University of Victoria

Faculty of Computer Science

CSC 461 Final Course Project Report

What is Internet streaming and how it works

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Introduction

With the significant development of the information networks, internet streaming has become more and more widely used in our daily lives. Not only because of it is one of the most important application of multimedia system, but also for it's considerable contribution that changes people traditional way to live. Streaming is important to us since it is used to transfer data and information through the internet and allow users to watch content using different platform applications.

Technically, streaming is considered as a one-to-many relationship that is a live broadcaster. When streaming starts, the broadcaster will firstly push the encoded from the Open Broadcaster Software to the platforms. The term Real Time Messaging Protocol is used for the data transmission between the platform and the server. After that the platform will then transmit the streaming content to the client side application to enable watch. Through the whole streaming process and concepts, we will then discussed each important terms and concepts in very specific details that will be used during the streaming process includes bitrate, ingest, egress, CDN, transcoding, transmuxing and instances.

The main problems of Internet streaming is that the physical distance among the broadcaster, platform and viewers; the platform needs to buffer the streaming data before sending to the viewers; and the platform player should include some features to improve the quality of service. After solving these issues above, the Internet streaming can be physically achieved.

For the future work, we still need to improve on the delay that caused from the physical distance between the platform server and the client side. Furthermore, with more and more streaming applications been developed, they also will work on supporting multiple video formats and users' network autodetection for the best suitable video quality. The problem of much more rate of flow will be better solved.

Why streaming is important

Nowadays, internet streaming is considered as one of the most important application of multimedia systems all over the world. It makes huge contribution for changing people's way from work, study, and entertainment. It is important to understand that streaming is the technology that transfer datas and deliver contents through computers and mobiles over the internet and allows audiences to watch the streaming content anywhere within the internet connection.

Streaming is also one of the most convenient and quickest way to access internet-based content. For instance, a brief example from our daily lives can be watching live TV shows on whatever devices you like other than just the TV if there is the internet connection within that area. Therefore, the advantage of steaming can be that the it is not required to be previously download before you start watching the video, which is much better compared to progressive downloads that has been used in the past years. Moreover, for the traditional downloads, it might leave the huge amount of data or cache on your computer if you don't delete them. But for the streaming, the extra amount of data and cache will be automatically deleted.

It is well known that streaming has usually been used to deliver audio and video contents until Apple has developed and implemented the new technology called on-demand resources which will allow stream to work with games and apps too. To be more specific, it provides applications with set of core features or even functions for the user to firstly download the video and then stream new content when they need.[1]

Lastly, streaming also has variety of applications in different aspects. Streaming applications will provide many benefits from centralized management. With the streaming application, it then comes with big amount of associated files and data. When the streaming application is requested, only certain amount of associated data will be downloaded instead of all components. If it is needed, the remain data can be downloaded as background until it finishes. When all parts are completely downloaded, the streaming application won't require any other network connections.[2]

How streaming works

Theoretically, Streaming is a one-to-many relationship that is a live broadcaster, corresponding to a lot of people watching. From a holistic architecture, there is a push-end who is sending the real-time video or audio and many pull-ends who is receiving the live video.

Technically, the broadcaster can directly push real-time video to each viewer, but it will face many problems:

- If the bandwidth of broadcaster sufficient to support enough playback terminals.
- If the broadcaster can directly connect with viewers.
- How to manage and surveillance the streaming?

Therefore, we usually introduce an intermediate platform who the broadcaster pushes the stream to. Then, the intermediate platform will pull back the stream to many viewers. Thus, our simple network from one-to-may becomes to a new network from one point to another, and from another point to multiple points. However, we need a more complex topology in reality, but until now, we have treated the intermediate platform as a point for the sake of convenience.

Firstly, from the broadcaster to platform, the broadcaster pushes the encoded video from the Open Broadcaster Software (OBS)[9] to the platform over the Internet. Normally, the Real Time Messaging Protocol (RTMP)[10] is used during the data transform. RTMP is developed by Adobe for audio, video and data transmission between the Flash/AIR platform and the server. And RTMP is based on TCP and includes various variants such as the RTMP basic protocol and RTMPT/RTMPS/RTMPE. In the RTMP protocol, the video must be H264 encoded, the audio must be ACC or MP3 encoded, and the packet is mostly encapsulated in flv format. RTMP is currently the most mainstream streaming media transmission protocol because it has good support for CDN and low implementation difficulty. Therefore, RTMP is the best choice of most intermediate platforms.

