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5. Proactive Scalability and Management of Resources in Hybrid Clouds via Machine Learning

Dr. Avresky has published more than 126 papers, including IEEE Transactions journals papers, in the area of: network (control, routing, fault tolerance, dynamic reconfiguration, adaptive routing, self healing, performance analysis, virtual/overlay networks, middleware), software and protocol verification, parallel computers, functional programming, testing and diagnostics, wireless sensors networks.

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Introduction

We present **Inter-ACM Framework (I-ACMF)**, a novel framework for supporting the management and optimization of application subject to software anomalies and deployed on **large scale cloud architectures**, composed of different **geographically distributed cloud regions**.

- **I-ACMF** uses **machine learning models for predicting failures** caused by **accumulation of anomalies**.
- **I-ACMF** introduces a novel **workload balancing approach** and a **proactive system scale up/scale down** technique.

Proactive Scalability for guarantee elasticity property in hybrid clouds

The proposed solution allows to enforce high scalability of the deployed application. In fact, scalability can be controlled at different levels:

- Intra-ACM controllers can decide upon the number of VMs which are currently active. By controlling at runtime the execution dynamics of VMs into a cloud region (specifically, by controlling the Mean Time to Failure), the controller is able to make a prediction on the number of VMs in the cloud region. The controller can decide whether new VMs are required to fulfil the requests coming to the region. In this way, the **Intra-ACM** controller is able to ***proactively** scale up/down the number of VMs composing the region – elasticity property* .
- **Multiple cloud regions could be proactively connected together, even at a runtime.** This gives the user of the framework an additional level of scalability. In fact, rather than adding single VMs to the system, entire regions, composed of any number of VMs, could be connected. This allows, for example, to inject a higher amount of computing power, which could be possibly required only during certain operating periods of the system.

Machine Learning techniques

In particular, the ML Framework generates ***out of the box*** prediction models according to the following regression techniques:

- Lasso as a predictor
- Linear regression
- M5P
- REP Tree
- SVM
- LS-SVM
- As well, the ML Framework can manage a large set of Machine Learning Techniques.

