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Towards an Enhanced Quality of IPTV Media Server Architecture over Software Defined Networking

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***Abstract*—**The aim of this paper is to present the QoE (Quality of Experience) IPTV SDN-based media streaming server enhanced architecture for configuring, controlling, management and provisioning the improved delivery of IPTV service application with low cost, low bandwidth, and high security. Furthermore, it is given a virtual QoE IPTV SDN-based topology to provide an improved IPTV service based on QoE Control and Management of multimedia services functionalities. Inside OpenFlow SDN Controller there are enabled in high flexibility and efficiency Service Load-Balancing Systems; based on the Loading-Balance module and based on GeoIP Service. This two Load-balancing system improve IPTV end-users Quality of Experience (QoE) with optimal management of resources greatly. Through the key functionalities of OpenFlow SDN controller, this approach produced several important features, opportunities for overcoming the critical QoE metrics for IPTV Service like achieving incredible Fast Zapping time (Channel Switching time) < 0.1 seconds. This approach enabled Easy and Powerful Transcoding system via FFMPEG encoder. It has the ability to customize streaming dimensions bitrates, latency management and maximum transfer rates ensuring delivering of IPTV streaming services (Audio and Video) in high flexibility, low bandwidth and required performance. This QoE IPTV SDN-based media streaming architecture unlike other architectures provides the possibility of Channel Exchanging between several IPTV service providers all over the word. This new functionality brings many benefits as increasing the number of TV channels received by end –users with low cost, decreasing stream failure time (Channel Failure time < 0.1 seconds) and improving the quality of streaming services.

***Keywords*—**Improved QoE, OpenFlow SDN controller, IPTV service application, softwarization.

I. Introduction

IPTV is a method of delivering TV content to end-users. Hence it is a paid service, end-users require to deliver in real-time audio and video IPTV Streaming services with high quality, low bandwidth, low cost and in high-security manner. Consequently, the IPTV Providers' interests are involved in assuring high QoE for real-time end-to-end services and at the same time increasing their revenue. Software-defined Networking (SDN) approach is a rich solution for managing the real-time video streaming services. Through the continuous improvement of the SDN Controller, recently it is made possible to simplify the configuration, control, and management of the channels through MNG Web interfaces.

Many virtualized SDN Controllers can collaborate to each other to increase the scalability of the management solution between multiple domains all over the world. By doing this, is performed the delivering of video content to thousands of the end-users continuously and in high delivered QoE. The QoE IPTV SDN-based Media streaming architecture presented in this paper consists of QoE Management enabled by OpenFlow SDN controller to meet the performance requirements of the IPTV Multimedia service. Through the Load Balancing Systems, this flexible approach offers the high possibility to increase the security of the delivered IPTV Streaming Services. Through the Network Function Virtualization (NFV) [1], it is made possible to increase the security of Streaming resources, interactivity, and level of reliability which are required on top of Managed IPTV SDN Networks. Years ago, it was not possible to transmit HD or full HD channels due to the high required bandwidth 10-15 Mbps. Now by easy using Transcoding techniques keeping the same QoS (Quality of Service), the delivered video streaming is achieved within 2-3 times lower bandwidth

The rest of this paper is organized as follows: In Section II, we present the related works. In Section III, we present the innovation of building a Virtual QoE IPTV SDN-based topology. Then, Section IV presents the QoE IPTV SDN-based Media Streaming Architecture, and it is followed by the key functionalities of OpenFlow SDN Controller in Section V. Lastly, Section VI summarizes the conclusions.

II. Related works

IPTV Service provider's offer the virtual TV channels through the usage of SDN networks by virtualized network functions and implementing new supporting protocols to target multimedia applications (IPTV Service Application). In such a way, they improve the performance and QoE of end-users. Reference [2] have proposed an SDN QoE Architecture for enhancing the performance of Over-the-Top Applications. Based on the QoE modeling, monitoring and Steering, this SDN-based QoE architecture guarantees the required QoE level for real-time on demand services. It offers advanced treatment to premium end-users and exploits different Business models based on Enhanced QoE Service. Reference [3] proposes a management platform which is able to enhance the QoS and the QoE of the multimedia applications. This platform guarantees the quality level requirements for Multimedia services over SDN. A QoE Softwarized SDN-enabled, NFV-based control, and management architecture is proposed in [4]. This architecture aims to offer flexible networking and configurable approach for QoE Provisioning to end users through the integration of SDN and NFV. This QoE-aware SDN-NFV architecture implements QoE policies and new techniques in SDN Controller for QoE controlling of

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delivered multimedia applications over 5G Networks.