Then, essentially, the platform will transmit the streaming video to its website or application for allowing the viewers to watch. People no longer use the RTMP during this part of transmission because the biggest disadvantage of RTMP is that the browsers are not supported and Adobe is no longer updated. It needs an additional protocol to support the browsers. Therefore, the Http Live Streaming (HLS)[11] protocol is introduced.
HLS is an HTTP-based real-time transport protocol defined by Apple. Its principle is to divide the entire streaming data into many small files to download. The server will generate a new small file from the latest data and the platform will broadcast the file as long as it continuously plays the files obtained from the server. Basically, HLS experiences an on-demand technology. The platform can quickly switch the bitrate to accommodate the playback under different bandwidth conditions because the duration of each small file is very short.

Basic concepts of streaming

In Order to better understand streaming techniques, some important basic concepts and terms should not be ignored. In this sections, we will go over each terms that used in the streaming concepts with sufficient details and explanations. These important terms and phrases include bitrate, Ingest, egress, CDN, transcoding , transmuxing and instances at the end. When we finish setting up the live streams in the streaming platform cloud engine, the different number of statistics will then be provided like in and out bound bitrate. We already mentioned that bandwidth states the upload and download speed of the network during streaming.

Talking to the bitrate, it is for representing the throughput of the streaming that the user is receiving and also the amount of data that is been sent to the internet per each second. Therefore, bitrate is important terms during the internet streaming since that the higher bitrate we have, the better video quality will be provided. Moreover, discussing the bitrate, it also comes with the adaptive bitrate streaming, which states that the video quality will be automatically adjusted by the bitrate on the following current network conditions. You might not so familiar with this term, but when the video quality drops and becomes sharper during the internet streaming, it will then be very commonly observed on the video streaming platforms.

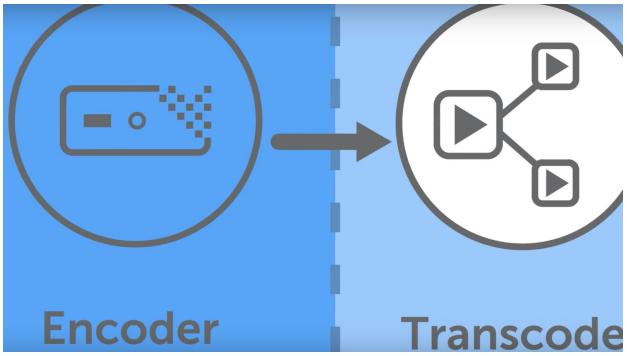

Figure 4.1- Transcoding process [3]

Next step move up to the transcoding, in order to allow video from the regular carema to be streamed, the video needs to firstly be converted to a form of data which the computer can understand. So this process of conversion and transmission is called transcoding. To be more specific, during the streaming process, the conservation states that convert from basic cameras PL and ntsc to the format that computer can read and understand like mp4, mov, and rmvb, etc. furthermore, the data can be treated as computer type of language. Therefore in this case, it is obvious that different computer programs will require the video to be translated

into different languages for different version of devices and platforms. So the transmuxing, is the process of changing that video from one type of language into another type of language. The transmuxing is important and should not be ignored during the video streaming since the different devices will require data to be delivered into multiple formats and types.

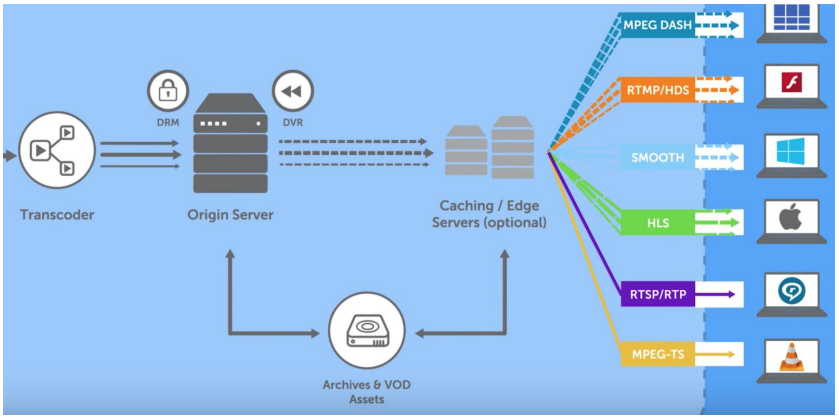

Figure 4.2- Transasdmuxing process [4]