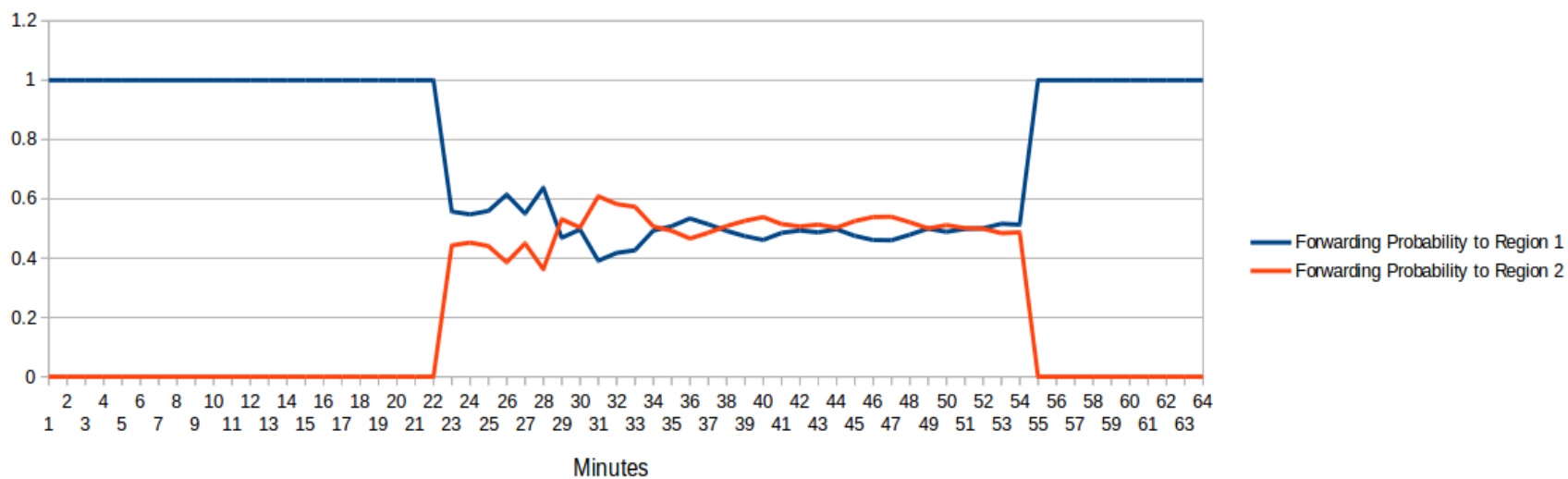
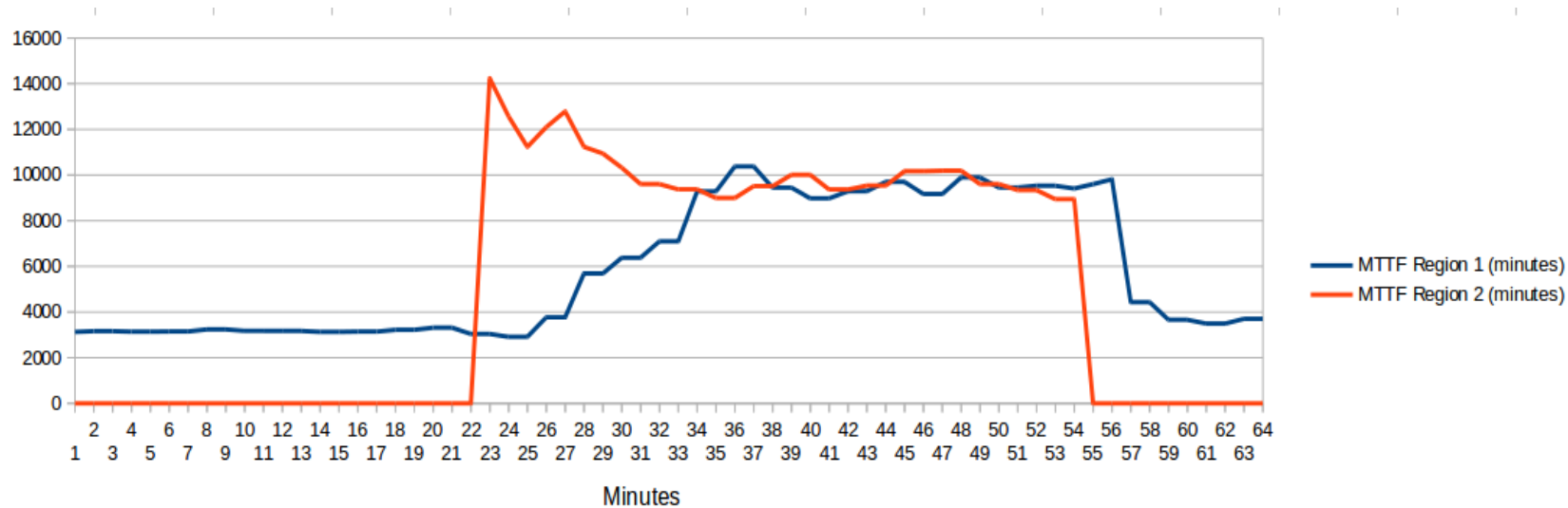
Summary 1