III. The Innovation of Building a Virtual QOE IPTV SDN-based Topology

Fig. 1 presents a virtual QoE IPTV SDN-based topology to provide an improved IPTV service based on QoE entities. The Control and Management of multimedia services are performed through a well-defined SLA (Service Level Agreement) or an innovative orientation based on ELA (Experience Level Agreement) [5]. IPTV service is offered by two IPTV Multi Media Server hosted geographically in different places (TV1.IPTV.Net and TV2.IPTV.Net.

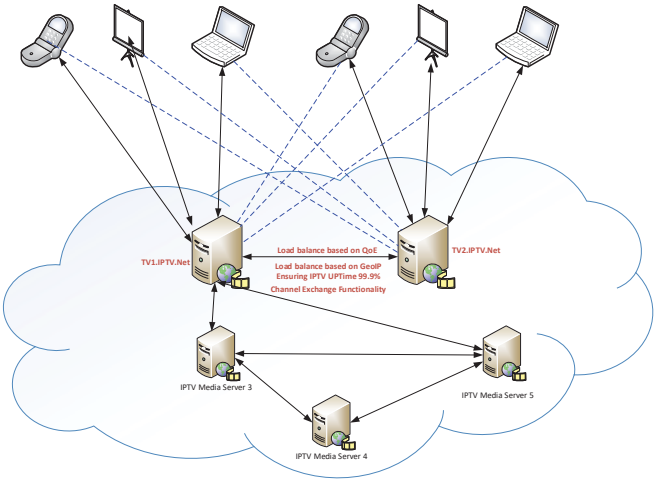

Fig. 1 An improved virtual QoE IPTV SDN-based Topology

This two Multi-Media Streaming Servers interact with each other and act virtually like a single server making possible the establishment of end-users according to well pre-defined rules. Also, these Media streaming servers realize with high-efficiency Load –Balancing based on GeoIP Coordinates and Load – Balancing based on QoE Module. For example, the IPTV end-user connects with the pre-defined Root Media streaming server specified from the IPTV Provider. This root server receives the request by the IPTV end-user which owns an IP address. It stores this IP in Nginx web server. Through GeoIP Database, it is performed the translating of this IP address to certain geographical coordinates. After receiving these results, Root Media Streaming server analysis distance of this IPTV end-user from the other streaming servers in Network. After this step, it decides definitely to connect the end-user with the near server, in short distance between them ensuring the delivery of IPTV Service with high performance and high QoE. Also, these two servers serve to each other like Backup servers by increasing the security of delivered IPTV Service. In this virtual QoE IPTV SDN-based topology, it is achieved a decreased distance connection between IPTV end-users and IPTV Server achieving:

- An improved delivery performance of QoE IPTV service,
- Reduced signaling delays due to traffic localization and good synchronization
- High throughput, low transmission time, low Jitter, low propagation delay and reduced congestion effects, etc.

Also, this two servers can act as clients of the other IPTV Servers (IPTV Media Server 3, IPTV Media Server 4 and IPTV Media Server 5) performing the Exchange of the channels between IPTV Providers. This new functionality added, offers benefits like delivering of channels with low cost and in high number. Through it, it is made possible to ensure two or three IPTV Sources for one channel increasing the uptime greatly for each Source channels in 99.99%.

IV. QoE IPTV SDN-based Media Streaming Server Architecture

Fig. 2 presents the QoE IPTV SDN-Based Media streaming server architecture which takes into consideration the softwarization advantages by using principles of SDN and NFV. It is focused more on QoE Management functionality powered by OpenFlow SDN Controller in order to meet the key performance requirements. In our approach, OpenFlow SDN controller is used to allocate paths and provide connectivity dynamically acting as an enabler of network virtualization. The Media streaming server consist of five important blocks which must be able to satisfy the requirements as:

- To handle multiple audio and video formats;
- To allow thousands of users to stream in parallel;
- To accommodate thousands of viewer requests;
- To be flexible, adaptable and scalable;
- To allow users to store video;
- To convert videos to high-resolution and low-resolution alternatives;
- To maintain a list of active streams in real time;
- To track device, resolution and connectivity quality;
- To perform real-time monitoring and Network Management;
- To ensure QoE Monitor, QoE Control and QoE Management of delivered IPTV Service Application in perceives of end -users;
- To check user access details before enabling streaming;
- To ensure port availability for incoming streams.

To fulfill these requirements, this Media streaming server must be able to accept communications from end-users and also to communicate with Web Application. This is achieved by utilizing libraries and Application that support the integration of these components. Mainly Media streaming servers operate in a Linux environment that provides a graphical user interface (MNG GUI) for users to manually connect streams to the system. They offer IP audio/video streaming using a multi-protocol, low latency streaming server platform.