For the streaming engine, in order to allow the engine to be worked, we need the application to be placed and lived somewhere. So we introduce the instance, the instance is just simply a computer or server that is set up to do a specific job. As in our case of internet video streaming, the instance is just like a server that is telling the applications to receive and send stream from one location into another specific locations. Therefore, it is obvious that the more specific locations uses we need, the more internet streaming instances will be required.

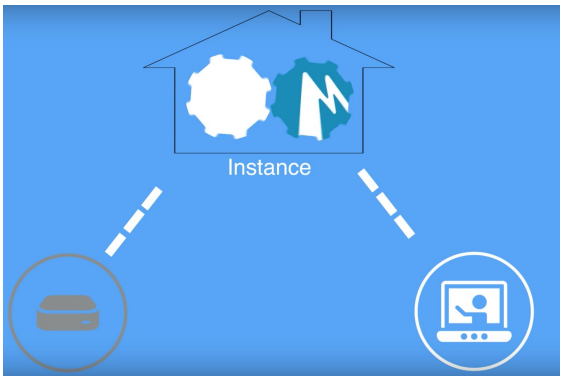

Figure 4.3 - Streaming Instances [5]

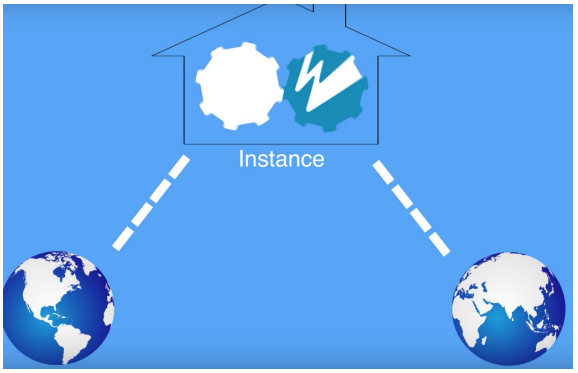

Figure 4.4- Instances examples[6]

Lastly, for the ingest and egress are used to measure different concepts. To be more specific, ingest is used to measure the total amount of data that has been received during the internet streaming. Corresponding, egress is the term that used to measure and calculate the total amounts that has been sent without time is set up to a factor. Similarly, the CDN, which is the content delivery network is especially the series of servers that has been placed around different locations in the world with extremely fast internet connections which enable users' contents to be delivered. The advantages of this is that we don't need to care too much about our current network conditions since CDNs has huge amount of different servers in many different places that connected with high speed network which will also increase the potential speed for receiving the contents.

Main issues and solutions

During the streaming data transmission among the broadcaster, platform and viewers, many issues are appeared and solved to form the streaming chain for nowadays. Considering the broadcaster to platform:

1. The long physical distance between broadcaster and platform will cause obvious delay or bad network status.
2. The platform need to buffer the streaming data before broadcasting to viewers.

For the first issue mentioned above, generally, the platform sets up many physical receiving nodes all around the world. So, the broadcaster is able to select the most nearby node to transmit the streaming data. By this way, the physical distance will be decreased to achieve a faster network connection. For the platform, it is possible to quickly push across some area by setting up a dedicated line and other schemes to alleviate the relatively serious delay caused by long-distance transmission.

For the second issue, normally, the platform has to update the computer hardware to allow the platform handling such a computing power. Technically, the platform can also use some software or algorithms to ease the issue. For instance, platform with enough computing power can easily set up a larger buffer zone, or many other buffer zones to accelerate the transmission speed.

For the part between the platform and the viewers, there are also two main issues:

1. The physical distance causes the delay and decreased the viewers' quality of service.
2. The platform player should include some features to improve the viewers' quality of service.

