Fast and Easy Live Video Service Setup Using Lightweight Virtualization

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ABSTRACT

The service broker provides service providers with virtualized services that can be initialized rapidly and scaled up or down on demand. This demonstration paper describes how a service provider can set up a new video distribution service to end users with a diminutive effort. Our proposal makes use of Docker lightweight virtualization technologies that pack services in containers. This makes it possible to implement video coding and content delivery networks that are scalable and consume resources only when needed. The demonstration showcases a scenario where a video service provider sets up a new live video distribution service to end users. After the setup, live 720p30 video camera feed is encoded in real-time, streamed in HEVC MPEG-DASH format over CDN network, and accessed with a HbbTV compatible set-top-box. This end-to-end system illustrates that virtualization causes no significant resource or performance overhead but is a perfect match for online video services.

CCS CONCEPTS

• Information systems → Multimedia streaming; Multimedia content creation; • Networks → Cloud computing;

KEYWORDS

Virtualization, Dynamic adaptive streaming over HTTP (DASH), High Efficiency Video Coding (HEVC), Hybrid broadcast broadband TV (HbbTV), Content Delivery Network (CDN), Docker

1 INTRODUCTION

Content Delivery Networks (CDNs) are broadly used for improving the speed, accuracy, and availability of delivered content in the Internet. Today, CDN also plays a key role in video service provisioning, as Adaptive HTTP-based video streaming has become the most dominant technique to deliver video content over the Internet. In adaptive HTTP streaming, such as MPEG-DASH [8], the stream is split into short segments. A media presentation description (MPD) file is used to tell the client where to get the segments. The client requests and seamlessly plays the short segments of the original stream defined in the MPD. To support adaptation, the MPD includes several representations and the client can switch dynamically between the available representations on a per-segment basis. This means that an encoder has to produce multiple versions of a single video.

Hybrid broadcast broadband TV (HbbTV) is intended to enable the users to access both broadcast and broadband content directly with the TV set in a seamless and user-friendly manner. HbbTV is both an industry standard [4] and a global initiative to aim at harmonizing the broadcast and broadband delivery [5]. MPEG-DASH is part of the HbbTV specification and stated to be the main streaming format for both live and Video on Demand (VoD) content.

Traditionally, services related to video delivery such as video encoding and CDNs used to run over specialized hardware, typically placed inside the service provider premises. With the emergence of the cloud platforms and lightweight virtualization such as Docker [1], video services can be implemented in a way that they can be started rapidly, scaled up or down, or moved to another computing platform. Docker containers allow a lightweight virtualization of a smaller or larger component with very little computing overhead. In [10], Docker performance was compared against virtual machines (VM) for cloud gaming systems and containers had lower overhead despite of VM-related optimizations. In [6], Docker related technologies have been studied in terms of supported functionalities. Several managing suites for Docker containers are listed, one of which is Rancher [11] with an integrated Docker-based service catalog for application deployment.

This work showcases a demonstration where live MPEG-DASH video distribution service is set up using available virtualized applications. After the setup, the encoder encodes live camera feed in HEVC format and encapsulates video to MPEG-DASH format. The
encoder pushes video content to the CDN that delivers the video content to the HbbTV client for playback.

2 SYSTEM OVERVIEW

The demonstrated system consists of a service broker, a video encoder, a CDN, an HbbTV platform, and a MPEG-DASH client. The overview of the system for fast and easy video service setup using lightweight virtualization is presented in Fig. 1.

2.1 Service Broker

The Service Broker (SB) is responsible for 1) brokering the services; 2) receiving and storing the service specifications; 3) accounting available services and their resource consumption; and 4) requesting deployment or undeployment of the services. The overview of the SB is presented in Fig. 2.

Service brokering and orchestration have been developed based on Rancher [11] and Docker Registry [2]. Rancher enables running and management of Docker and Kubernetes-based services. Rancher includes infrastructure orchestration, container orchestration and scheduling, application catalog, and enterprise-grade control. Rancher can be integrated with computing resources in private or public clouds.

In our setup, we had three Linux hosts in our Rancher infrastructure, which allows users to create their own private application catalog for own applications. In this work, we created a private catalog where we added a video encoder, an origin server, and an edge server applications. We stored Docker images of the applications to Docker Registry which distributes the images to hosts when the user launches the application in Rancher.

