

Any questions?

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