GAUSS project - Kick-off Meeting

Semantic Run-time Models for Self-adaptive Systems

Milano, February 22-23, 2017

Paolo Ciancarini, **Francesco Poggi**, Davide Rossi
DISI - UniBo

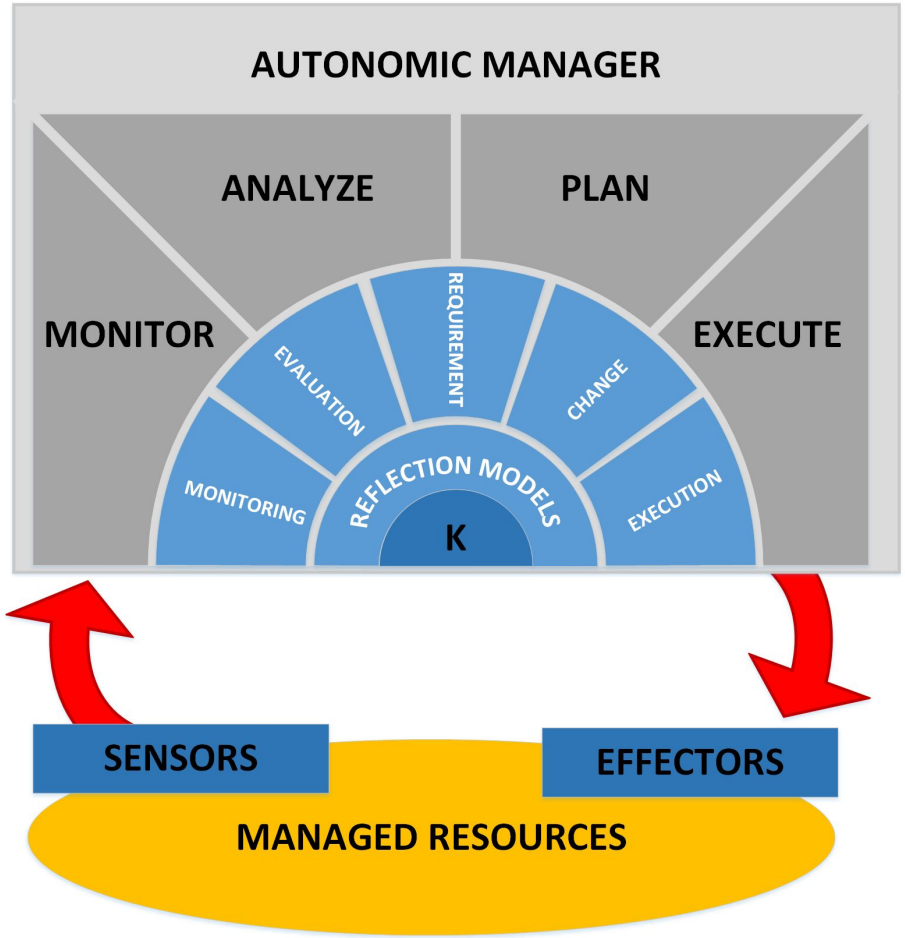
Outline

- Declarative approach for reasoning about adaptive systems
- Adaptation guided by semantic models
- Dynamic requirements and goals management
- UniBo@GAUSS: activity plan

What we have done so far

- Reasoning driven adaptation:
  - use semantic models to enable run-time reasoning about virtualized infrastructures
  - two dimensions of adaptability (environment and reqs&policies)
  - derive low-level adaptations policies (i.e. elasticity) from high level constraints and priorities
  - adapt to the needs of applications and processes (e.g. SLA)

