RESEARCH CHALLENGES AND FUTURE VISION OF AUTONOMIC COMPUTING

Smitha Madhukar

Amrita Vishwavidyapeetham, Mysore Campus.
Email: smithamadhukar1012@gmail.com

Abstract

Autonomic computing is all about making the technology work smarter. This will free the IT professionals from a lot of burden. There are many diverse scenarios that an autonomic computing model handles. An autonomic computing model manages itself by controlling the system and applications without any input from users. As a result, there are many challenges faced by such a computing model. Providing a secure environment, returning to normalcy from unpredictable failures, fine tuning themselves, managing complexity are some of the noteworthy features of an autonomic computing model. This paper highlights these challenges and the future vision. Furthermore, this paper tries to explore the new aspects of achieving autonomic features in systems.

Keywords: Autonomic, Sensors, Effectors, Context Awareness, Critical Mission, Hot swapping, Hot plugging.

I. INTRODUCTION TO AUTONOMIC COMPUTING

Let us understand as to what an autonomic system offers:

Self-configuring: An autonomic computing model configures itself. It doesn't require any intervention or deployment of new components.[1]

Self-Healing: An autonomic model recovers all by itself from unprecedented events and resumes its functioning.[1]

Self-awareness: An autonomic computing model is quite aware of all its states and its behaviors. [1]

Self-protection: An autonomic model has the burden of safeguarding its resources from both external as well as internal attacks to maintain the integrity of the system.[1]

Self-optimizing: This feature of an autonomic computing model refers to the maximum utilization of resources to meet the end users requirements. This feature poses a very big challenge due to the fact that all the components need to fine tune themselves pro-actively towards meeting the demand of overall business objective.[1]

There are numerous challenges faced by autonomic computing paradigm. Firstly, to even think of systems possessing the capability to self-manage makes us sit up and think for a while. This is nothing less than virtual reality. Research scholars are oriented towards this particular aspect of autonomic computing wherein positive steps are being taken towards implementing novel methods to foresee a brighter future for autonomic computing.

II. RESEARCH ARENAS TO BE EXPLORED

Meeting the growing demands of Autonomic computing model that ranges from Application level to Middleware, Conceptual and Architectural levels is highly complex.

A. Application Challenges

The key challenge here is to configure, formulate or create a system capable of self-management and being strong enough to be compatible with autonomic elements. This may include programming models, frameworks or even middleware solutions. Maintenance of these highly competent, self-driven, independently-executable systems remains as a bigger challenge. [4]

B. Middleware Challenges

Realizing the autonomic behavior of the elements and providing a secure, convenient and a reliable mechanism to exchange data poses as an important middleware challenge. Autonomic systems need autonomic elements to discover entities of their interest. These elements should be able to establish dynamic relationships in a safe and secure manner.[4]

C. Conceptual Challenges

These challenges may include:

- Creating, models to specify understand, and model the autonomic behavior of elements.

- Providing effective models for negotiation to let autonomic elements establish multi-lateral relationships with entities of their interest.
- Designing models to help autonomic elements predict various kinds of problems with the help of sensor data.[4][5]

D. Architectural Challenges

Autonomic computing challenges stems from the fact that internal behavior and other relationships between interacting elements are established from already existing policies pre-determined by humans or other external entities. Therefore, developing architecture to balance the nature of local and global elements in a robust, secure and predictable manner remains a key challenge for research scholars.[9]

1. Smart Act by a DBMS

We, as frequent users of databases would like to use a smart database system that would self-configure and lessen the burden of maintenance.

A small attempt is being made to present an idea that could be the future of database management systems.

The day is not far when a DBMS will accomplish the below mentioned tasks on its own. These databases will perform their tasks with minimum intervention from the personnel. [7]

1. Dynamically re-organize and re-structure the layout of data.
2. Collect, organize and analyze relevant information about its components, performance and workload.
3. Predict effectively as to when a periodic backup is necessary and perform these operations with minimal system disruption.
4. Re-configure itself without disturbing online operations.
5. Periodically log all operations, archive the database and implement strategies to recover from failures.

2. Critical mission - An important demand for Autonomic computing paradigm

Critical mission happens to be the driving force behind the appropriate functioning of Autonomic computing models.

Autonomic computing models have to be mission-critical which means that autonomic systems should be available 100% of the time and must not be interrupted because an interruption may mean that there is a disturbance for mission-critical operations. This requirement of high availability implies that any event of failure is a matter of big concern for all the components of the autonomic model. Therefore, degradation must be minimized and the fault-tolerance ability of these components should be maximized. [8]

III. AUTONOMIC ARTIFACTS

It is assumed that an autonomic Computing model is constructed with the help of well-connected autonomic elements. [11]

Each element includes **sensors and effectors.** Monitoring the behavior of the elements through sensors, comparing the behavior with the expected, decide what action has to be taken, executing the action with effectors. This mechanism is very much similar to the fig.1.

