Multi-agent Negotiation of Virtual Machine Migration Using the Lightweight Coordination Calculus

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Abstract. LCC is a Lightweight Coordination Calculus which can be used to provide an executable, declarative specification of an agent interaction model. In this paper, we describe an LCC-based system for specifying the migration behaviour of virtual machines in a datacentre. We present some example models, showing how they can be used to implement different policies for the machine allocation and migration. We then describe a practical implementation of the system which can directly execute the LCC specifications.

Keywords: autonomic computing, multi-agent systems, virtual machines, OpenKnowledge, Lightweight Coordination Calculus.

1 Introduction

Virtualisation technology has recently transformed the availability and management of compute resources. Each *physical machine* (PM) in a datacentre is capable of hosting several *virtual machines* (VMs). From the user's point of view, a virtual machine is functionally equivalent to a dedicated physical machine; however, new VMs can be provisioned and decommissioned rapidly without changes to the hardware. VMs can also be *migrated* between physical machines without noticeable interruption to the running applications. This allows dynamic load balancing of the datacentre, and high availability through the migration of VMs off failed machines. The resulting *virtual infrastructure* provides the basis for *cloud computing*.

Managing the placement and migration of VMs in a datacentre is a significant challenge; existing commercial tools are typically based on a central management service which collates performance information from all of the VMs. If the current allocation is unsatisfactory (according to some policies), then the management service will compute a new VM allocation and direct agents on the physical machines to perform the necessary migrations.

As the size and complexity of datacentres increases, this centralised management model appears less attractive; even with a high-availability management service, there is possibility of failure and loading problems. If we would like to extend the domain of the virtual infrastructure to encompass multiple datacentres,

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