Self-aware Pervasive Service Ecosystems

SAPERE
Overview and Self-awareness Issues

Franco Zambonelli
Università di Modena e Reggio Emilia
The Consortium

- Università di Modena e Reggio Emilia
  - Franco Zambonelli & Marco Mamei
- Université de Genève
  - Giovanna Di Marzo Serugendo
- Alma Mater Studiorum – Università di Bologna
  - Mirko Viroli & Andrea Omicini
- University of St Andrews
  - Simon Dobson
- Johannes Kepler Universitaet Linz
  - Alois Ferscha
The Scenario

- **Pervasive computing**
  - Sensor rich and always connected smart phones
  - Sensor networks and information tags
  - Localization and activity recognition
  - Internet of things and the real-time Web
  - Social networking

- **Innovative pervasive services arising**
  - Situation-aware adaptation
  - Interactive reality, pervasive interactive displays
  - Pervasive collective intelligence

- **Open co-production scenario, very dynamic, diverse needs and diverse services, continuously evolving**
The Overall Objective

- Develop and demonstrate a highly-innovative theoretical and practical framework for pervasive service ecosystems
  - Adaptivity and self-management as inherent properties of the ecosystem
  - Systemic self-awareness as an observable property of the overall system
  - Long-lasting (eternal) adaptivity
  - Bio-chemical inspiration

- Foundational re-thinking of
  - Service architectures and associated middleware
  - Self-* algorithms and contextual knowledge management
The Reference Architecture

- Open production model
- Smooth data/services distinction
  - LSA $\rightarrow$ live semantic annotations
- Interactions
  - Sorts of bio-chemical reactions among components (i.e., their LSAs)
  - In a spatial substrate
- Eco-laws
  - Rule all interactions
- Built over a pervasive network world
Expected Key Tangible Results

- A novel model and methodology to support the development of complex service systems in open and dynamic pervasive scenarios

- A uniform set of:
  - Self-* algorithms for service/data composition and aggregation (in the form of libraries)
  - Algorithms and tools for distributed management of contextual-knowledge, to enforce present- and future-awareness in the ecosystem

- A novel middleware for pervasive computing scenarios (Open Source)
  - Integrating the stated algorithms in the form of libraries

- A set of released innovative application showcased on the Ecosystem of Displays testbed
Key Results after 1 Year

- **SAPERE operational model defined**
  - Component and interaction model
  - Semantic LSAs modelling

- **Algorithms**
  - Analysis and classification of patterns for self-organizing service coordination
  - Analysis and classification of mechanisms for context- and social-awareness
  - Modeling and experimentations in SAPERE terms

- **Middleware**
  - First release of the SAPERE distributed middleware on Android
  - Programmable chemical tuple spaces
  - Integration for smart phone sensors and environmental sensors
  - Integration with social sensors (e.g., access to Facebook data)

- **Applications**
  - Ecosystem of displays testbed put in place
  - First experimentation of SAPERE concepts in use cases related to pervasive interactive displays
What does it mean for the SAPERE ecosystem to be self-aware?
- Services adapt and evolve
- As if they were aware of such adaptation and evolution

But it not trivial to identify proper measures/metric to “quantify” self-adaptation and self-awareness
- Many dimensions of “awareness” → social, environmental, system-level, component-level, etc.
- Not necessarily metric dimensions

Quantifying awareness is a first key challenge in itself
SAPERE Ecosystem: Confidence

- SAPERE brings forward the idea of systemic self-awareness
  - Awareness as an emergent observable property
  - No component can claim self-awareness
- So there are no intrinsic measure of self-awareness (or of its reliability / confidence)
  - Measures are extrinsic -> observable behavior?
  - Does this mean being necessarily situation-/application dependent
  - Or can be made general? (another key challenge)
Ideas for Addressing the Issue

- Since self-awareness is an observable property
- Measure the response to solicitations
  - To evaluate the degree of self-adaptability of the system
- Identify a methodology to perform such tests?
Expertises Needed

- Complex systems
- Decentralized control
- Social/urban behavior