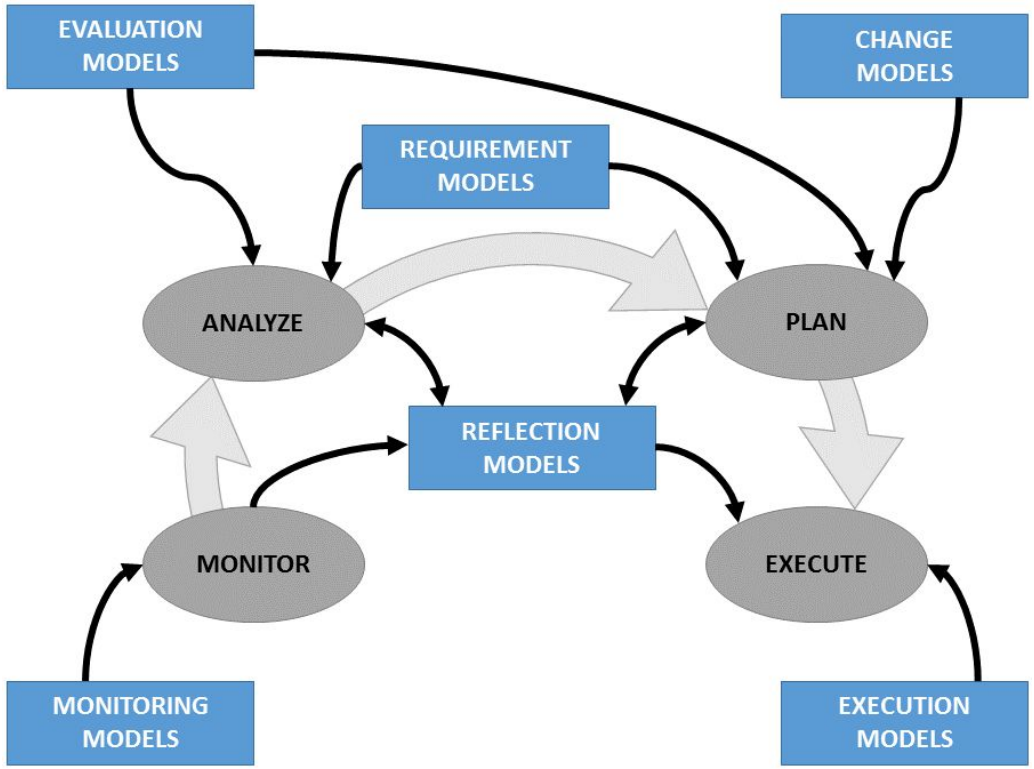
Model Driven Autonomic Manager



Semantic Run-time Models

We want to **reason** about a reconfigurable system at the model level:

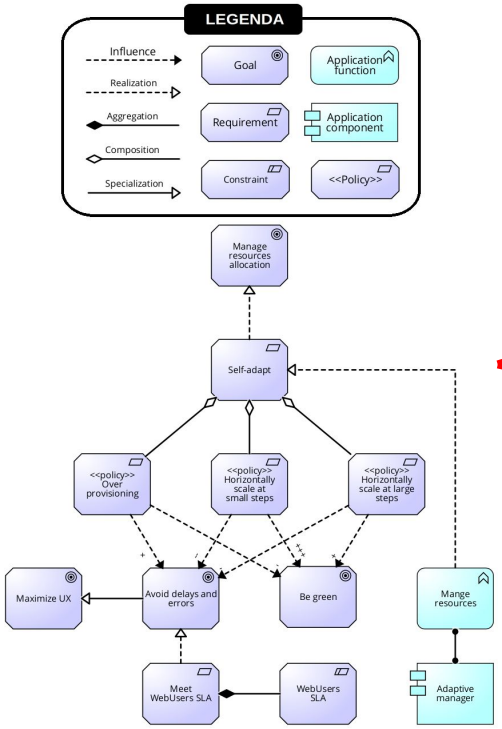
- the whole knowledge needed for reconfiguring the system is represented by **semantic run-time models**
- the information about the system state and the policies governing the adaptation activities can change at run-time (**open reconfiguration space**)



Run-time Requirement Models

Archimate Model

(Motivation Extension)



Semantic Models

(based on the iStar 2.0 meta-model)

