Chapter 2
Bio-Inspired Techniques for Resources State Prediction in Large Scale Distributed Systems

Andreea Visan
University Politehnica of Bucharest, Romania

Mihai Istin
University Politehnica of Bucharest, Romania

Florin Pop
University Politehnica of Bucharest, Romania

Valentin Cristea
University Politehnica of Bucharest, Romania

ABSTRACT

The state prediction of resources in large scale distributed systems represents an important aspect for resources allocations, systems evaluation, and autonomic control. The paper presents advanced techniques for resources state prediction in Large Scale Distributed Systems, which include techniques based on bio-inspired algorithms like neural network improved with genetic algorithms. The approach adopted in this paper consists of a new fitness function, having prediction error minimization as the main scope. The proposed prediction techniques are based on monitoring data, aggregated in a history database. The experimental scenarios consider the ALICE experiment, active at the CERN institute. Compared with classical predicted algorithms based on average or random methods, the authors obtain an improved prediction error of 73%. This improvement is important for functionalities and performance of resource management systems in large scale distributed systems in the case of remote control ore advance reservation and allocation.

DOI: 10.4018/978-1-4666-2647-8.ch002

INTRODUCTION

The size of distributed systems followed an ascending trend during the last decade leading to today's Large Scale Distributed Systems (LSDSs). As a result, resource management has richened more and more importance, being considered a main component used to improve the system performance.

Monitoring can improve the performance of resource management systems (Shoorehdeli et al., 2009) in various ways, and for this reason most of the current resource management systems use monitoring instruments. A monitoring module should satisfy several important functional requirements, namely, to provide accurate information for all relevant parameters, to support various data delivery models, to offer an extensible data representation, to have access to real-time and history data, and to be easily ported. We have also to mention the scalability, a minimal monitoring overhead and the ability to process and distribute, in real-time, large amounts of gathered data.

Resource management also relies on prediction mechanisms (Loc et al., 2006), used to estimate what the resources utilization will be in the near future, or how many resources are likely to fail. The prediction mechanisms use monitoring data that have been collected from the system and usually stored in repositories. Based on a set of previous values for a certain parameter, the next value is forecasted and sent to the resource manager. Classical prediction algorithms are based on mean, median and standard deviation theory, but approaches inspired from natural models can also be successfully used. Our research uses a framework for distributed system monitoring, real time prediction and also a real-time error analyzer for different prediction approaches.

The paper is organized in the following way: First we briefly introduce the components of the monitoring and state prediction tool used in our research. Next, we give a definition of the prediction problem. Next, different performance criteria are expressed. In the following section, different prediction algorithms are described: from simpler one such as those based on simple mean or advanced, bio-inspired. Next, a performance comparison between all algorithms is made for different system parameters describing one system's state. The experimental tests were made in both one-step ahead and multi-step ahead prediction.

THE MONITORING AND STATE PREDICTION TOOL

This section briefly describes the monitoring and state prediction tool used in our research. Its main design goals were the scalability, the flexibility and the ease-of-use. In the meantime, we assured that the main requirements of a monitoring module are satisfied. Figure 1 presents the architecture of the monitoring and state prediction tool taken into account. Its main components are represented by the monitoring module, the repository server, the prediction server, the database and the web server. These components will be briefly introduced in the current section.

A. The Monitoring Module

The purpose of the monitoring module is to provide accurate information about the current states of different system parameters. We have considered only dynamic system that presents various aspects from the monitored systems that usually vary in time. These parameters refer to the percent of the time spent by the CPU in user, system, nice and idle mode, CPU usage percent, average system load over the last 1,5 or 15 minutes, amount of free memory and swap memory, number of total, blocked and running processes, waiting time for IO operations, number of interrupt requests and software interrupt requests, etc (Yang et al., 2003).

There are also general (static) system parameters, collected only once. They measure characteristics that do not vary in time, such as the