Monitor (Sensors)

|

Compare

|

Decide

|

Execute (Effectors)

Fig 1. Monitor-compare- decide-execute loop.

IV. ACHIEVING AUTONOMIC COMPUTING ON SERVERS IS EASY. [5]

Servers are supposed to be high capacity systems with a very strong fault tolerance level as compared to clients.

Servers are equipped with functionalities such as hot swapping and hot plugging.

A. Hot swapping

It is defined as replacing components without creating any interruption to the overall working of the system, [4]

B. Hot plugging

It emphasizes upon adding newer components to the system without interrupting the existing functionalities. [4]

Servers are more likely to have a user base of skilled teams where as clients are mainly confined to personal computing domain.

It is obvious that autonomic computing is an evolutionary process and comprises of 5 steps.

1. Initial: This is the elementary step where many IT systems are placed today. Frequent interactions from the IT personnel to use, monitor and enhance the day-to-day operations. [7]

2. Managed: At this level, there are system management technologies to reduce the work of system administrator to a little extent. It reduces the time spent by the admin to collect and combine information.[7]

3. Predictive: This step can be considered to be the first initiative towards achieving spontaneity of systems. [8] At this level, systems possess the ability to recognize patterns, predict the configuration and provide an opinion on what course of action the system administrator can take. [8]

4. Adaptive: This is a great advancement from the previous step. The system takes the necessary actions based upon the available information provided by users.[7]

5. Autonomic: At this level, the systems will be fully independent and will be governed by business policies and decisions. There will be least interaction from users wherein the users will only formulate the policies and systems will independently execute the policies with great amount of ease. [6]

Research scholars are more and more oriented towards achieving or attaining the fifth level and the future of autonomic computing depends heavily on the implementation and success of this level. There is a high possibility of deploying systems that exhibit autonomic nature.

There are many areas where the autonomic computing methodologies have been adapted and considerable progress has been achieved.

A few illustrations are mentioned below to support the cause.

(a) Servers are being deployed to capture the potential of autonomic computing models. Strategies are in-built within them to delegate resources to other tiers to improve total performance of the system.

(b) Even though, the goal is to create an autonomic behavior, timescales differ from application to application based upon the expected response rate.

Applications involving aerodynamic. Stabilization and neural control may require millisecond level response. While oil reservoir management may require responses in seconds, hours, days or weeks depending on the nature of the application.

V. AN INSTRUMENTAL EFFORT TOWARDS FUTURE OF AUTONOMIC COMPUTING

The future of Autonomic computing offers lot of promise for research scholars. This emerging field has raised a lot of expectations for people to define higher levels of infrastructure to deal with greater complexities in an efficient manner.

Testing the behavior of autonomic elements in large scale systems will be challenging because it is hard to anticipate their environment especially when it extends beyond all domains of engineering disciplines. [10]

Soft computing principles are being employed to provide tolerance for imprecision, uncertainty and partial truth. [13] The autonomic concepts of self-awareness, self-adjustment and autonomic behavior stem from the fields of Artificial Intelligence that offers plethora of opportunities for researchers to initiate progress in their respective work. [12]

VI. REMARKABLE DEVELOPMENTS IN THE FIELD OF AUTONOMIC COMPUTING

Many positive steps have been taken in this direction. CA (Context Awareness) systems that can sense as well as react to the environment are already on the rise. [6]These systems may have information about the circumstances under which they are able to operate and adapt their behavior accordingly based on rules or an intelligent stimulus. Context aware mobile computing systems are concerned with the acquiring

context, the abstraction aspect and high deal of understanding of the context, and applications behave based upon the identified context. In some applications, as the user's activity and location are critical, context awareness systems have been concentrated more intensely on location determination and activity recognition capabilities.

VII. VISION OF AUTONOMIC COMPUTING

The future of Autonomic computing offers many challenges to research scholars. This area of research has close resemblance to human self-regulating nervous system where new components should integrate themselves as "seamlessly as a new cell enters and adapts itself into the human body". Autonomic Computing throws open challenges at research scholars.[13] This challenge can be faced through a combination of process revolutions, implementation of new paradigms and forthcoming industry standards. [9]

VIII. CONCLUSION

Autonomic computing is an emerging holistic approach to computer system development that aims to bring a new level of automation and dependability to systems through self-healing, self-optimizing, self configuring and self-protection functions. [1] A sincere attempt has been made to educate the readers about the ongoing challenges in autonomic computing. A few illustrations are also presented in this paper as well.