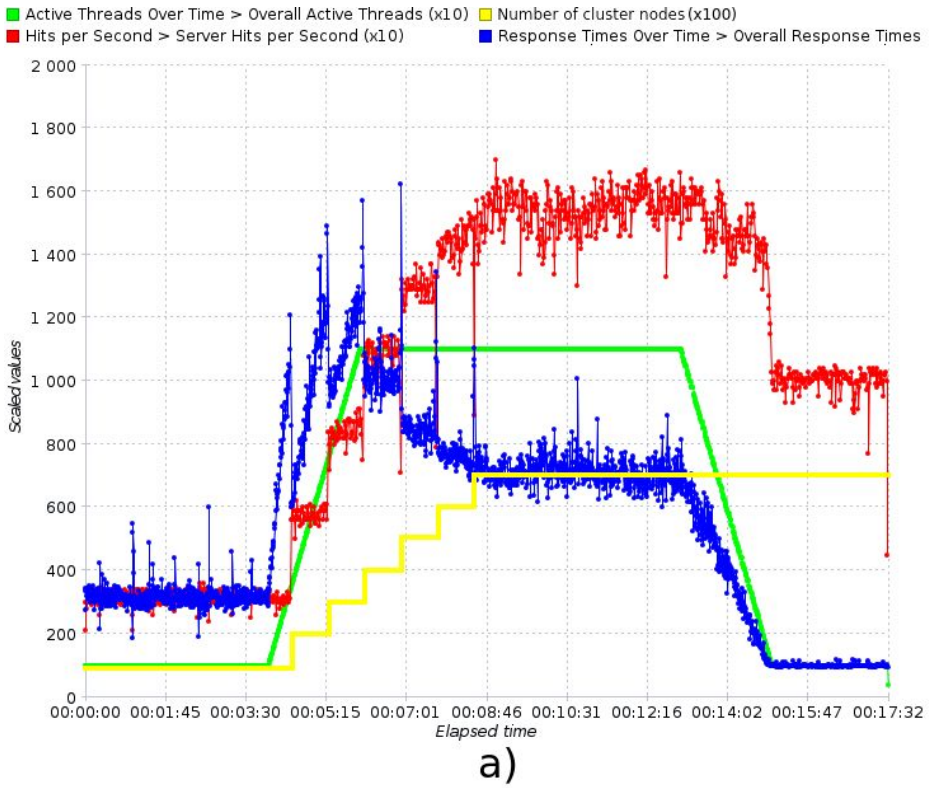
M2M^{I}

M2M^{II}

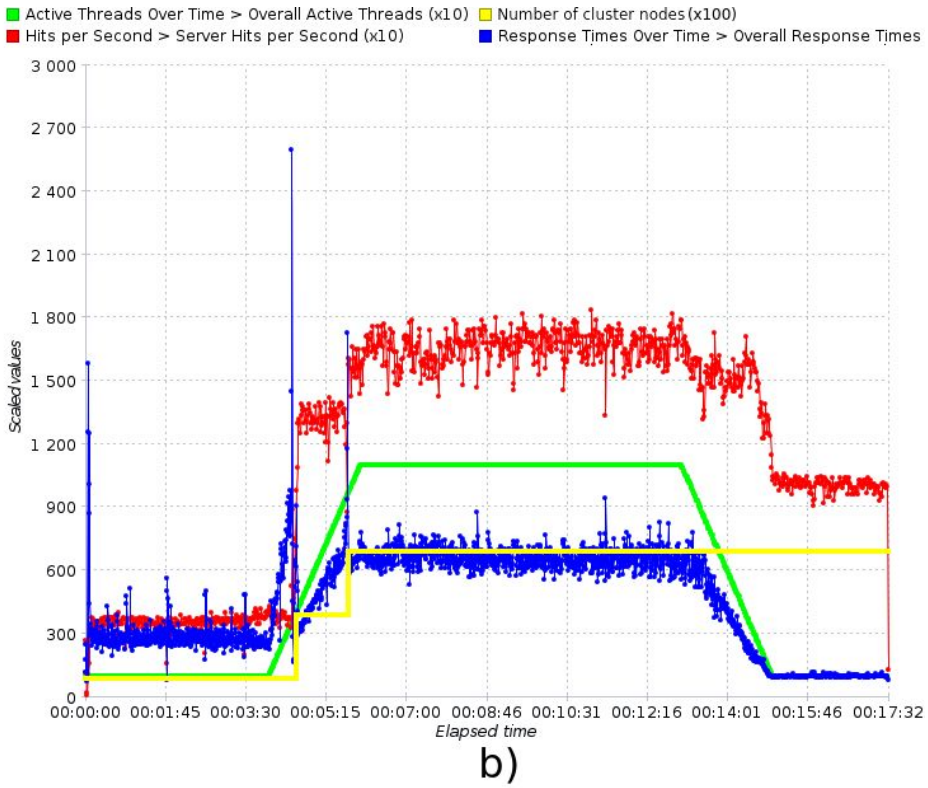
REQUIREMENT MODELS

CHANGE MODELS

Visualizing Adaptation



a)



b)

