Chapter 5
Challenges in Future Intra-Data-Center Networks and Possible Solutions

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ABSTRACT

This chapter briefly introduces the data center network and reviews the challenges for future intra-data-center networks in terms of scalability, cost effectiveness, power efficiency, upgrade cost, and bandwidth utilization. Current data center network architecture is discussed in detail and the drawbacks are pointed out in terms of the above-mentioned parameters. A detailed background is provided that how the technology moved from opaque to transparent optical networks. Additionally, it includes different data center network architectures proposed so far by different researchers/team/companies in order to address the current problems and meet the demands of future intra-data-center networks.

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INTRODUCTION

The facility used to house massive amounts of computing, storage and network resources like servers, hard drives and bandwidth is called a Data Center (DC). These resources can either be used by the DC operators to deploy their own services or be rented to their customers. These customers are usually Small and Medium Enterprises (SMEs) which have reduced resource requirements and would find very expensive to deploy and maintain their own infrastructure. Therefore, the DC operators provide Infrastructure as a Service (IaaS) (Buyya et al., 2009) to their customers.

The main issues which DCs address are linked to the fulfillment of the Service Level Agreement (SLA) (Bouillet, Mitra, & Ramakrishnan, 2002) which their operators sign with the customers and the maximization of the profits they obtain. In such a context, the key challenges DCs operators have to face are:

- **Scalability**: The capability of being able to increase the number of housed resources and bandwidth.
- **Fault Tolerance**: The capability of being able to withstand failures without producing an impact on the service.
- **Cost Effectiveness**: The capability of reducing the amount of required resources. This can be achieved through the use of several virtualization technologies, abstracting the physical resources into several virtual (or logical) resources. This allows the DC operators to optimize the resource usage by providing to each customer only what he needs and pays for.
- **Power Efficiency**: The capability of minimizing the power consumption produced by the resources.

By taking a closer look into intra Data Center Networks (DCNs) it can be observed that they intend to follow these same principles. An intra DCN's function is to allow resilient, high bit-rate and low-latency communications between the DC's computing and storage resources.

This is a critical task since a failure (or congestion) in the network would degrade the performance of the connections or directly block them. If this happens, the outcome (from the user's point of view) is the same as if the computing or storage resources were down since his request cannot be attended. An example of this would be the communication between a virtual machine and a storage server (Figure 1).