Generally, the platform uses CDN nodes to solve the first issue. The streaming data on the platform is transmitted to the CDN node through a relatively large bandwidth and low latency line. Then, the viewers select the nearby CDN node to pull the streaming data. This transmission process is very similar to the transmission from the broadcaster to the platform but in the opposite direction. Considering the features that viewers can have during watching the stream, the most important one is changeable resolution. The viewers can change their streaming video's resolution by themselves to fit each of their bandwidth. As we have talked above, the HLS allows the platform to quickly switch the bitrate so the resolution can be switch from viewer's point of view. For the second feature, the platform can decide the best CDN node for each viewer by two ways. For the one, the platform will check the pings from viewer to each CDN nodes, and then picking the one with the lowest ping. For the other, the platform can use DNS or IP to check the around physical location of the viewer, so the CDN node that the viewer connect with will depend on the physical location. There are also some features like 'pause' and 'play', that need the platform to buffer the entire video data to make an achievement.

Possibly Future work

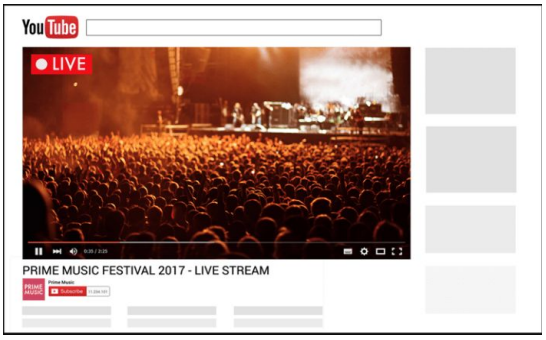

Figure 7.1 - Youtube streaming example[7]

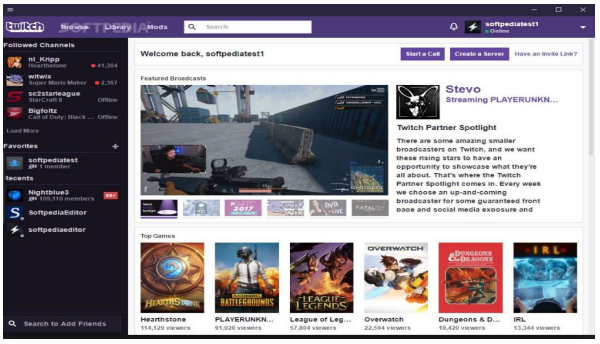

Figure 7.2 - Twitch streaming example[8]

Furthermore, with time passed by, more and more live streaming platforms and streaming mobile apps will be developed. Some identical features will be added like for instance, those streaming platforms and apps might add some transcoding functions like adding company copyrights and brands at the screen corner (like youtubes ,twitch and so on). Besides, some application can better support multiple video formats for different audience devices just like mp4, mov, rmvb and so on. Lastly, at the same time, the video quality is also associated with the client side network speed. To be more specific, it will then auto detect the client side internet speed and choose the best video format quality for the audience.

Conclusion

With the improvement and solutions of the issues of the streaming chain, the updated PC hardware for ordinary people, and the increased Internet bandwidth, the Internet streaming media is form to nowadays streaming. Also, the streaming is influencing more and more people's daily life all around the world. Nowadays, the video-gaming streaming is very popular, people can watch the streamers playing games in real time to entertain themselves. Many companies are using streaming to collaborate the workers around different countries and places. In conclusion, the Internet streaming is changing the world in many different ways. So, it is very important for people to understand the principle and method of Internet streaming.

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Figures

[3]https://www.google.ca/search_concepts

[4]https://www.google.ca/search_concepts

[5]https://data-artisans.com/what-is-stream-processin

[6]https://data-artisans.com/what-is-stream-processin

[7]https://www.lightcast.com/youtube-livestreaming/

[8]https://www.twitch.tv/

Other Resources

https://help.twitch.tv/customer/portal/articles/2420572

https://help.twitch.tv/customer/portal/articles/1253460-broadcast-requirements

https://www.adobe.com/devnet/rtmp.html

Working Portion

Lambert Su: 55% Lingyao Tang: 45%