Proactive Fault Management of IT Infrastructure

Arnak Poghosyan, Ashot Harutyunyan, Naira Grigoryan, and Mazda Marvasti

Advanced Statistics Center*
Integrien Corp.
114 Pacifica, Suite 290, Irvine, CA 92618

Abstract

A statistical and information-measures-based complex approach and analytics is developed for automated management of IT infrastructures. In particular, it consists of problem root cause identification/localization methodology, system bottleneck detection mechanism, and black swan events determination and its run-time risk prediction.

1 Introduction

Nowadays IT industry is faced with the problem of automated management of large network infrastructures with complex topology (thousands of servers and services, composite applications, sophisticated interrelations between infrastructure components, etc.) Manual and static efforts are no longer capable to adequately handle the increasingly complicated tasks in a timely manner. That is why we enter a modern age of IT intelligence with challenging problems with solutions rooted in mathematics specifically in areas of self learning, data mining, neural networks, and applied statistics. In other words, the key challenge of this field becomes the design of "IT brain" with

*Emails: {apoghosyan;ashharutyunyan;ngrigoryan;mmarvasti}@integrien.com

powerful analytical abilities to maintain the network systems "health" and business processes reliable.

Online banking, electronic commerce, and various web services are fragments of today's IT world with growing sophisticated demands on IT management. Each of those technologies consists of multi-tier complex business services. One way to determine when a business service is impacted is to measure service-level metrics such as application response time. Nevertheless, this method is by its nature reactive: when it identifies a business service that is slowing down, it's too late as the slowdown has already occurred.

Network management tools and techniques must therefore become better at detecting and identifying network faults, be able to capture precursors to the occurrence of problems, predict and prevent business service slowdown or failure before end-users are impacted. Indeed, one of the biggest challenges in providing computer systems performance management for a large IT organization is proactively identifying upcoming performance issues.

A typical enterprise environment has no shortage of data being collected from devices, applications, operating systems, etc. by multiple monitoring products. The purpose of data collection is to get a handle on problems that can impact the business.

The core of Integrien's software product (consult `www.integrien.com`), Alive, makes a data agnostic analytics which turns the sea of data collected by existing monitoring tools into actionable information for managing performance. Alive eliminates the time-consuming, labor-intensive troubleshooting efforts and take a proactive approach to managing performance of critical IT systems and services.

More information regarding the subject and current developments by research at Integrien can be found in [1].

2 Formalism

A group of statistical solutions to the above problems are given in the series of patents [3], [4], [5], and [6].

To solve another block of problems in IT networks, such as root cause determination, system bottleneck detection, and black swan events recognition and prevention, we developed a formalism in terms of a theory of random variables on graphs. Historical fault events make a directed graph of random variables with their probability distributions (Fig. 1). Shannon mutual infor-

mation becomes an important measure to estimate the relationships among the graph nodes and reduce the complexity of above mentioned detection problems. A fault is defined as the cause for malfunctioning.

Our approach is based on historical simulation applied on the correlated alarms set. Alarm generation is accomplished by setting the normal behavior of network components via hard or dynamic thresholds [7], [8], for which we have developed a statistical process control method [2].

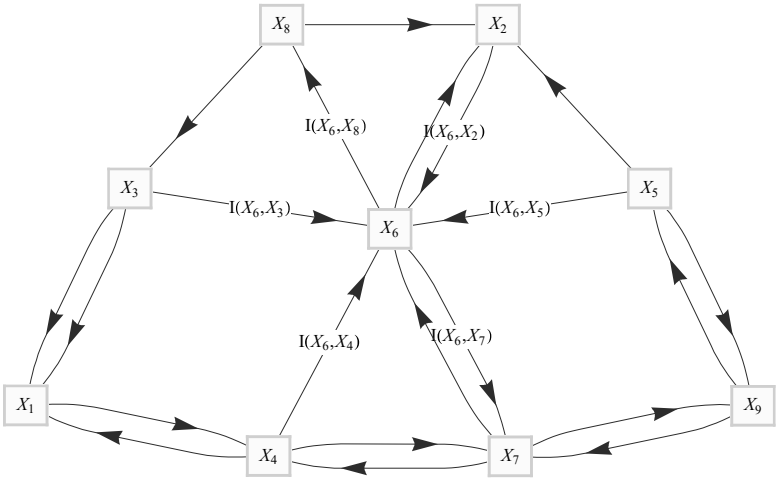

Figure 1: Virtual graph of historical fault events.

3 Algorithms

Root Cause analyzer automatically produces a guide in form of a recommendation list to advice the most probable resources of problem origin. If the problem source is not unique, then it recognizes separable causes of the abnormality resulting in several recommendation lists.

A further analysis of the graph reveals system bottlenecks – nodes with persisting presence in network failures, and black swans – class of rare events that inevitably leads to a network crash with their high impacting ability on a large set of components.

4 Experimental Results

Our experiments on real data sets from monitoring of large IT network systems show appropriate detection capabilities of developed algorithms. In particular, the root cause detection algorithm was able to make the right recommendations for system crash origins in several real banking applications.

References

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[7] M.A. Marvasti, A.V. Grigoryan, A.V. Poghosyan, N.M. Grigoryan, and A.N. Harutyunyan, "Methods for the cyclical pattern determination of time-series data using a clustering approach", US Patent application number 20100036857.

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