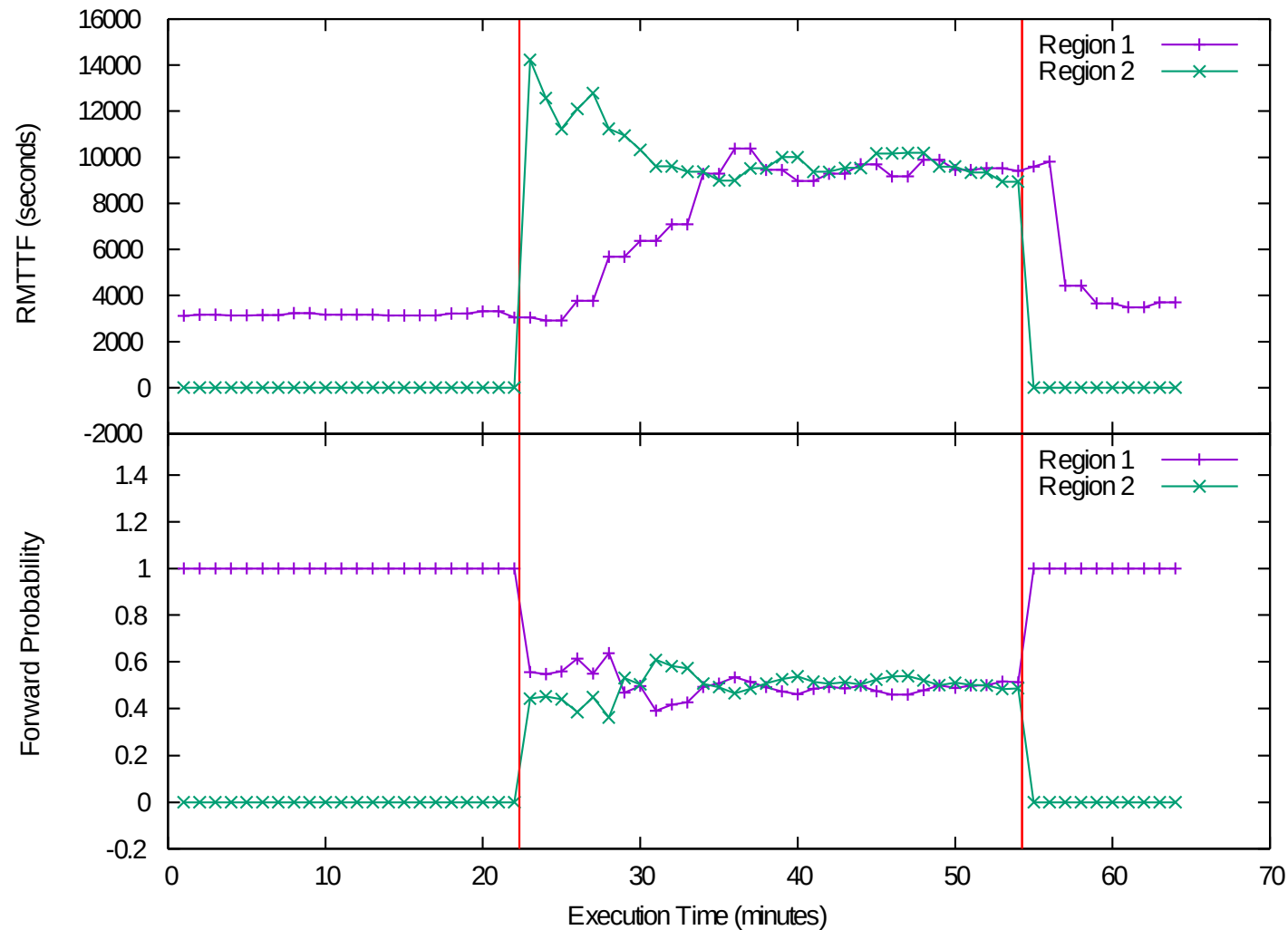
We presented **I-ACMF**, a framework for proactive management and optimization of application subjects to software anomalies and deployed on distributed geographical (hybrid) multi-cloud infrastructures.

- As building block, I-ACMF exploits **machine learning models** for predicting the **mean time to failure** of virtual machines of different **cloud regions** caused by accumulation of anomalies.
- Overall, I-ACMF uses a combination of strategies and techniques, such as a **proactive rejuvenation**, a workload balancing approach based on virtual machine failure rates, and a **proactive system scale up and scale down** technique.
- Experimental results show that I-ACMF can simplify application deployment and management, also in front of non-uniform client request rates in different **cloud regions**, workload variations and system scale up/scale down at both cloud region level and **global system level**.

