

Autonomic Management in the Future Internet

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Autonomic Management

The challenge of autonomic management of communications systems is seen as an important aspect of ICT Call 4 and Call 5 in FP7. The development of the FOCAL architecture has seen great advancement towards realising the crucial challenges in realising Autonomic Communications Management [1]. However further investigation is required in a number of supporting areas such as **Information Modelling and Ontological Engineering** [2]. To assist the development of advanced autonomic control algorithms, further investigation is also required in the application of **bio-inspired autonomic systems** [4] to various scenarios such as traffic engineering.

A vital aspect of any autonomic management system is the ability to monitor and gain awareness of the state of the network. To this end, further research is necessary in the area of traffic monitoring and analysis to assist autonomic management of a variety of applications such as **QoS aware admission control** [5] and **network planning** [6]. The ability to reason over and understand traffic patterns can greatly improve network management from the point of view of **anomaly detection, fault detection and diagnosis, intrusion detection, traffic classification and characterisation**.

Within this domain of research, the need to evaluate and extensively test proposed architectures and algorithms must be facilitated through the development of **real testbeds (IMS, IPv6) and network simulations (OPNET)**.

Information Modelling Challenges

We state that “further investigation is required in a number of supporting areas such as Information Modelling and Ontological Engineering. To assist the development of advanced autonomic control algorithms, further investigation is also required in the application of bio-inspired autonomic systems to various scenarios such as traffic engineering, and traffic management; anomaly, fault detection and diagnosis, intrusion detection, traffic classification and characterisation”. There is a clear opportunity to structure the above information modelling along various SAFs, attempting to identify common and domain or feature specific models. The promise here is to find a common information modeling framework for a particular SAF, to which a technology specific driving model shall appear as an embedded specific control. Another promise in this respect is to achieve control plane self-similarity assuring scale free properties of SAF controlled networks.

The Role of Design (Meta-)Models, and Information Models in implementing Self-Awareness

The role of Design (Meta-)Models, and Information Models as "enablers" for implementing Self-Awareness cannot be underestimated. Currently, in the domain of systems engineering, system design models specified using notations such as UML or Formal Description Techniques such as SDL [7], are only used for implementing the systems under design. The question is: can the design models be used together with other types of models by the system(s) described using the design model(s), during its run-time, to reflect on the "self" aspect of the system in order to be "self-aware" and use this knowledge in deriving behaviour? On the other hand, Model-based systems development, simulation, validation, transformation and code generation is the new paradigm for cost-effective development of complex systems. Meta-models are required as a starting point in designing a model-based systems development environment. Meta-Models capture the concepts of a domain and their relationships and constraints. Meta-Models will continue to play a role in engineering autonomic systems via formal approaches, especially as the domain of autonomic network engineering continues to grow (as being witnessed currently).

TSSG Plans

TSSG plans on building on its current experiences to address a number of challenges at the heart of Call 4 and Call 5.

- Leverage knowledge of **Information Modelling and Ontological Engineering** to build information systems for autonomic management.
- Leverage knowledge of **Traffic Measurement and Analysis** to enable system wide traffic **awareness** within the autonomic management system.
- Leverage knowledge of **Bio-Inspired autonomic systems** to develop practical **autonomic behaviours**.
- Leverage **Testbed deployment** experiences to build and evaluate autonomic management systems under a variety of network scenarios.

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