Chapter 12

Network Management in Virtualized Infrastructures

Manuel Stein
Alcatel-Lucent Bell Labs, Germany

Karsten Oberle
Alcatel-Lucent Bell Labs, Germany

Thomas Voith
Alcatel-Lucent Bell Labs, Germany

Dominik Lamp
University of Stuttgart, Germany

Sören Berger
University of Stuttgart, Germany

ABSTRACT

Service Oriented Infrastructures (SOI) build upon previous advancements in Distributed Systems, Grid Computing, Cloud Computing, Virtualization, SOA, and technologies alike. Capabilities merged under the banner of SOI offer a solution that serves long-standing business needs, but also meets increasing demand for infrastructures, enabling the fast and flexible deployment of new services.

However, typical current SOI realizations, e.g., Grid or Cloud solutions, do not take the network infrastructure, necessary for flawless service interaction, sufficiently into consideration. In most cases, those frameworks focus on providing huge and extremely divisible applications with hardware resources possibly distributed over several provider domains. They manage just computing related resources like CPU and RAM or Storage (e.g. Amazon Web Services), but network connectivity is typically taken for granted while network Quality of Service (QoS) aspects (e.g., jitter, delay) of the data exchange is usually not considered. Consequently, the data exchange between changeably deployed components cannot be comprehensively treated.

DOI: 10.4018/978-1-60960-827-9.ch012
Network Management in Virtualized Infrastructures

This chapter provides an overview on related state of the art technologies regarding topics such as QoS provisioning, virtualization, and network resource management. This background is enriched with latest research results on future trends and advances in state of the art in network management.

INTRODUCTION

Host virtualization has changed the landscape of hosting services over the past years from traditional server hosting towards rentable virtual machines. Under the concept of Cloud Computing, those virtual machines can be also be rented on-demand under a negotiated service level agreement (SLA), which makes Clouds coveted for outsourcing of application delivery networks from in-house data centers to a serviced infrastructure. At the same time, network virtualization could likewise facilitate on-demand provisioning of network services under negotiated SLAs. Yet, network management in virtualized infrastructures is challenged by current and emerging virtualization solutions to cope with differing parameter sets for virtual machine endpoints, networking QoS level agreements and multiple tenancies.

Cloud providers operate on geo-distributed data centers for reliability and redundancy, but argue that it is necessary to expand from large-scale computational silos towards a higher network distribution in order to improve efficiency both in operational cost and networking (Church, Greenberg, Hamilton, 2008). The operational expenses of a data center can be reduced if commodities (e.g. facilities, energy and networking) were used to build smaller and highly distributed data centers. In a more detailed reflection on video service provisioning (Norton, 2008), the author reports that strongly increasing traffic demands exhaust Internet exchange capacities, which, after a foretold period of higher transit pricing might leave transit wholesale with a traffic profile pricing scheme similar to the telephone system, making it worthwhile to consider construction of smaller data centers at the last mile. In such a distributed data center scenario, network management design has to consider higher propagation delays and capacity bottlenecks to remote data center locations in order to maintain its responsiveness. Techniques developed in the fields of distributed systems and agent communications are required to account for the stability of Network Management.

Future Internet research has adopted the trend of multi-homed service providers to develop the concept of a virtual service provider, whose infrastructure can span across multiple ISPs using network virtualization. Approaches exist to provide a multitude of virtual networks on the global infrastructure that would provision point-to-point and point-to-multipoint links or other topologies of virtual links under a negotiated SLA with assured QoS for mission-critical application delivery across existing carrier networks. This concept of network virtualization closes the market gap between investment in a costly, dedicated network infrastructure and rental of an over-provisioned IP transit that is subject to varying cross traffic conditions when interconnecting remote data center locations. In the pursuit for cost savings, the data center operator is unlikely to rely on a single option among these but rather employs several types of transport services in order to map cloud traffic onto individual transport resources, i.e. depending on the negotiated QoS terms of virtual machine communication. Hence, Network Management in Virtualized Infrastructures is facing an increased complexity to map virtual machine traffic onto resources, since it has to manage multiple transitions among data centers as opposed to the simple transit model that is unfit to provide network QoS among data center locations.

In the following, we have a closer look at network virtualization techniques developed in the context of Future Internet research and the Cloud business. We further look at network QoS