Thesis Overview:

Scalable and Autonomic Management to Computer Networks

Romildo Martins da Silva Bezerra
Advisor – Joberto Sérgio Barbosa Martins
Computer Science PhD
UFBA/UNIFACS, DMCC, Brazil
romildo@ifba.edu.br

Managing computers network has become a really complex task due to the diversity of offered services, devices heterogeneity and low granularity of management. In this context, Autonomic Management Systems (AMS) has being investigated as a possible approach able to handle the high complexity of management. Indeed, it is expected that such autonomic systems may, among other features, offer network resources configuration and optimization while maintaining scalable performance characteristics. Fundamentally, the scalability problem must be considered by current autonomic management systems at risk of solutions do not fit in different managed environments. Thus, it is expected that autonomic solutions are preferably found dynamically (on-the-fly), and can effectively replace the human intervention in network management.

This work aims at designing a solution for network autonomic management that provides, among other things, a feature of scalability in the verification of new network solutions with a case study on the flow allocation. To do so, we developed a self-managed framework to be used in several scalable scenarios, which were generated through the conception of a strategy of network partitioning (Network Partitioning Computing Engine or NPCE). NPCE simultaneously considers a set of specified requirements as quality of service parameters and execution time in the search for new configurations. Results demonstrate autonomic solution feasibility through tests in scenarios with different topologies, traffic profiles and with applying random failures.

In Chapter I is presented. the basic motivation of the proposed network partitioning solution presented in this paper is, in brief, to investigate alternatives to improve the AMS capability to scale in relation to network size and management complexity in the specific scenario of network reconfiguration with quality of service (QoS) requirements. The strategy developed is implemented in analysis and planning phases of an AMS to improve a dynamic and on-the-fly approach to the decision-making process towards the effective administrator expertise replacement (Figure 1). In general, when considering the management cycle (MAPE), the focus is placed on analyze and planning steps strongly coupled with the network knowledge involved.

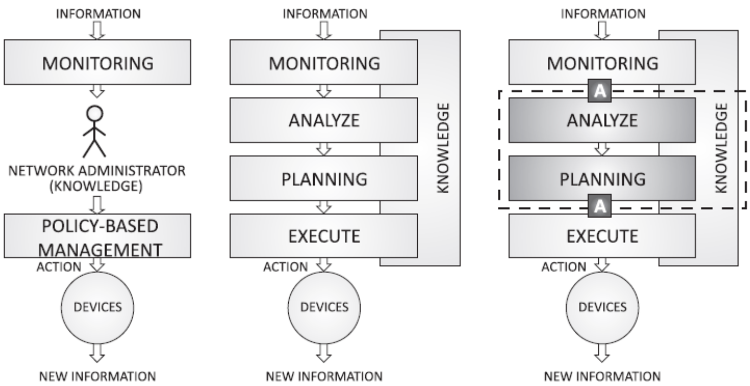

Figure 01. Administrator expertise replacement in analyse and planning phases

In practical terms, the autonomy will be used in the allocation of flows - in large areas - targeting the tradeoff between time allocation (Performability) and quality of solution found. A detailed overview can be seen in the Figure 2.

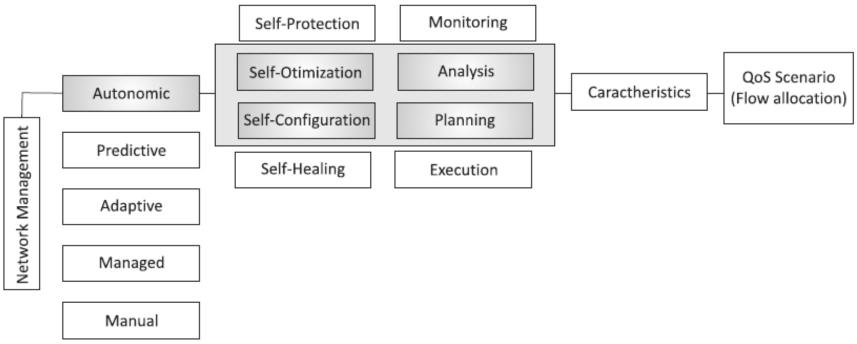

Figure 02. Caracteristics Overview

In Sequence, the concepts of autonomic computing, necessary for the understanding of this thesis and their application in the management of computer networks are described as: Self-Management Requirements, Architectural and Projects Aspects (Living Systems, Inspired Design (Bio-Inspired Survivability and Collective Behavior), Policy-Based Design, Knowledge Plane Design (Lack of centralized goals and control, Self-Stabilization, Reliability, Robustness, Scalability and Data analysis and visualization. Finally, the main projects was described. The Projects not properly deal with scalable autonomic management, ie, the autonomic manager has no guarantees to meet a greater number of devices and the increased volume of traffic with different network topologies. Some studies report that there may be more of a manager in the managed environment, but the division of the managed domains and the communication between them is not properly cited. In general, tests on the ability of autonomic systems act in environments of different scales are not properly treated, and do not have common metrics or a set of standard tests.

