Chapter 8

Optical Switching in Next-Generation Data Centers: Architectures Based on Optical Switching

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ABSTRACT

The leading content provider companies like Google, Yahoo, and Amazon installed mega-data centers that contain hundreds of thousands of servers in very large scale. The current data center systems are organized in the form of the hierarchal tree structure based on bandwidth-limited electronic switches. Modern data center systems face a number of issues like high power consumption, limited bandwidth availability, server connectivity, energy and cost efficiency, traffic complexity, etc. One of the most feasible solution of these issues is the use of optical switching technologies in the core of data center systems. In this chapter a brief description about the modern data center system is presented, and some prominent optical packet switch architectures are also presented in this chapter with their pros and cons.

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INTRODUCTION

Over the past few years, data-centric applications like high-definition video streaming (Hadbib, 2012) social networking (Koley et al, 2010) and cloud computing (Sato et al, 2009) in combination with the large diffusion of mobile devices such as smart phones and tablets (Jinno et al, 2009) have contributed to the rapid growth of the Internet traffic. Data centres form a key set-up of today’s Internet and providing a myriad of services from social networking to large-scale scientific calculations. They can be defined as mega-centres of computing and storage resources that communicate extensively with each other to serve the ever-increasing demands of customers (Habib et al, 2012). In the past two decades, the high-performance computing section has achieved a performance improvement trend of 85-90% of the compound annual growth rate (CAGR) (Taubenblatt et al, 2012). Due to the advancement in multicore processors, accelerators, and increasing levels of parallelism across all layers of the hierarchal system, this trend of performance improvement is expected to continue in the near future also. Besides the rapidly increasing demand of bandwidth, that requires massive-scale interconnection solutions, the ICT (Information and Communication Technology) industry reported a contribution of 2 to 3 percent of global greenhouse gas emissions, which will rapidly increase soon (Despins et al, 2011). Data Centres, being ICT infrastructure, thus needs to be revisited in terms of interconnection design to support very large scales data centres while leading to ultimate footprint and power savings. In recent years, many researchers focused on examining the various approaches to address the scalability, speed and footprint requirements of Next-Generation data centres (NGDCs).

One of the main objectives of this chapter is to develop an effective networking solution which is good enough for the Next Generation Data Centre. Our definition of Next Generation data centres, contains massive-scale data centres that can host millions of processing cores. Also referred to as cloud data centres, these entities will be employed by large online service providers to offer Internet-facing services and are expected to host data-intensive applications. In this chapter, we are trying to report the requirements of these data centres in terms of footprint, scale, energy efficiency and flexibility. Inspired by the ongoing efforts in data centre network design, we aim at deploying the most appropriate technologies in the upcoming massive-scale data centres.

FUTURE SCENARIO OF DATA CENTRE

The rise of cloud computing and other emerging web applications have created the need of more powerful warehouse-scale data centres. These data centres comprise
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