SMPTE Meeting Presentation

Quality Control & Monitoring in OTT Workflows

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Written for presentation at the

SMPTE 2017, Sydney, Australia

In the OTT world, viewers are watching content when they want, where they want and on the device they want. Content needs to be streamed as per user requirements, on demand and as per the resolution of the playing device. Broadcasters need to ready their content for this mode of playback - they don't control the delivery, consumer does. OTT technology is evolving, and the requirements for monitoring are also changing. Monitoring tools need to be architecturally versatile in order to accommodate this environment and allow broadcasters to figure out which issues are the most critical. Ultimately, broadcasters should choose an OTT monitoring solution for Live and VOD assets that works in tandem with a file-based Quality Control (QC) tool. By deploying a complete QC and monitoring solution for ingest to delivery, broadcasters can deliver the best Quality of Service (QoS) and Quality of Experience (QoE) to viewers in the OTT world.

OTT, Over the Top, VOD, Video-on-Demand, Live Event, QoE, QoS, Quality of Experience, Quality of Service, File-based QC, Real-time Monitoring

Introduction

OTT and video streaming are here to stay. Millennials are increasingly watching content on their mobile devices and computers and a 71% growth in viewership has been observed since 2012. However, watching video on mobile devices is not limited to the youth. In the US, 86% of Smartphone users watch video content on their phones[1]. Broadcasters need to brace up for the changing viewing styles by embracing Over-The-Top (OTT) workflows, which threatens to take the center stage if the viewing patterns are any indication. Ensuring right delivery of technically sound content is critical for every broadcaster. The right set of Quality Control tools are a must to ensure that you stay ahead in the OTT race.

The Changing Face of Media Delivery

The traditional broadcast delivery is a linear flow with content being pushed downstream to set top boxes on the consumer side. The channel of delivery may be cable or satellite, DTH or IP network. The delivery format is singular and resolutions are SD, HD or UHD. Users view the content on their TV sets. But this mode of programming has been rapidly changing. Viewers are increasingly shifting to watch content when they want, where they want and on the device they want. Content needs to be streamed as per user requirements, on demand and as per the resolution of the playing device. The content is now being pulled by the consumers as per their needs. Broadcasters need to ready their content for this mode of playback – they don't control the delivery, consumer does. Welcome OTT!

What is OTT?

OTT uses the Internet to bring audio-video content to the consumer. As opposed to traditional video distribution methods, which operate under a dedicated and controlled network, OTT video uses the Internet, which is an unmanaged network, used across the globe by millions of people. OTT content from broadcasters and video service providers typically include streaming of content such as TV programs, movies, live sports, and other special events. YouTube videos are also a prime example of OTT video. Other OTT providers include Amazon, Netflix, Hulu, etc.

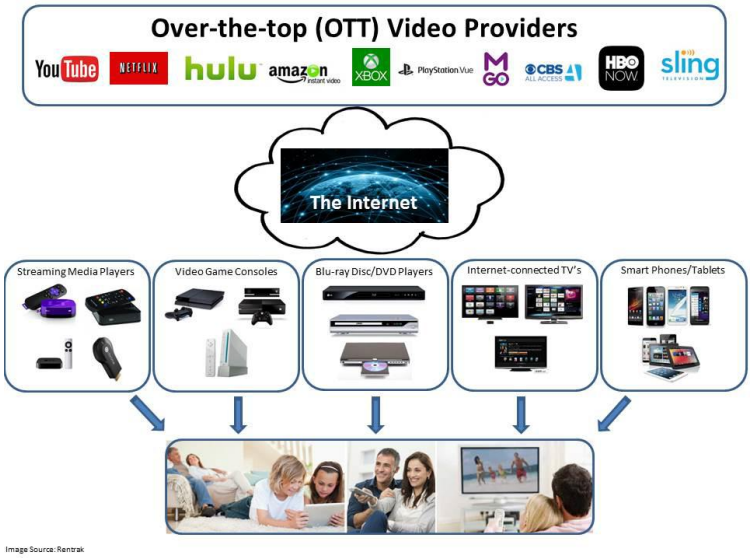

Image Source: Rentrak

To enable OTT deliveries, broadcasters need to embrace multiple technologies, more complex than the traditional linear flow – a delivery where the content is repurposed based on the user device, the quality/bandwidth of the delivery is changed based on the network congestion, and the content is not broadcasted to multitudes, but pulled by individual consumers. This is achieved using adaptive bit-rate (ABR) technology.

What is ABR?

With ABR, multiple versions of a video are created - each version encoded at a different bit rate and profile. Each of these versions is further broken into short-duration segment, which is aligned with the same segment in other versions. Depending on the network bandwidth available on the consumer device, an appropriate segment from a specific file is pulled by the user. This assures that the user views the best quality video in an uninterrupted manner.

