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Comprehensive Link Sharing Avoidance and Switch Aggregation for Software-Defined Data Center Networks

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Abstract

An effective way to reduce network energy consumption of data center networks (DCNs) is to activate network elements as few as possible, complete transmission in as short a time as possible, and set unnecessary network elements to sleep mode. At present, most existing energy saving works considered the network energy saving from the dimension of time or power separately. However, in fact these two dimensions can interact with each other, i.e., reducing the network delay may lead to the increase of network energy consumption, and vice versa. In this paper, two dimensions of time and power are comprehensively studied in the Minimum Network Energy Consumption (MNEC) problem. First of all, we formulate the MNEC problem by considering both time and power, and prove that it is a NP-hard problem. Furthermore, we propose a heuristic Integrated Time and Power (ITP) algorithm, which combines the link sharing avoidance algorithm to reduce the network delay from the dimension of time as well as the switch aggregation algorithm to reduce the energy consumption from the power dimension. Finally, the performance of ITP algorithm is evaluated under different network topology, network size, traffic size and flow number under the network environment based on Mininet and Ryu controller. Experimental results show that the ITP algorithm outperforms the existing network energy saving algorithm in terms of energy consumption.

Keywords: Link sharing avoidance, Switch aggregation, Energy saving, Software defined data center networks, Heuristic algorithm.

1. Introduction

In recent years, with the development of cloud computing and video services, the scale and energy consumption of data centers have increased dramatically. In 2013, the energy consumption of data centers in the United States reached 91 billion kilowatt-hours, which was close to that of the Three Gorges hydropower station, the largest hydropower station in the world, with an annual capacity of 98 billion kilowatt-hours. In addition, it is expected that by 2020 the energy consumption will reach 140 billion kilowatt-hours [1]. Due to the rapid increase of energy consumption in data centers, energy saving has become one of the major bottlenecks of design data centers. In the meanwhile, the network energy consumption dominates the whole energy consumption in the data

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