An Efficient Resource Management Method for DASH Streaming in Cloud Environment

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Abstract. Recent DASH streaming system has proved that it can seamlessly adapt to any network condition as well as several of different devices. However, the content servers must do the difficult works such as encoding content, segmenting content which requires high computation resources. Thus, sharing content between servers is crucial to reduce resource consumption as well as improve network services. In this paper, we propose a system to transcode and synchronize streaming content between CDN servers. We use NFV orchestration system to manage network resources and speed up the system response to any request from clients. The experiment shows that the proposed method increases the readiness of the streaming system up to 10% compared to traditional approach.

Keywords: Video Streaming, Dynamic Adaptive Streaming, Content Synchronization, NFV, Orchestration and Management.

1 Introduction

The network today works on heterogeneous devices, such as mobiles, computers, routers and switches. Cooperating these devices sometimes causes vulnerable functions, or system networks work inefficiently. The rise of significant competition from major Internet technology companies, such as Netflix, Microsoft, Skype, and Google has proposed a new way of managing network resources. Network function virtualization (NFV) [1] describes how to virtualize and manage network resources, such as storage and computing in a network. The virtual network functions manager (VNFM) [2] is a fundamental component of the NFV management and organization (MANO) architectural framework. The VNFM works in concert with other NFV-MANO [2] functional blocks, such as NFV orchestrator (NFVO) and the virtualized infrastructure manager (VIM), to increase the interoperability of software-defined networking elements and help standardize the functions of virtual networking. These standard components can increase new feature deployment and help lower costs by providing a standard framework for building NFV applications.

VNFs is an important essential to carry out the business benefits outlined by NFV architectural. In this paper, we exploit the MANO structure to build a video streaming system. The MANO manages streaming servers. It can start/stop a server depending on the current load of the system. In this way, we can manage network resource efficiently.

We arrange the order of articles as follows. In section 2, we present related works. In Section 3, we describe the system in details. In section 4, we present experiment and discuss the results. In conclusion, we present the findings with research directions.

2 Related Work

The authors [3] introduced a novel user-level fairness model UFair and its hierarchical variant UFairHA, which orchestrated HAS media streams using emerging network architectures and incorporate three fairness metrics (video quality, switching impact, and cost efficiency) to achieve user-level fairness in video distribution. Their experiment demonstrated that the design is feasibility for video distribution over future networks.

In the research [4], the authors implemented and evaluated a novel architecture that leveraged the benefits of SDN to provide network assisted Adaptive Bitrate Streaming. They showed that network assistance for both clients and content providers benefited significantly regarding QoE and content origin offloading. They also illustrated the difficulty of the problem and the impact of SDN-assisted streaming on QoE metrics using various well-established player algorithms. Their results showed the substantial improvement in cache bitrates indicating a rich design space for jointly optimized SDN-assisted caching architectures for video streaming applications.

3 System Overview

In the streaming system, we have three main components. First, a DASH management server is responsible for listening requests from clients and directing those requests to content servers based on selecting algorithms. Secondly, an uploading and transcoding server makes uploaded files from clients to DASH content. Finally, DASH CND servers respond requests coming from clients and provide video streaming to clients. Fig.1 illustrates the system overview.

The main server collects measurement information of CND DASH servers to redirect a request from a client to the best serving server at the requesting time. We use seven parameters to evaluate the performance of a DASH streaming server. Regarding local measurement, we have; 1) Working CPU, 2) Free memory, 3) Total memory, 4) Load average. Regarding network measurement, we have; 5) Ping, 6) Throughput upload, 7) Throughput download. It sorts the DASH servers based on these seven metrics. The management server also shares information about the order of the servers for other DASH servers through a synchronization mechanism using a file-sharing protocol such as File Transfer Protocol (FTP). DASH servers use this information for the purpose of retrieving DASH files from other servers in case it does not serve a transcoding request from a client. This technique is a solution for sharing DASH files of a server when it contains a multimedia video while other servers do not have the video content. A server can retrieve DASH files from other servers based on metric information from the available parameters. For example, Server A and Server B has the same DASH video, and Server A is faster than B 25%. If Server C does have the video content, it can get 75% video DASH files from A and 25% DASH files from B.