Different wrapper formats have emerged for ABR technology, the most popular ones being HLS, DASH and HSS. Different devices consume different streaming formats, for example, Android and iOS devices consume HLS (now a universal streaming format), Microsoft XBOX, Windows8 phones can consume HLS / HSS and so on. For a broadcaster, embracing these multiple OTT formats over and above the linear flow has suddenly made their life a lot more complex. And amid this complexity, one is still struggling to cost effectively provide streaming option in addition to traditional deliveries.

OTT workflow – Video-on-Demand (VOD) vs. Live Streams

For the purpose of this paper, we would like to distinguish OTT workflows based on whether we are talking about *stored program content* or *live programming*. Stored programs are managed using file-based workflows typically as VOD assets. Here, the broadcaster has the time and luxury to ensure quality of assets during the content preparation stage using file-based QC tools. However, in the case of live-streams, content is transcoded in real-time into the chosen ABR formats and made available for streaming. In both the cases, any delivery issues with *real-time streaming* are verified using real-time OTT content monitoring tools. The next sections discuss the QC and monitoring needs for both the workflows in further details.

QC & MONITORING for VOD assets in OTT workflow

To be able to effectively monetize OTT for VOD assets, the media companies need a unified QC & monitoring solution, as shown in Fig. 1, for **content preparation** as well as **content distribution** to ensure good experience for viewers in the OTT/ABR world.

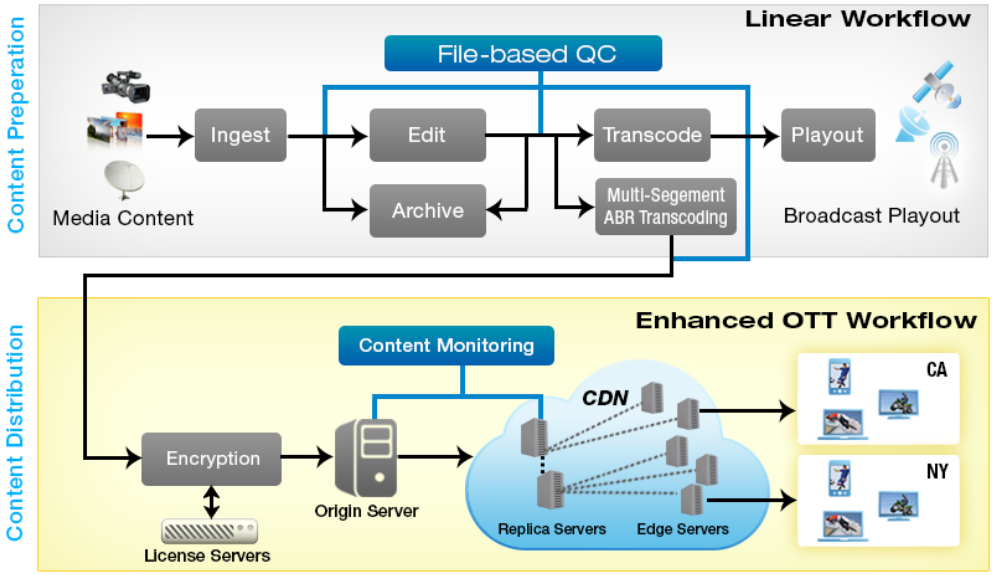

Figure 1Typical Broadcast Workflow Enhanced with the OTT Delivery Flows

Next, let us look at the QC needs during the content preparation stage, and the monitoring during the content distribution stage.

QC During Content Preparation

You need to ensure that the quality of original content is *good*. At the content preparation stage, file-based QC solutions help you to address quality challenges, quite comfortably. From ingest to editing issues, compression artifacts introduced during transcoding, as well as file assembly issues – most are easily identified by the modern QC tools.

You must deploy the right QC tools that match your quality needs for the content preparation stage to mitigate your risks and ensure that technically sound content is available downstream.

The QC checks can be broadly classified as follows:

- **Baseband Quality Checks**

  It is important to ensure that the content is checked on various quality parameters before the final delivery. A comprehensive QC tool needs to be used for a wide range of baseband quality checks, such as video signal levels, color bleeding, blotches, blur, defective pixels, black frames, color bars, RGB color gamut, mosquito noise, audio levels, audio noise and a host of other such artifacts. Good QC tool must ensure that these are detected with high level of accuracy and reliability and minimal false positives.

Figure 2 Chroma Phase Error

- **Compression Artifacts**

  When the content is compressed, several compression artifacts like blockiness, pixelation, Moire pattern, ringing artifacts, and more can get introduced in the lossy compressed video. A good QC tool needs to ensure that the transcoded content is free from these artifacts.