A. Socket IO

Socket IO is a cross-browser web socket library for supporting real-time applications. The library is developed using JavaScript and allows for real-time communications in all browsers and mobile devices.

B. Node.JS

Node.js is a platform built on Chrome's Javascript runtime and is an event-driven, non-blocking I/O model enabling data-intensive real-time applications across different devices. Through using Node.js, we profit one of the predominant advantages that are the ability for the application to prevent deadlocking allowing concurrency and multi-threaded processing: It can also be used as the sole server application which serves HTML content to browsers as opposed to Apache and Nginx.

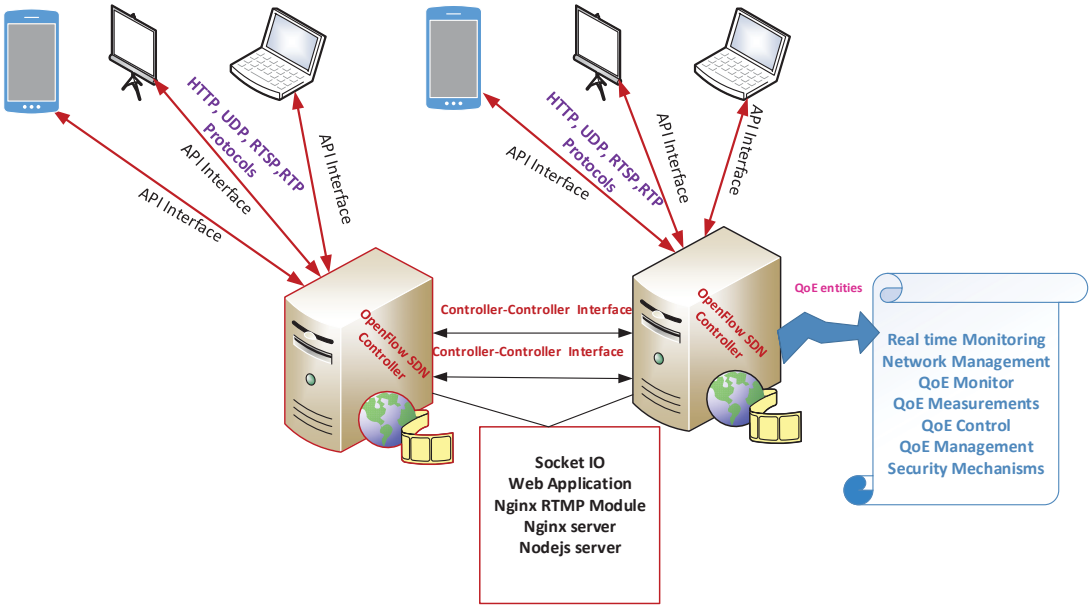

Fig. 2 An Enhanced QoE IPTV SDN-based Media Streaming Server Architecture

C. Web Applications

All end user will need to experience live updates of video feeds in accordance with the type of stream being broadcasted. The prime functionality determined previously is fulfilled by using a suitable set of technologies to allow the communication between the streaming server and the web application. Through a web application, IPTV users will be able to observe streams as they are retrieved from mobile devices, TV or PC using media player. The web application will need to be able to display live feeds across multiple devices. It allows for the broadcasting of varying types of media formats such as WebM, MP4, OGG, and Flash.

D. Nginx Server

Nginx is a web server similar to APACHE which allows system and web administrators to deploy websites. In our Media Streaming server architecture, there is used Nginx because it is able to scale easily on minimal hardware and it utilizes light-weight recourses. It is responsible for providing under load with high resources efficiency static contents and to pass dynamic requests off to other software very quickly. Also, the most important feature of this server realizes Load-Balancing across multiple application instances.

E. Nginx RTMP Module

Nginx RTMP Module is a plugin which is integrated into the Nginx engine that enables live streaming through the RTMP protocol in Adobe Flash format in the predominant delivery format. This module performs live streaming as well as broadcast video on demand. It guarantees the delivery streaming services like IPTV, VoD, VoIP, Video Conferencing, Video Telephony, etc. in high quality that the other open source formats are not capable of. The Nginx RTMP module depends on a framework that is able to capture video on demand or live streams and forward the streams to the server. This requires capturing streams from any device or input format and forward the streams to the Nginx server. For this task, it was very important to choose FFMPEG encoder. It simply acts as the application that connects incoming streams to the streaming server with the flexibility to choose how the stream is handled. FFMPEG encoder is a powerful solution that allows users to record, convert and stream audio and video. It provides functionalities such as encoding, decoding, and transcoding with support for antiquated and current formats. It is composed of several libraries that include decoders and encoders for audio and video codecs, input device grabbing, media filters, image scaling and audio resampling. It is able to customize factors such as streaming dimensions, bitrates, latency management and maximum transfer rates. By doing these, it ensured the flexibility and required performance of the delivered streaming services in low bandwidth.