Outcomes

- **CH1 - heterogeneity management**

  ONTOLOGIES (for providing a shared and unified representation of complex and heterogeneous domains of interest)

  ↳ +

  REASONERS (for driving complex systems' adaptation)

- **CH2 - need for runtime queryable models**

  ↳ **TRIPLESTORES** (for providing standard access mechanisms to semantic models at runtime)

Poggi, F., Rossi, D., Ciancarini, P., & Bompani, L. (2016). An application of semantic technologies to self adaptations. In *Research and Technologies for Society and Industry Leveraging a better tomorrow (RTSI), 2016 IEEE 2nd International Forum on* (pp. 1-6). IEEE.

Poggi, F., Rossi, D., Ciancarini, P., & Bompani, L. (2016). Semantic Run-Time Models for Self-Adaptive Systems: A Case Study. In *Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE), 2016 IEEE 25th International Conference on* (pp. 50-55). IEEE.

Open Questions@GAUSS

- In our approach, system architecture is initially derived by Archimate (UML-like) models, while the adaptation space is defined by reconfiguration policies wired by administrators
  - How emergent reqs/context changes can drive the synthesis of new/unplanned architectures?
  - Can we model an archetypal system architecture (with system logic), and use reasoning mechanism to evaluate the variability space (e.g. reqs, context, etc.) and infer/instantiate/reconfigure them?
- How can we collect and model new requirements that emerge at run-time in an unplanned SoS?
- Performance issues?

Activity Plan

- GAUSS = Governing **Adaptive** and **Unplanned** Systems of Systems
- Two dimensions of adaptability:
  - environment
  - reqs&policies
- Reason about the architecture of SoS with emergent behaviors

Case Study

- We are starting a collaboration with the municipality of Bologna about this topic
- Mobility management in Bologna:
  - traffic monitoring
  - topological information
  - parking
  - public transport
  - charging point
  - vehicular networks
  - etc.

Mobility Ecosystems

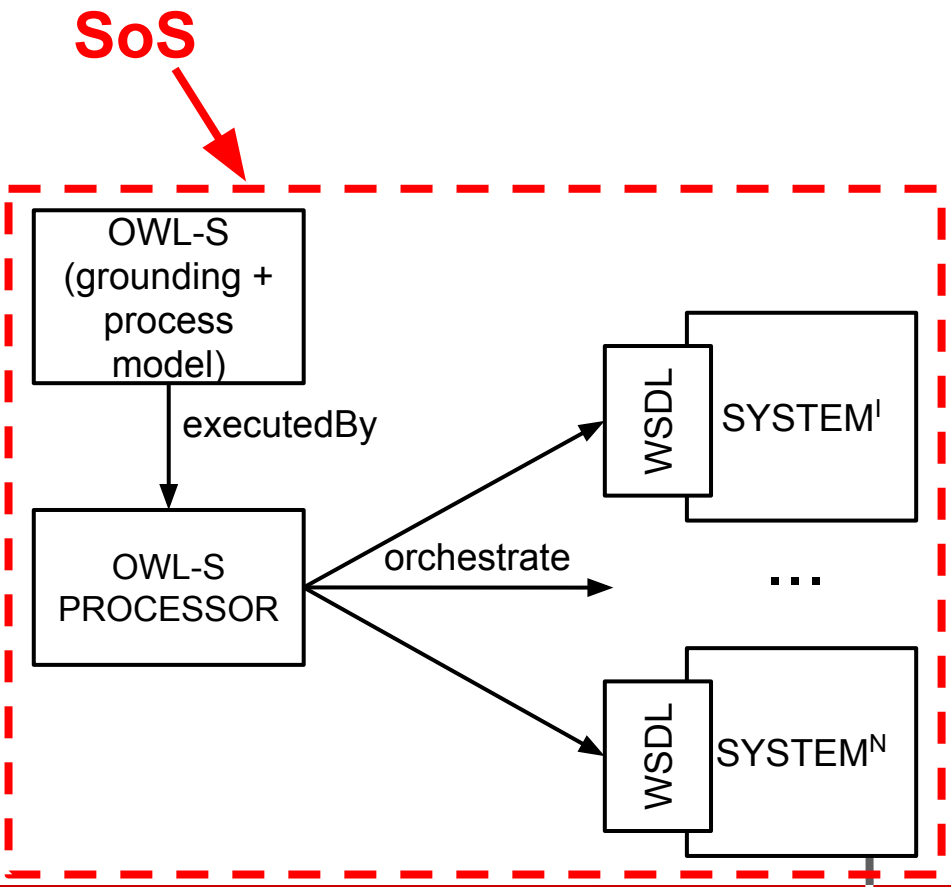
Challenges

- We focus on three main challanges:
  - interaction is limited because systems are not designed to be integrated (heterogeneity)
  - cooperation may change according to specific needs and conditions
  - dynamic and opportunistic engineering