In Chaper III, The goal is to provide a framework with autonomic features which is capable of being used for autonomic network management, with a focus of applicability and specific case study for QoS. For this purpose, initially will be specified the expected framework requirements, the structure of structured planes, in special decision plane. Then a partitioning strategy (NPCE - Partitioning Network Computing Engine) is presented to the integrated search engine solutions targeting the treatment of scalability with respect to use in atmospheres containing different amounts of devices and/or traffic volume. The NPCE is composed of three phases (Figure 3):

1. The Partitioning Approach (Phase 01)
2. Traffic Allocation and Cost Evaluation (Phase 02)
3. Tradeoff Evaluation for Partitioning Choice (Phase 03)

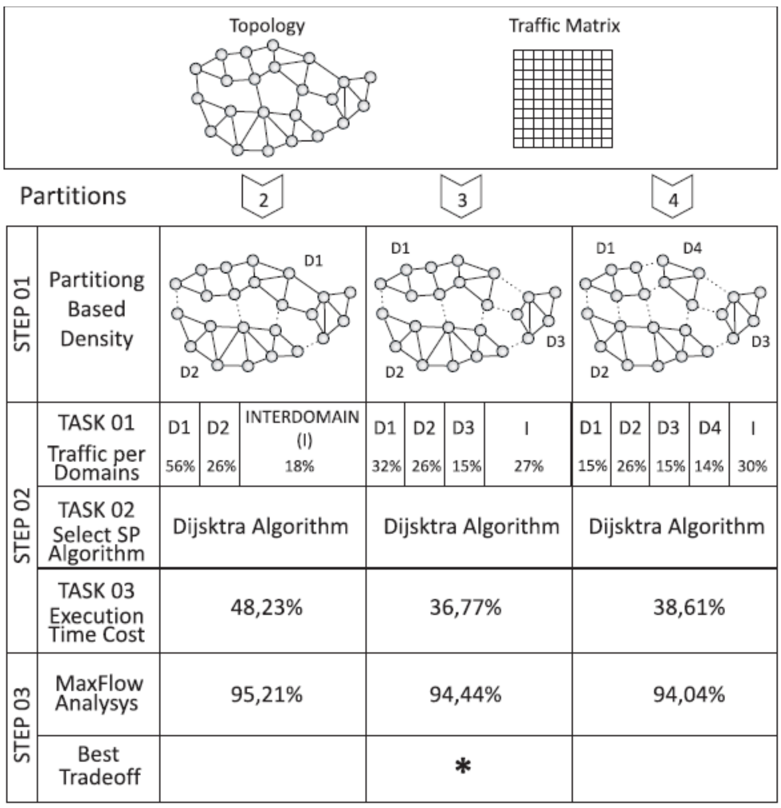

Figure 03. NPCE Example from two until four partitions

The operation is exemplified with many use cases and the search engine com Case-Based Reasoning (CBR). In general, the proposed framework can be considered as performing a modeling of the problem of autonomic network management with requirements, specific characteristics and focus, which will be detailed.

In Chapter IV, the proposed framework will be analyzed according to the requirements specified through the test scenarios (simulations), mathematical analyzes and discussions in not measurable issues(functional requirements) such as adaptability. The goal of this chapter is to provide a more thorough study of the management framework used depending on the results obtained, especially with the simulations. The tests performed through simulations considering the operation cycles as an assessment framework with the scalability and quality through the link failures; The scalability tests are performed as a function of increased number of streams and the increase in number of nodes. The simulations considering the worst case, that is, allocation of all flows in a network. The measurements in this case involve the comparison of response times. The solution quality is measured by the average percentage of the allocation of links and the average length of the paths of flows. Regarding failures, the tests check the reacting capacity of the framework, based on the percentage of flow relocated with faults. The results were analyzed using traditional statistical inference, since it allows to estimate a parameter of a population-based sample data.

Finally, The differential of work is presented highlighting the scalability and low response time. Also shown are future research points as: survivability limits analysis with faults, analysis of the CBR full history and application in networks capacity planning.

Romildo Martins da Silva Bezerra
romildo@ifba.edu.br

Joberto Sérgio Barbosa Martins
joberto@unifacs.br