Through the analysis of streaming services, it is observed that FFMPEG and Nginx RTMP module fulfill the functional requirements. They provide greater control over the streaming process with heavy customization. Now the mobile application can send live streams to FFMPEG which will capture the incoming stream and forward the output to the Nginx RTMP module. Also, end-users will need to be able to see updated

video feeds in real time whilst observing a stream.

One of the most important functions of a Media Streaming Server is the ability to stream audio and video to a streaming server. Streaming involves the transfer of video and audio content over a network using a network protocol such as HTTP, UDP, RTSP (Real Time Streaming Protocol) or RTP (Real Time Protocol) [6]. In addition, the video and audio being captured must be encoded in the desired format such as H265/H264, H263, MP4 for video and AAC, FLAC or MP3 for audio.

The communication between the end-users and the Media streaming server (OpenFlow SDN Controller) is realized via a programmable Application called API interface. This interface is used for streaming audio and video over a network using the necessary protocols.

In our QoE IPTV SDN-based Media streaming architecture, the OpenFlow SDN controller enables the delivery of multimedia services with optimized or Acceptable QoE. In our Media streaming server exist two OpenFlow SDN Controllers because the single controller architecture does not scale well when the network is large. All over the world, delivery of real-time entertainment (video and audio streaming) through current Internet is tremendous increased. In this way, it is also needed to increase the number of the OpenFlow controllers placed in the network. They communicate with each other through the interface Controller-Controller interface, which allows controllers to share the necessary information to manage the whole network cooperatively.

V. The New Key Functionalities of OpenFlow SDN Controller

In our QoE IPTV SDN-based media streaming architecture, the OpenFlow SDN controller enables the delivery of multimedia services. SDN controller plays a key role by involving very mechanisms for QoE enhancement of Multimedia services like IPTV Service Application, VoD, VoIP, Video Conferences, and Video Telephony, etc.

The QoE control and management of multimedia services in different network domains will be made through SLA or QoE ELA [5]. The QoE Monitoring and QoE managing module perform the QoE estimation and measurements per multimedia traffic flow. They acquire network topology information and implement QoE-based network policies like traffic prediction, admission control, load balancing and user density prediction.

The new key functionalities added on this OpenFlow SDN controller are as follows:

- It offers Unlimited Streams allowing unlimited Users through Authentication to deliver Application streaming services;
- It supports Live Streams, VOD, Radio, YouTube, Lives tramer, Twitch and many other video platforms;
- It performs Load Balancing (Server Load Based, GeoIP Based, ISP Based);
- It builds Connection Anti-Drop on stream failure;
- It offers Easy and powerful Transcoding System;
- It supports all common streaming protocols (HTTP, RTMP, RTSP, RTP, UDP, MMS);
- It is able to support security methods like Fingerprint Sender;
- It offers Concurrent Connection limitation, ISP, and Country Locking;
- It gives possibility to create your Own Live Channels by combining multiple videos;
- It achieves Fast Zapping time < 0.1 Seconds;
- It appears powerful Logging, Statistics and Connection Logs and Client Speed;
- It supports MAG Devices, (Stalker Portal Built In), Enigma2 Plugin, Android and iOS and others.

VI. Conclusion

In this paper, we present a Novel QoE IPTV SDN-based Media streaming server Architecture which improves greatly the delivered QoE of Multimedia Services. This architecture makes possible to deliver IPTV Service with low cost, low bandwidth, high quality and also high security. The aim is to achieve an improved QoE IPTV service application delivery through the fulfillment of the QoE Application requirements. This novel approach through OpenFlow SDN Controller provides new features, new functionalities to achieve a high QoE performance and quality of IPTV Service. Unlike other architectures, this enhanced QoE IPTV SDN-based media streaming server architecture brings new innovations like:

- Through OpenFlow SDN Controller it enables QoE Monitoring, QoE Measurements, QoE Control and QoE Management to meet the performance requirements of the IPTV Multimedia service
- This approach provides an improved QoE IPTV service delivered performance using Load balancing based on GeoIP Coordinates
- For the first time, it is made reality the process of Channels Exchange between two Media streaming servers. This new functionality increases the number of delivered channels with low cost and the uptime of the Source channel in 99.9%.
- Achieves insignificant Fast Zapping time (Channel Switching time) <0.1 seconds.

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