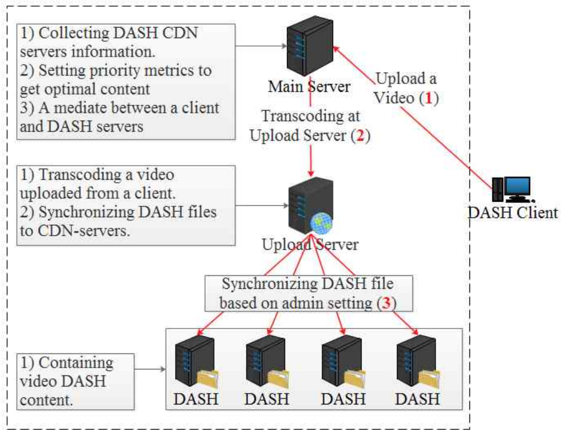

Fig. 1. CDN-DASH Streaming Server System

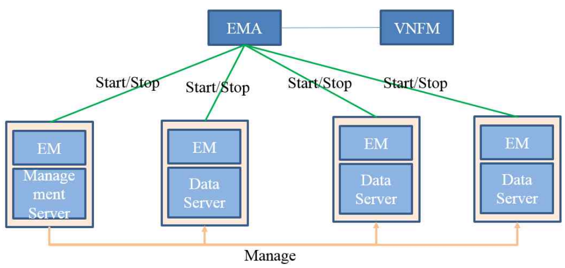

Fig. 2. VNF DASH Streaming System Overview

In the system, we have a VNFM managing other network components, such as Element Management (EM) via Element Management Agent (EMA). As shown in Fig. 2, EMA acts as a router to mediate between VNFM and EM. Each EM manages a particular network component, such as Management Server, Data Streaming Server.

4 Experiment And Result Discussion

We implemented the system in Ubuntu 14.04. Server applications are Node.js-based application. It runs on containerized technology Docker version 1.12. Fig.3 shows the structure of the streaming servers. In the experiment, we use a Docker-based web interface application to test the streaming system. VNFM manages server applications by Docker start/stop command, Element Management Agent (EMA) receives these command and start/stop application correspondingly.

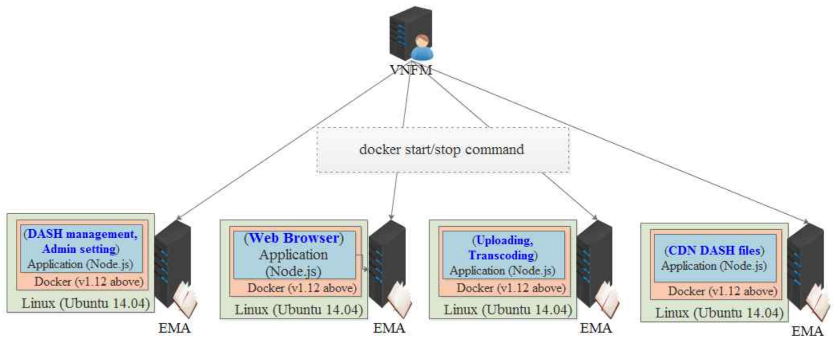

Fig. 3. System Implementation Overview.

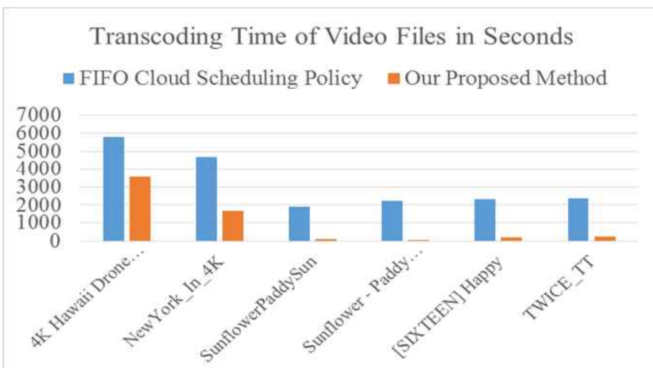

Fig. 4. Comparison of the System using Docker and NFV Orchestrator with FIFO policy.

We arranged three physical upload servers with mediocre performance, two physical CDN DASH servers to provide video streaming. Each server can start several Node.js applications running on Docker. The main server and the client web browser running on a same physical computer but executed on Docker to ensure that it is separate virtualize machines. The client requests to upload video files to the upload servers. These files are transcoded to DASH format. This job requires extensive computation resource. Therefore, the VNFM will start new upload servers if it recognizes that current system cannot respond to client requests. The VNFM can also start new CDN DASH servers if current DASH servers overload upon current requests from clients. In this case, the new starting DASH servers synchronize DASH files to its local disk based on selected metric such as these server sync video files with the most viewed. We upload five videos to the upload server. Our system can share video files once it is available to other DASH servers to reduce computation resources.

In the method illustration, we compared the proposed method with First In First Out (FIFO) scheduling policy [5] in a cloud environment. We ran three DASH streaming server in which one server is a management server and other two act as data servers. As a result in Fig. 4, our method reduced transcoding time significantly compared to existing methods.

5 Conclusion

In this paper, we proposed the system which is based on network virtualization technologies such as NFV management and organization. We then used Docker container which is a containerized technology to virtualize the system as a cloud. We also implemented of DASH streaming using MANO architecture. The result of the experiment showed that our proposed system increased the readiness of the system up to 10% compared to FIFO policy in the cloud environment. In the future research, we tend to reduce space for DASH content in the CDN.

Acknowledgments

This research was supported by the IT R&D program of MSIT(Ministry of Science and ICT),Korea / NIPA(National IT Industry Promotion Agency) 12221-14-1001, Next Generation Network Computing Platform Testbed, and also was supported by the MSIT(Ministry of Science and ICT), Korea, under the ITRC(Information Technology Research Center) support program(IITP-2017-2016-0-00314) supervised by the IITP(Institute for Information & communications Technology Promotion).

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