2.2 Video Encoder

The video encoder component generates MPEG-DASH content from a raw input video with a given encoding parameters. The input video can be either a live feed from a camera or an offline video file. The encoder pushes the encoded video segments and manifests file uplink to the origin server. The proposed system supports three open-source encoders: x264 [13] for H.264/AVC video coding and x265 [14] or Kavazaar [12] for H.265/HEVC video coding. This work uses Kavazaar [7] via FFMpeg. The encoder is containerized using Docker and added to our private Rancher catalog.

2.3 CDN

The CDN in the system contains the origin server and the edge server. The encoder encodes the video, packs it into MPEG-DASH format, and pushes it to the origin server. The origin server listens HTTP POST request and stores segments and MPD files.

In this work, the origin server listening is based on Eclipse Jetty [3] and the serving of the live video files is based on Nginx [9]. When a client requests video from the CDN, the edge server distributes video to the client. If the requested data is not available in the edge server, it requests the data from the origin and forwards it to the client. The edge server stores the requested data for a certain time according to its caching rules. The edge server is based on Nginx.

The origin and the edge servers are containerized using Docker and they are added in our private Rancher catalog.

2.4 HbbTV Platform

Sofia Digital’s Sofia Backstage® HbbTV platform provides all the necessary HbbTV functionalities to HbbTV compatible TV receivers in DVB network. Platform back-end components are virtualized using Docker containers and they can be scaled up or down easily. In this demonstration, a video application is created and published to HbbTV receivers with Sofia Backstage® Author. The application is placed on Sofia Backstage® HbbTV platform server.

2.5 Video Client

One HbbTV application is made available for the demonstration. The application contains a hypertext link to MPEG-DASH video stream that is delivered through the CDN network. Vestel T9110 set-top-box (STB) running the application presents HEVC encoded live MPEG-DASH video stream. The firmware of the STB has been updated to support HEVC encoded MPEG-DASH video (profile: urn:mpeg:dash:profile:isoff-live:2011, dynamic). The adaptive streaming is handled at the browser layer running on the STB. The browser gets stream chunks and injects them into the driver layer in the form of elementary stream. Finally, the STB sends the decoded content through HDMI to a TV.

3 DEMONSTRATION

In the demonstrator, the SB brings virtualized services or applications available for a video service provider (VSP) in order to start new services rapidly or scale services up and down using a private catalog. The catalog contains the live video encoder, the origin server, and the edge server. The encoder encodes live camera feed using HEVC format and encapsulates live video to MPEG-DASH format. The encoder pushes MPEG-DASH segments and MPD file to the origin server as soon as they are ready. The CDN consists of the origin server that receives MPEG-DASH files from the encoder and an edge server that delivers video content to the clients. The live MPEG-DASH streams are delivered via CDN to HbbTV and played back by HbbTV application that uses STB to decode live MPEG-DASH HEVC stream.

3.1 Scenario

This demonstration shows a scenario where VSP sets up a new video distribution service to stream a live event to end users. The new service is constructed and launched using a SB, which maintains a catalog of the applications. The service provider selects appropriate applications from the SB’s catalog. The applications are deployed to the desired environment.

The service creation contains the following steps:

1. VSP selects the CDN from the SB's catalog
2. VSP selects configuration requirements for the CDN and hosts 1 and 2 (see Fig. 2) where CDN components are deployed
3. SB creates the CDN and deploys them into the selected hosts 1 and 2
4. VSP selects the live encoder from the catalog
5. VSP selects configuration requirements for the live encoder and host 3 (see Fig. 2) where encoder is deployed
6. SB creates the live encoder and deploys it into the selected host 3
After these seven steps, the service is up and running. End users can access and use the services smoothly. The running service contains the following steps:

1. Real-time Kvazaar HEVC encoder compresses live 720p30 camera feed into one or two bit streams
2. The encoder packs the bit stream to MPEG-DASH format and pushes the video segments and MPD file uplink to the origin server
3. An end user opens an HbbTV application and opens a link to the live video
4. The end user watches the live video from TV

Finally, the live video event ends and the VSP switches off the service using SB’s user interface.

4 SUMMARY

This demonstration paper showcased a scenario where video service provider sets up a new live video distribution service to end users. After the setup, live 720p30 video camera feed is encoded in real-time, streamed in HEVC MPEG-DASH format over the CDN network, and accessed with an HbbTV compatible STB for playback.

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REFERENCES