- **File Integrity and Standards Compliance Checks**

  The file integrity and compliance checks ensure that the file or content being delivered is not corrupt and has been encoded as per the standard to ensure that the downstream tools are able to play it without issues. This becomes even more important in the OTT context, where there are a host of devices with different form factors and players from multitude of vendors – and the content is expected to play well on all of those devices.

- **ABR Compliance Checks**

  Once master/mezzanine content has been verified using a file-based QC solution, it can be subsequently submitted for ABR transcoding. ABR transcoding is a complex process involving creation of multiple renditions of the same content at different quality levels/bitrates. The transcoding process is not only time consuming but also needs to ensure proper alignment between different variants and rightful segmentation of each variant. Thus, several additional checks need to be done on the transcoded content to ensure that the content is ABR ready. Some of those checks are listed below:

  - **Checks to ensure each segment starts with an independent frame**. This is to ensure that any chunk does not have any decoding dependency on the previous one, so that during playback, a seamless switch can happen when moving from one chunk to another.

  - **Checks to ensure that all variants of the content are properly aligned in terms of number of segments, segment duration, total duration and content structure**. A client can choose to playback a particular variant depending on the download bandwidth available and device screen size, therefore, it is imperative to ensure that all the variants are consistent with each other and allow seamless switching across all of the available variants.

  - **Ensure consistency between metadata and actual content properties**. A client uses the metadata in the manifest files to choose the best playback quality. If there is any inconsistency between the metadata and the actual media properties, it may lead to playback issues and hence a bad user experience.

Once the content is validated on these checks, it is ready for delivery, both for linear as well as OTT flows. The content is encrypted with one or more DRM technologies before it is moved to the origin server for OTT delivery.

A good file-based QC solution should have capability to perform all of the above ABR checks and also do a deep analysis to identify any baseband issue. Once the content moves to the distribution stage, the focus shifts to ensuring a smooth content delivery and the best possible user experience. This creates a need for state-of-the-art monitoring solutions that can ensure a superior QoS as well as baseline QoE. The next section talks about the monitoring requirements in detail.

Monitoring During Content Distribution

At this stage, we need to ensure that no issues will be encountered during delivery of VOD content – in short ensure QoS as well as QoE. The monitoring requirement at this stage is to perform real-time streaming validations. There is some overlap with the File-QC done during the content preparation stage, and that is necessary to ensure the content sanity as it is replicated from the origin server to cache/replica servers in a typical distribution or Content Distribution Network (CDN) environment. However, the accuracy and details of file-based QC are not needed at this stage. It is sufficient to do limited QC which is significantly faster. Monitoring tools at this stage need to ensure the following:

- The asset manifest should be accessible over HTTP/HTTPS and all the references to profile manifests and individual segments should be accessible
- Ensure that the content is properly conditioned for ABR (refer to ABR checks in the previous section)
- Server responds fast enough to ensure that content is downloaded within acceptable delays and buffering needs - this can have a major impact on the playback experience for a user
- Content downloads are simulated in network congestion environment to observe how the distribution server behaves under stress conditions
- Ensure that the content can be decrypted using the referred keys to ensure that no issues were introduced during encryption
- Basic audio-video quality checks (for example, blockiness, black frame, audio loudness etc.) are required to ensure a minimum quality of experience
- Passive monitoring of all the requests/responses for actual clients accessing the content - this can be done at the Origin Server as well as the end-device level
- All HTTP response codes – 3xx,4xx,5xx should be monitored and logged

Several OTT monitoring solutions have emerged in the market. The OTT technology is still evolving and the requirements for what is needed for a monitoring solution at this point are also evolving. The monitoring tools need to be architecturally versatile to accommodate this evolving environment, while broadcasters figure out which issues are the most critical ones to focus on. The ideal scenario for VOD based assets is the one where OTT monitoring leverages the file-based QC tool, working in tandem and seamlessly with it. The Fig 2 below illustrates how a complete QC & monitoring solution works from ingest to delivery in the OTT world.

