Tutorial Proposal:
Autonomic Computing in Real-Time Systems

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Abstract

Autonomic Computing has as its vision the creation of self managing systems to address today's concerns of complexity and total cost of ownership while meeting tomorrow's needs for pervasive and ubiquitous computation and communication. This tutorial reports on the latest Autonomic Systems research and technologies to influence the Industry; it looks behind Autonomic Computing, summarising what it is, the current state-of-the-art research, related work and initiatives, highlights research and technology transfer issues, and provides some examples related to real-time systems (specifically, NASA sensor network applications).

Introduction

Autonomic the name suggests, is a metaphor based on biology. The Autonomic Nervous System within the body is central to a substantial amount of non-conscious activity that allows us as individuals to proceed with higher level activity in our daily lives. Typical examples that have been highlighted are heartbeat rate, breathing rate, reflex reactions upon touching a sharp or hot object, and so on. The aim of using this metaphor is to express the vision to enable something similar to be achieved in computing, in other words, to create the self-management of a substantial amount of computing function to relieve users of low level management activities allowing them to place emphasizes on the higher level concerns of running their business, their experiments or their entertainment.

The need and justification for Autonomic Computing is based on the ever increasing complexity in today's systems. It has been expressed that the IT industry's single focus has been on improving hardware performance with software burgeoning with additional features to maximise on this additional capacity, at the neglect of other vital criteria. This has created a trillion dollar industry with consumers' consenting to the hardware-software upgrade cycle. Its legacy though is a mass of complexity within 'systems of systems' resulting in an increasing financial burden per computer (often measured as the TCO: total cost of ownership).

In addition to the TCO implications of complexity, complexity is a blocking force to achieving Dependability. Dependability, a long-standing desirable property of all computer-based systems, integrates such attributes as reliability, availability, safety, security, survivability and maintainability. The autonomic initiatives offer a means to achieve dependability while coping with complexity.

Overview

1. Motivation for Autonomic Computing in Real-Time Systems
2. What is Autonomic Computing?
3. Self-* properties
4. Autonomic Managers and Autonomic Elements
5. New and emerging biological metaphors
6. Real-Time Systems and Autonomic Management
7. Examples from NASA Sensor Network applications

Relevant Publications

1. Sterritt R, (2005) "Autonomic Computing", Innovations in Systems and Software Engineering, Vol. 1, No. 1, Springer, ISSN 1614-5046, Pages 79-88

2. Sterritt R, Hinchey MG, (Apr 2005) "Why Computer-Based Systems Should be Autonomic", Proceedings of of 12th Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems (ECBS 2005), Greenbelt, MD, USA, 3-8 April, 2005, Pages 406-414

3. Sterritt R, Hinchey MG, (Apr 2005) "Birds of a Feather Session: "Autonomic Computing: Panacea or Poppycock?"", Proceedings of IEEE Workshop on the Engineering of Autonomic Systems (EASe 2005) at 12th Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems (ECBS 2005), Greenbelt, MD, USA, 3-8 April, 2005, Pages 335-341

4. Sterritt R, Symth B, Bradley M, (Apr 2005) "PACT: Personal Autonomic Computing Tools", Proceedings of of IEEE Workshop on the Engineering of Autonomic Systems (EASe 2005) at 12th Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems (ECBS 2005), Greenbelt, MD, USA, 3-8 April, 2005, Pages 519-527

5. Sterritt R, Hinchey MG, (Apr 2005) "Engineering Ultimate Self-Protection in Autonomic Agents for Space Exploration Missions", Proceedings of IEEE Workshop on the Engineering of Autonomic Systems (EASe 2005) at 12th Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems (ECBS 2005), Greenbelt, MD, USA, , 3-8 April, 2005, Pages 506-511

6. Sterritt R, Hinchey MG, (Dec 2004) "Apoptosis and Self-Destruct: A Contribution to Autonomic Agents?", Proceedings of Third NASA-Goddard/IEEE Workshop on Formal Approaches to Agent-Based Systems (FAABS III), Washington DC, April 26-27, 2004, in "LNAI 3228", Springer-Verlag, Pages 262-270

8. Sterritt R, (Oct 2004) "Autonomic Networks: Engineering the Self-Healing Property", Engineering Applications of Artificial Intelligence, Vol. 17, No. 7, Elsevier, ISSN 0952-1976, Pages 727-739

9. Sterritt R, Mulvenna M, Lawrynowicz A, (Oct 2004) "A Role for Contextualised Knowledge in Autonomic Communications", Proceedings of 1st IFIP TC6 WG6.6 International

Workshop on Autonomic Communication (WAC 2004), Berlin, Germany, 18th - 19th October,

