Chapter 6
Addressing Transport Layer Issues in Cloud Computing: A STEM Perspective

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ABSTRACT

Due to bandwidth limitations and overflowing in the Internet, connectionless transport-layer protocols are migrating to connection-oriented, mainly because of the flow control it offers. Because of this, many Internet Service Providers (ISPs) and network administrators have restricted user traffic to only Transmission Control Protocol (TCP) segments. Optimizing TCP-based protocols will benefit significantly the performance of any centric system, such as the STEM clouds. The challenging scenarios, when using TCP-based systems, are transmitting large files over long distances, as these have a large bandwidth-delay product (BDP) which hinders drastically the performance, even if the network's physical link is broadband (e.g. fiber optics). There are various transport protocols today that address these problems. This chapter aims at explaining the transport layer limitations, an overview of how we arrived at the protocols used today, and some techniques that could be adopted in the future, with a focus on cloud computing systems.

INTRODUCTION

STEM learning is an important foundation that everyone should possess, regardless if the job they decide to perform requires a deep knowledge of these fields. STEM learning is powered by knowledge and the diffusion of knowledge, so computer networks play an important role in education in the twenty first century. In the last decade, cloud computing has become a pervasive technology and it has done so because of all the advantages it offers. A few advantages of implementing a cloud network include: (a) Easy access: End-users can access data and applications through any terminal connected to the Internet, from any location and at any time. Data and applications will not be confined to a single location, such as a university, enterprise or home, enabling ubiquitous access. (b) Economical: Client hardware cost will drop drastically, as the intelligence can be placed in the

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cloud, and the need for hardware upgrades will gradually become less frequent, perhaps one day there will be no need for upgrades. (c) Software licensing: Companies running licensed software can have a centralized processing grid that allows access to its users, resulting in a reduction in license costs. Also, renewal of licenses can be automatic and have an even lower cost. (d) Storage: Organizations with massive storage needs can save physical space, energy consumption, and managing costs, by utilizing cloud services. By utilizing these services, consumer organizations will save money on maintenance, energy, software upgrades, hardware repair, support, and many in many other aspects as streamlined equipment, in general, has fewer problems than fully integrated systems. (e) Finally, processing power: If the cloud network is equipped with a computer grid system, then the client can take advantage of the network's parallel processing power to send demanding computational processes to the cloud. As it can be observed, all these traits: easy access, economical, centric software licensing, storage, and processing power are very beneficial to STEM learning. Here are a few examples: Students and teachers can benefit tremendously from sharing experimental results located in a central database that everyone (that is allowed) can access it from home, school or university. Given that students have access to public computer grids, they can run processor-demanding tasks from a tablet or laptop. Students do not have to invest in expensive computers. Having centric software licenses allows students to use programs, like Matlab or Mathematica, in any computer using the school's license. Storage is necessary in any organization, educational or not, to store the institution's data in a safe and accessible way. In schools, the storage can be used to digitize books and share them with students. It occurs often that there are not enough hard copies to satisfy the demand for a specific group. If soft copies were kept, now demand for knowledge is too high; of course, this would need a lot of storage space. Lastly, access to a computer grid will allow students to program even the most processor-hungry algorithms. Solutions to problems that do not have closed-form expressions can be found by exhaustive search, an alternative that may not have been an option before granting access to computer grids. Now that we have discussed the advantages, a discussion of some issues related to cloud computing follows.

Cloud computing undoubtedly has improved our way of life, and it has done so for many years. E-mail is one of the earliest cloud-based systems, and it basically replaced regular paper-based mail. When e-mail was born, the term 'cloud' did not even exist in the context of technology. After many years, in which the Internet has grown significantly, cloud networks still encounter many challenges (Dillon, Wu, & Chang, 2010; Moreno-Vozmediano, Montero, & Llorente, 2013), including: Privacy, Scalability, Interoperability, Reliability, and Performance issues. Privacy is a big concern for the user as the data resides on the cloud's servers, so it is vulnerable to hacking attempts. Scalability is essential for any cloud service provider, as the number of users increases, the cloud must be able to sustain the demand. Interoperability is a difficult task because of a lack of standardization; each provider has its own interface. Reliability is important to retain users. High system downtime will discourage users from utilizing specific providers. Performance is one of the most important issues and can encompass many aspects of the cloud, including quality of service (QoS), throughput, and delay. The cloud's performance is among the top priorities, without good performance, the other issues become less relevant. Performance can be significantly enhanced by improving the effectiveness of transport layer protocols. This is the focus of this chapter.

CLOUD COMPUTING IN STEM

Cloud computing is making a huge impact in STEM learning. Much work has been dedicated

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