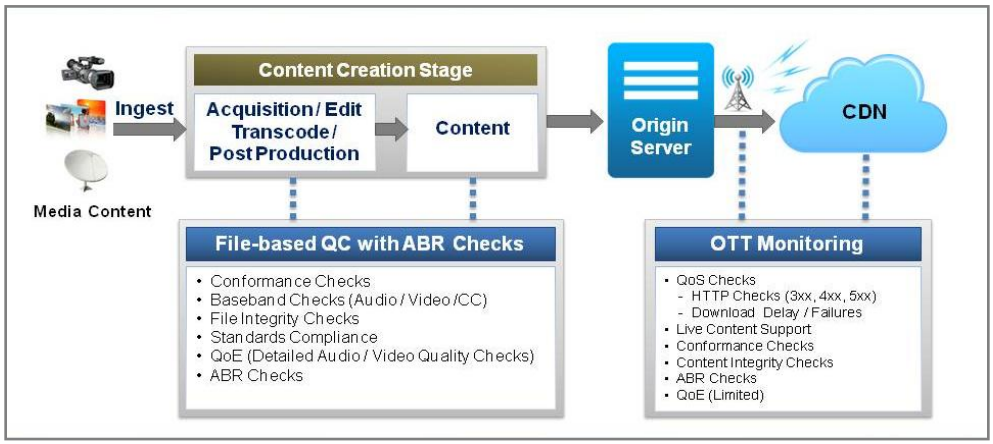

Figure 3 QC & Monitoring - Adaptive Bitrate Streaming

QC & Monitoring For Live Streams in OTT Workflow

The typical live stream workflow enhanced for OTT deliveries is shown below in Fig. 3. The live stream is split into segments, and as segments are received, they are transcoded in real-time to the desired ABR format. The segments are encrypted using any of the popular DRM technologies and placed for real-time consumption on the origin servers. More segments get added while the older ones get removed. The process continues 24x7 for live channel streams or through the duration of a live event.

Monitoring During Content Preparation

As evident, a full file-based QC does not play a role here as the content is available in real-time and not offline. However, we still need to ensure the following:

- **Basic baseband checks are done.** We need to ensure that source as well as the transcoded output of the live feed is free from basic baseband quality issues and compression artifacts

- **ABR transcoding is happening properly.** As part of this, we need to ensure that the "Encoder Boundary Points" are inserted at the right points so that the ABR segments created are compliant with the ABR specs as defined in the previous section

Monitoring During Content Distribution

Essentially, on the content distribution side, the monitoring requirements for Live streams are very much similar to VOD assets. However, there are a few specific requirements for Live streams discussed as below:

- **Live Manifest updates.** There is a need to ensure that the manifest files are updated in time and there is no stale data present. Issues in manifest updates can lead to video freeze during playback

- **Timing and the load is well managed** to ensure that ABR segments are made available at the right time on the servers, and the servers are able to manage the load

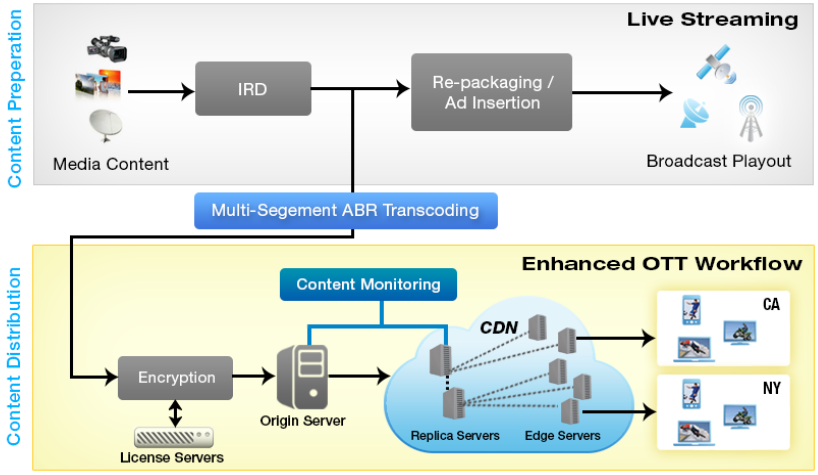

Figure 4 Monitoring for Live Streams in OTT Workflow

End-To-End Centralized QC & Monitoring

As seen above, QC and Monitoring in OTT workflows is not a single point check, but needs to be performed at multiple stages and at multiple points. For example, content needs to be checked pre and post transcoding during the preparation stage, at Origin Server, CDN and client device level during the distribution stage. Over and above the QC & Monitoring needs at each of these individual checkpoints, doing fault isolation and correlation in such complex OTT workflows requires an advanced centralized QC and Monitoring platform that collects data from multiple points and builds a complete end-to-end picture with meaningful insights.

Conclusion

OTT technology is still evolving, and the requirements for monitoring are also changing. Monitoring tools need to be architecturally versatile in order to accommodate this environment and allow broadcasters to figure out which issues are the most critical ones to focus on. Ultimately, broadcasters should choose an OTT monitoring solution for Live and VOD assets that works in tandem with a file-based QC tool. By deploying a complete QC and monitoring solution for ingest to delivery, broadcasters can deliver the best QoS and QoE to viewers in the OTT world.

References

1. Ericsson: TV AND MEDIA 2015|The empowered TV and media consumer's influence