

Panel Report from the 1st International IEEE WoWMoM Workshop on Autonomic Communications and Computing (ACC 2005)

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Title: “Autonomics” – A Common Cause or a Flag of Convenience

Panel:

- *David Lewis*, Trinity College Dublin (Dave.Lewis@cs.tcd.ie) - Chair
- *John Helmbock*, IBM Autonomic Computing Architecture Group
- *Sajal Das*, University of Texas at Arlington
- *Archan Misra*, IBM Research TJ Watson Labs, Pervasive Infrastructure Department
- *Spyros Denazis*, Consultant at Hitachi Europe and Assistant Professor at University of Patras

Introduction

The last few years has seen a huge growth in research activity into autonomics, first focusing on Autonomic Computing but now also encompassing Autonomic Communications. However, by encompassing a wide variety of research topics from context-aware systems, ad hoc networks, policy-based management to multi-agent systems, self-organizing systems, bio-inspired systems , control theory, games theory etc., the current explosion in workshops and journal special issues in this area risks presenting an unfocussed vision of autonomics as a research topic.

This panel will address itself to whether we can identify core common principles of "autonomics" that apply across the Autonomic Computing and Autonomic Communications domains and if so what might they be. In addressing this question we aim to guide researchers in what does and does not qualify as autonomic-related research, what fruitful areas of autonomic research might be and ultimately to allow us to know an autonomic system when we see one.

Position Statements

John Helmbock started by making the point that in Autonomic Computing there is a clear focus on solutions for autonomic system that dramatically decrease the cost and complexity of administering a system. Research into autonomic systems should keep this goal in mind and consider the self-managing capability of whole systems and should not be driven by adherence to a particular system architecture. Important areas for autonomic research were identified as learning and negotiation in multi-agent systems, architectures for emergent self-managing behavior and policy language design based on studies of system administrators' activities.

Sajal Das discussed the development by his team of a new paradigm, called Pervasive Community Computing (PCC), for creating mission-oriented dynamic communities of autonomous software entities that perform tasks for users and devices in an invisible manner, collaborate proactively to handle dynamic and heterogeneous information, provide selective content delivery, and facilitate application interface. This pervasive

computing example was used to highlight many of the issues relevant to autonomic systems, including the need for a middleware and for learning-driven adaptation.

Archan Misra began by emphasizing that autonomic systems must move beyond adaptive, context-aware behavior by responding to business level goals and rules. For Autonomic Communications, self-healing and self-protection were presented the main challenges, especially for distributed wireless networks. He identified key research themes as: role/capability based addressing of resources, including human ownership, as a first-class addressing primitive; the application of robust control theory using incomplete knowledge, the general availability of programmable MACs, and, more specifically, the need for improved wireless network monitoring tools.

Spyros Denazis characterized autonomic system as enacting an intelligent control loop that collects a view of network state, uses inference and planning to decide on a course of action that it then enforces. He identified the need for clear shared scenarios defining autonomic behavior, semantic languages for clear communication and common purpose between elements of the control loop and a suitable model from components from which autonomic system can be composed.

David Lewis completed the position statement by focusing on the issue of human interaction between human administrators and the autonomic system and identifying the need for successful autonomic system to include a model of the system of administrators who govern it. In addition to accepting policies from this community, an autonomic system must provide them with feedback on its attempts to understand and enforce those policies and thereby evolve a mutual understanding between the system and its administrators.

Discussion

The discussion began with the question of whether autonomics was essentially about replacing or empowering humans. John Helmbock responded in support of the latter, noting that the way humans interact with an autonomic system must focus both on the trust humans place in that system as well as the trust the system has in the human policies, though humans must remain in ultimate control. The next questioner made the point that humans are reluctant to trust what they don't understand, so how will autonomics help us to have confidence in the correct operation of increasingly complex systems. Sajal Das agreed with this and stated that we must be able to manage this trust relationship between human users and autonomic system in the context of cost/benefit tradeoffs. John responded by observing that this was a matter of properly capturing and using policy to develop trust and that suitable policy languages were a key research goal. Spyros Denzis supplemented this with the point that the policy mechanism must itself be manageable. Archan Misra countered the initial question by observing that people are willing to trust complex system, e.g. fly-by wire airplanes – is there something to be learnt from this?. David responded to the initial question by pointing out that the field of adaptive hypermedia focuses on the measure of scrutability in assessing the degree to which a system's adaptive decision making is understood by the user, which in turn promotes a feeling of empowerment resulting in improved system acceptance. Sajal concluded however by stating that such sociological and psychological aspects were still difficult to quantify accurately.

Next a questioner asked whether autonomic communication was a good means of drawing together the various technologies addressing self-management. David supplemented this question by asking whether the communications community has the right analytical techniques to assess new technologies on the basis of operational costs saving rather than just efficiency of throughput. Spyros confirmed that such techniques were lacking and needed to be developed if new intelligent, self-organizing communication networks were to be assessed critically. Archan pointed out that many of the costs in introducing autonomic communication would be taken by network element vendors while the benefits are experienced by the network operators, so a strategic alliance is needed to guide the direction of autonomic communications. This spurred another question from the audience on whether network operators will be willing to pay the extra capital cost implied by autonomic network elements. Spyros observed that initiatives to open up the functionality of today's network elements had not progressed well, so the more complex interoperability requirements of autonomic elements were a major challenge in the existing communication market structure..

The last question from the audience concerned the need for greater theoretical underpinning, a point upon which the panel agreed. Archan indicated that the area seemed ripe for input from control theory research while Sajal appealed for this to be better integrated into a cohesive engineering methodology for autonomic systems.

Conclusion

In conclusion, the panel revealed there was good potential for fruitful discussion between the mainly US-based Autonomic Computing community and the Autonomic Communication community currently emerging in Europe. Autonomic Computing may be able to learn much from learning and mediation capabilities from multi-agent systems already being applied in Autonomic Communications. The Autonomic Communication community, on the other hand, needs to address the challenge of building models to assess if approaches to achieving autonomic behavior can in fact deliver dramatic cost reductions in administration that drive Autonomic Computing. Also, a clearer understanding is needed of how new or existing business models for the procurement and operation of network elements will help or hinder the commercial acceptance of autonomic elements.

It also seems apparent that pervasive computing research is a productive medium for studying the core issues in autonomic systems, especially considering its diverse ownership, ad hoc organization and user-centric adaptation.

We hope to continue this debate and contribute to the further progress of autonomic system research and its industrial application through two international groups, in which we invite you to participate:

- Autonomic Communications Forum
 - <http://www.autonomic-communication-forum.org/>
- IEEE Computer Society Task Force on Autonomic and Autonomous Systems
 - <http://www.computer.org/tab/tclist/TFAAS.htm>