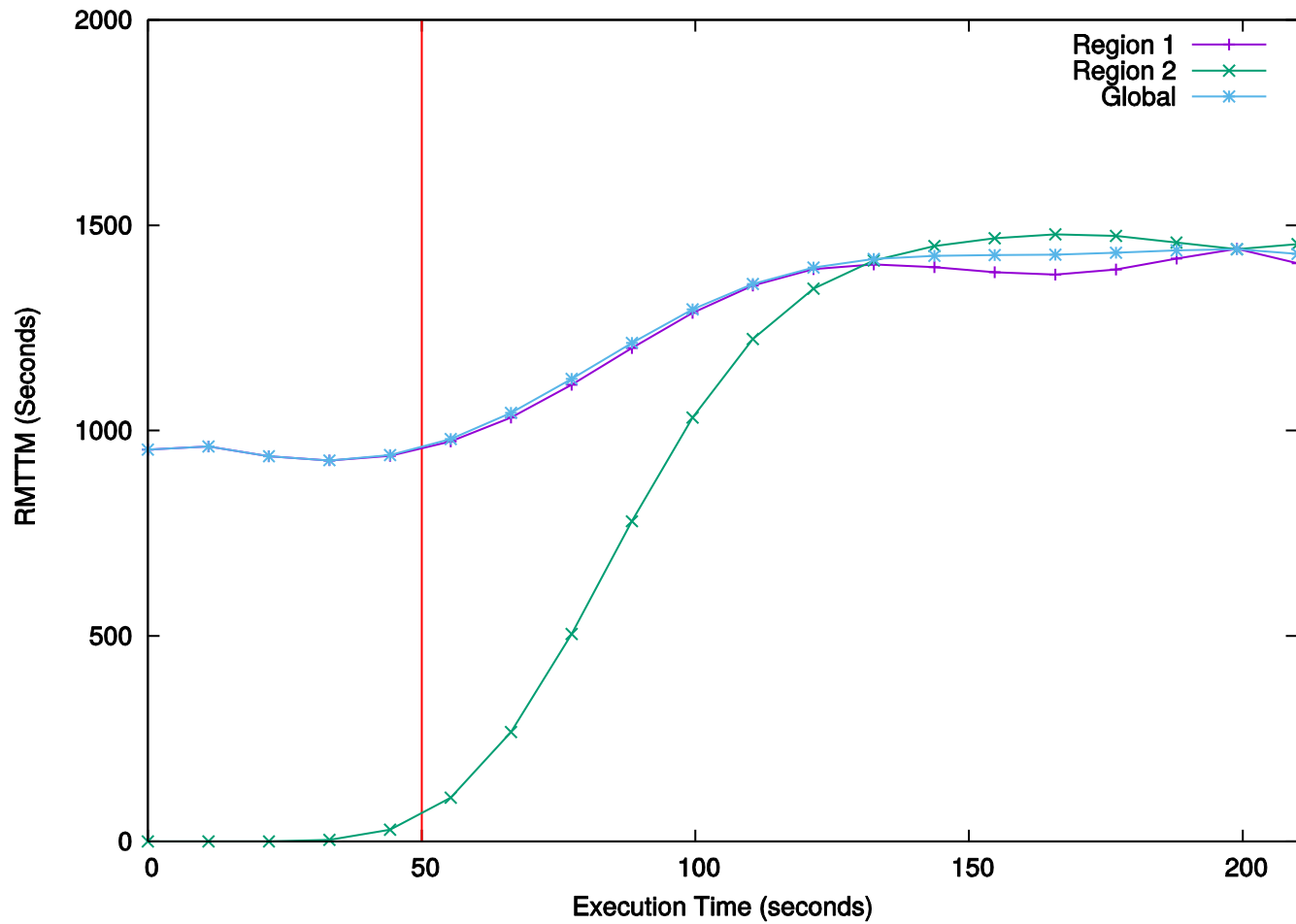
Summary 2

In this presentation, we demonstrate the implementation of Virtualization and Machine Learning Frameworks for enhancing the availability and performance of web based applications. We automatically generated *Machine Learning (ML) models*, based on monitoring a set of system features, during the off-line training phase. The implemented *ML framework predicts the time to crash of applications*. Intra ACM controllers are interconnected over a distributed/geographical clouds. In this way, multiple cloud regions can *proactively to scale(up/down)* to increase the *availability of the application*, and to *ensures the response time* seen by the users of the application.





RMTTF and Forward Probability with 2 cloud regions and constant Request Arrival Rate (500 req/sec)



RMTTF variation when a new cloud region joins the system

Intelligent Systems – Adaptivity

- ❑ Systems must provide services meeting given requirements in interaction with intrinsically uncertain (non-deterministic) environments
- ❑ Adaptivity consists in using control-based techniques to ensure correctness despite uncertainty