Implementing Autonomic computing will require new standards from many IT vendors. First of all, organizations should be convinced that these autonomic systems will not deprive them of control but will instead simplify them with more time to deal with important aspects like formulating IT policies and strategies. The cost involved to do this is too high and not many vendors are ready to take this risk so early. [9]

Most existing systems can't be redesigned or redeveloped to be able to engineer the autonomic computing capabilities. [8] The process of equipping the existing systems with autonomic computing will be evolutionary rather than revolutionary.

In spite of autonomic computing technology being readily prescribed and taught in computer science and information science curricula, it will take another decade for the actual implementation of autonomic computing in existing systems.

IX. ACKNOWLEDGEMENT

I sincerely thank my Institution, Amrita Vishwa Vidyapeetham, Mysore campus for supporting me in authoring the paper entitled "Research Challenges and future vision of Autonomic Computing". I am thankful to my husband **Mr. Madhukar. M** for his unconditional support and encouragement. I am also grateful to the authors and co-authors of the reference papers from where I derived help and inspiration to proceed further with my existing ideas.

REFERENCES

[1] Autonomic Computing: Concepts, Infrastructure, and Applications, Manish Parashar, Salim Hariri

[2] Autonomic Computing, IBM Press, Richard Murch.

[3] A Survey of Context Adaptationin Autonomic Computing by Cornel Klein, Reiner Schmid & Christian Leuxner, 2008 http://www.perada.eu/documents/articles-perspectives/context-adaptation-autonomic-computing.pdf

[4] Autonomic computing is the future: but will rivalry kill it? An article from Computer weekly. by Simon Quicker http://www.computerweekly.com/feature/Autonomic-computing-is-the-future-but-will-rivalry-kill-it

[5] The vision of Autonomic computing jan 2003 Jeffrey O.Kephart David M.Chess http://users.soe.ucsc.edu/~griss/agent-papers/ieee-autonomic.pdf

[6] The dawning of the Autonomic computing era by A. G. Ganek T. A. Corb IBM systems journal 2003 http://www.cs.unm.edu/~darnold/classes/cs591-f12/papers/Ganek03Dawning.pdf

[7] Autonomic Computing Approximated by Fixed-Point Promises by Mark Burgess and Alva Couch http://research.iu.hio.no/papers/MACE-v2.pdf.

[8] Evaluation Issues in Autonomic Computing by Julie A. McCann, Markus http://www.netlab.tkk.fi/ opetus/s384030/ k06/papers/EvaluationIssues.pdf

[9] Towards Autonomic Network Management: an Analysis of Current and Future Research Directions Nancy Samaan and Ahmed Karmouch http://www.hit.bme.hu/~jakab/edu/litr/NGN/NewConcepts/AutonomicNetwork Management_05208731.pdf

[10] Policies, Grids and autonomic computing by Bradley Simons and Hanan Luftiya. http://www.csd.uwo.ca/~bsimmons/personal/papers/simmonslutfiyya-deas2005.pdf

[11] Challenges and Opportunities in Autonomic Computing June 25, 2002 by Alfred Z. Spector http://ecse.monash.edu.au/conferences/ics/2002/slides/keynote_spector.pdf

[12] A Survey of Context Adaptation in Autonomic Computing by Cornel Klein, Reiner Schmid Christian Leuxner, Wassiou Sitou, Bernd Spanfelner http://www.perada.eu/documents/articles-perspectives/context-adaptation-autonomic-computing.pdf

[13] Towards Cloud Management by Autonomic Manager Collaboration by Omid Mola, Michael A. Bauer Vol.4 No.12A, December 2011.

[14] Autonomic computing - engineering and scientific challenges by M. Litoiu 26th International Conference on Software Engineering - W6S Workshop "Fourth International Workshop on Adoption-Centric Software Engineering (ACSE 2004)"

[15] Defining Autonomic Computing: A Software Engineering Perspective by Paul Lin, Alexander MacArthur, John Leaney http://epress.lib.uts.edu.au/research/bitstream/handle/10453/2634/2005000985.pdf

I am Currently Working as Lecturer in Computer Science department at Amrita Vishwavidyapeetham, Mysore campus. I have 7+ years of teaching experience. My current area of specializations include Autonomic computing, Cloud computing, Service Oriented Architecture.

Recently presented a paper on “Security in Mobile computing and Integration of Mobile and cloud paradigms at the 2nd World conference on Applied sciences, Engineering and technology held at Gitam University, Hyderabad.

My related skills include: Exploring different arenas based upon my specialization and contributing significantly towards journals and conferences to improve my knowledge and exchange my ideas with the outside world.