10. Sterritt R, Bantz DF, (Aug 2004) "PAC-MEN: Personal Autonomic Computing Monitoring Environments", Proceedings of IEEE DEXA 2004 Workshops - 2nd International Workshop on Self-Adaptive and Autonomic Computing Systems (SAACS 04), Zaragoza, Spain, August 30th - September 3rd, IEEE, Pages 737-741

11. Sterritt R, Gunning D, Meban A, Henning P, (May 2004) "Exploring Autonomic Options in an Unified Fault Management Architecture through Reflex Reactions via Pulse Monitoring", Proceedings of IEEE Workshop on the Engineering of Autonomic Systems (EASe 2004) at the 11th Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems (ECBS 2004), Brno, Czech Republic, 24-27 May, Pages 449-455

12. Sterritt R, (Oct 2003) "Autonomic Computing: the natural fusion of Soft Computing and Hard Computing ", Proceedings of 2003 IEEE International Conference on Systems, Man & Cybernetics, Washington, D.C., USA. , October 5–8, 2003, Pages 4754-4759

13. Sterritt R, Bustard DW, (Sep 2003) "Towards an Autonomic Computing Environment", Proceedings of IEEE DEXA 2003 Workshops - 1st International Workshop on Autonomic Computing Systems, Prague, Czech Republic, September 1-5, 2003, Pages 694-698

14. Sterritt R, Bustard DW, McCrea A, (Aug 2003) "Autonomic Computing Correlation for Fault Management System Evolution", Proceedings of IEEE International Conference Industrial Informatics (INDIN 2003), Banff, Alberta, Canada, 21-24 August 2003, Pages 240-247

15. Sterritt R, (Aug 2003) "Pulse Monitoring: Extending the Health-check for the Autonomic GRID", Proceedings of IEEE Workshop on Autonomic Computing Principles and Architectures (AUCOPA 2003) at INDIN 2003, Banff, Alberta, Canada, 22-23 August 2003, Pages 433-440

16. Sterritt R, Bustard DW, (Apr 2003) "Autonomic Computing-a Means of Achieving Dependability?", Proceedings of IEEE International Conference on the Engineering of Computer Based Systems (ECBS'03), Huntsville, Alabama, USA, April 7-11, IEEE CS Press, Pages 247-251

17. Sterritt R, (Dec 2002) "Towards Autonomic Computing: Effective Event Management", Proceedings of 27th Annual IEEE/NASA Software Engineering Workshop (SEW), Maryland, USA, December 3-5, IEEE Computer Society, Pages 40-47

Biosketches

Roy Sterritt currently is a Lecturer at the University of Ulster and Researcher within the Computer Science Research Institute (CSRI) and the Centre for Software Process Technologies (CSPT). He holds a B.Sc. (honors) degree in computing and information systems and the M.A. degree in business strategy. He spent several years with IBM at North Harbour and IBM Hursley Park, U.K., as a Software Engineer developing intelligent distributed applications to support project management and risk assessment.

He then returned to the University of Ulster to research automated and intelligent approaches to the development and testing of fault management telecommunications systems in a series of collaborative projects with Nortel Networks. Sterritt is the author of over 80 technical papers on Artificial Intelligence, Software Engineering, and Autonomic Computing and has been active within the research community on program and organizing committees. He is also a Vice-Chair of the IEEE Technical Committee on Engineering of Computer Based Systems (ECBS).

Mike Hinchey is Director of the NASA Software Engineering Laboratory, located at NASA Goddard Space Flight Center, near Washington DC. He is also a Visiting Professor of Computer Science at Loyola College in Baltimore, Maryland.

Prior to joining the US government, Dr. Hinchey held positions as Full Professor in the USA, Ireland, Australia, and Sweden (Skövde) , and as Visiting Professor in the UK, Ireland, Japan, Sweden and the USA.

Hinchey received the degrees: PhD in Computer Science from University of Cambridge, UK; M.Sc. in Computation (Mathematics) from Oxford University, UK; B.Sc. in Computer Science from University of Limerick, Ireland. He is a Fellow of the British Computer Society, Institute of Electrical Engineers, Institute of Mathematics and Its Applications, and the Institute of Engineers of Australia. He is also a Chartered Mathematician, Chartered Engineer, and Chartered Professional Engineer.

Hinchey is the author/editor of more than a dozen books and over 100 technical papers on formal methods, software engineering, and autonomic computing. He is also Chair of the IEEE Technical Committee on Complexity in Computing (which deals with issues such as verification and formal specification in complex systems, real-time systems, etc.) and is currently the Vice Chair of the IEEE Computer Society's Technical Activities Board.