Semantic Service Composition

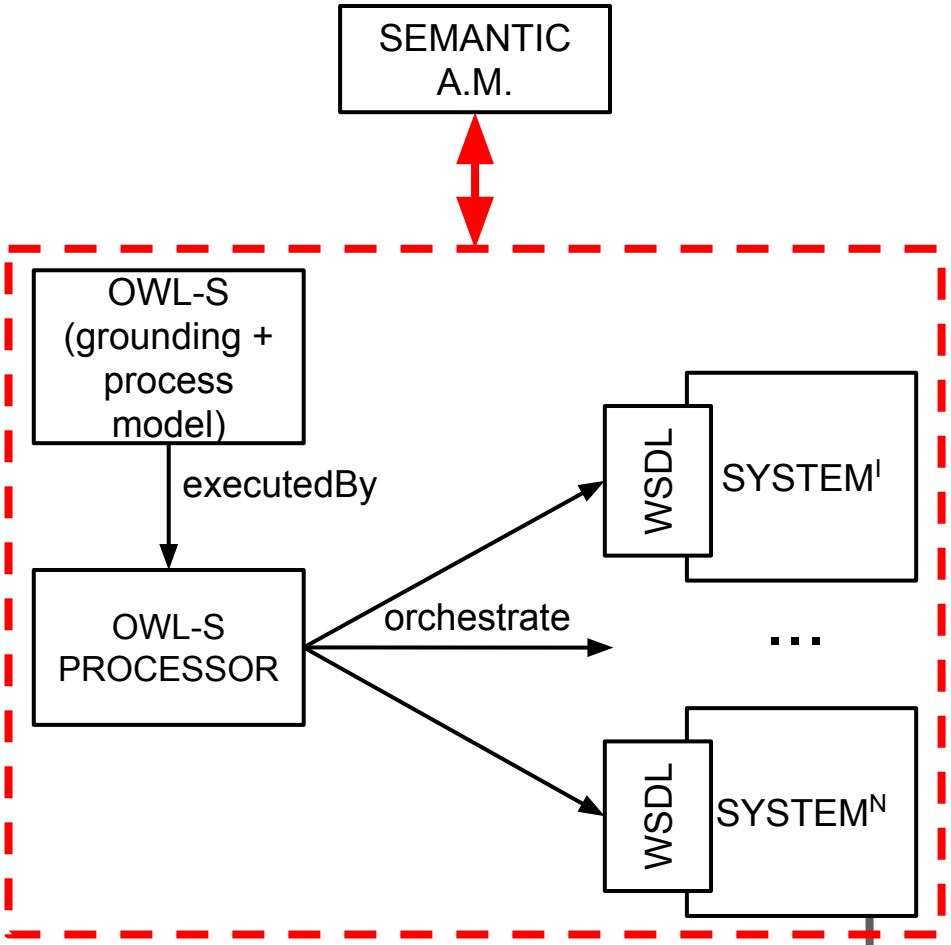
Semantic orchestration, e.g. OWL-S:

- the semantic counterpart of BPEL
- an OWL-based web service ontology
- describes the **properties** and capabilities of Web services in unambiguous, computer-interpretable form
- facilitates the **automation** of Web service tasks, including automated Web service discovery, execution, composition and interoperation



Adaptive Service Composition

- Use our adaptive manager for system synthesis and reconfiguration
- Integrate (and extend) the semantic description of services in our reasoning-driven autonomic manager



Research Directions

We are working on three main activities:

- heterogeneity management, e.g.:
  - integrating different protocols
  - aligning service description in different languages (e.g. using ontology matching techniques)
  - instantiating sensors & effectors components
- dynamic service selection (e.g. using logic-based semantic matchmakers)
- adapting process logic for managing environmental and reqs&goals changes

Thanks for your attention!