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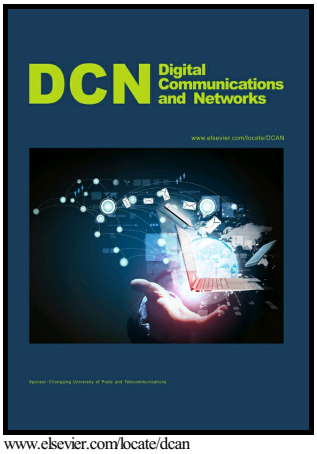
Niemah Izzeldin Osman



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Will Video Caching Remain Energy Efficient in Future Core Optical Networks?

NIEMAH IZZELDIN OSMAN
College of Computer Science and Information Technology
Sudan University of Science and Technology
P. O. Box 407, Khartoum
SUDAN
niema.osman@gmail.com

Abstract: - Optical networks are expected to cater for the future Internet due to the high speed and capacity that they offer. Caching in the core network has proven to reduce power usage for various video services in current optical networks. This paper investigates whether video caching will still remain power efficient in future optical networks. The study compares the power consumption of caching in a current IP over WDM core network to a future network. The study considers a number of features to exemplify future networks. Future optical networks are considered where: (1) network devices consume less power, (2) network devices have sleep-mode capabilities, (3) IP over WDM implements lightpath bypass, and (4) the demand for video content significantly increases and high definition video dominates. Results show that video caching in future optical networks saves of up to 42% of power consumption even when the power consumption of transport reduces. These results suggest that video caching is expected to remain a green option in video services in the future Internet.

Key-Words: - Core optical networks; High Definition video; IP over WDM; Lightpath bypass; Sleep-mode capable equipment

1 Introduction

The number of Internet users has grown to over 2.8 billion users [1] and Internet traffic is expected to exceed 1 Zettabytes (1 billion Terabytes) in 2016 with an annual growth rate of about 21%[2]. In a few years, video content is estimated to account for 80% to 90% of the total IP traffic, and on average one million minutes of video content is projected to cross the Internet every second [3]. Energy consumption is predicted to become the new Internet bottleneck of communication networks. Data centers which mange and provide content are a critical part of the Internet and consume significant energy—up to 70% of the total transmission energy [4]. These alarming figures depict the increasing energy consumption of the Information and Communication Technology (ICT) industry, thus implying increasing associated carbon dioxide (CO_2) emissions. ICT's CO_2 emissions are expected to increase from 0.5 billion tons in 2002 to 1.4 billion tons in 2020 [4], exceeding 3% of global emissions [5]. The possible environmental impacts of the Internet expansion have boosted a global movement towards reducing the CO_2 footprint of ICT.

One successful strategy in video service power reduction is content caching. The main objective of caching is to reduce traffic on the communication path between the data center and users by storing videos closer to the users. Due to their limited storage capacity, caches contain a small amount of the whole video library. As a result, it is important that they maintain the most popular content to maximize traffic served from caches.

Future optical network technologies are overviewed in [6] and [7]. It is likely that future networks will become all optical with intelligent ultra long-haul optical transmission. Future optical networks are expected to implement hardware improvements in laser, transmitter/receiver, amplification and multiplexing technologies [6][7]. The main focus of these reviews and similar studies is the potential increase in network speed and capacity. However, there is still a need to assess the improvements in network performance considering expected growth in carried traffic.

Prior studies have proposed improvements to current optical networks that are expected to reduce power consumption when implemented. The authors of [8] propose a server provisioning strategy for a Video-on-Demand (VoD) service that turns on/off servers with respect to traffic load. This strategy uses a proactive online algorithm to calculate the predicted number of requests at each time. The number of requests is used to