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Best Practices for Managing Video Streaming Platforms

A guide for business owners and OTT leaders for choosing the right protocols, transcoding formats and packaging, which can significantly reduce operational costs and improve ROI.

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ABSTRACT

In this white paper, GlobalLogic's OTT practices team has laid out guidelines for choosing the right mix of streaming protocols, video encoding and packaging formats for video-based businesses such as OTT and IPTV.

As technology transforms most industries, it's imperative for business owners to understand not only the basics of their technology platforms but also the technology areas which play a crucial role in the ROI.

This white paper is mainly aimed at CXOs, business heads and product heads of OTT companies who need to understand the best streaming protocols, how to save cost on video bandwidth by using proper video compression techniques, and packaging content with the most acceptable format to save on storage and streaming bandwidth cost. Collectively, these factors play a significant role in minimizing operations cost and enhancing user experience.

Contents

Introduction

One of the most concerning things for CXOs, business leaders and company product heads in direct-to-consumer businesses like OTT is the rising cost of technology and operations.

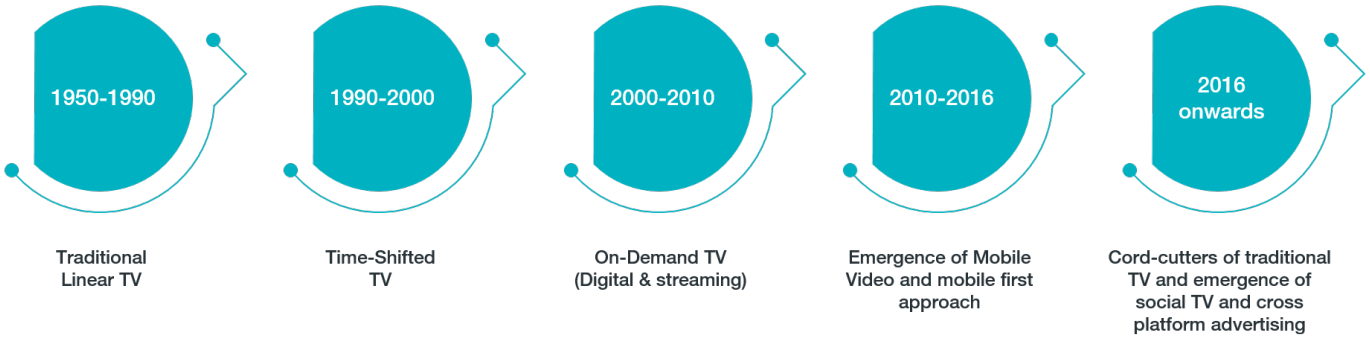
In the OTT landscape, the cost of technology keeps rising as its user base increases, which puts a toll on the budget for acquiring new content and customers.

One of the major costs involved in running a OTT business is the bandwidth cost, i.e., CDN (Content Delivery Network, like Akamai). There is also the cost attached to preparing content for delivery: ingesting the content, transcoding, storing, packaging and delivering.

This white paper will discuss the best streaming protocols, possible ways to save cost on video bandwidth by using video compression techniques, and various packaging methods that can decrease your delivery and storage cost by half if used properly.

First, let's understand the evolution of video technology, how it has grown, and how it will continue to increase in the coming years.

The Evolution of TV



1.0 The Evolution of Video & Streaming Technology

As TV technology changed from black and white to color in the 1950s, the number of television sets grew from 6 million to 60 million within the decade. [1] By 1990, plasma flat screens and LCD were available, and the number of televisions in the US increased to almost 220 million.

Since 2010, people have been able to watch video content online. It is estimated that the average person will spend 100 minutes every day watching online videos in 2021. This is a 19% increase compared to daily viewing minutes in 2019, which stood at 84. [2][3]

1.1 Problems faced by early video platforms

"On 5 September 1995, ESPN SportsZone streamed a live radio broadcast of a baseball game between the Seattle Mariners and the New York Yankees to thousands of its subscribers worldwide using cutting-edge technology developed by a Seattle-based startup company named Progressive Networks." [4]

The main problems early video platforms faced were bandwidth, scalability, reach and technological challenges related to proprietary technologies.

With their mess of proprietary protocols that were primarily based on the far less popular UDP, media streaming providers suddenly found themselves struggling to keep up with demand.

1.1.1 Device fragmentations and proprietary technology issues

There has been a huge consumer trend to watch movies on demand and view video content on any possible device (mobile, tablet, desktop, television, connected TV, gaming console, etc.). These devices run on various operating systems and versions, making it complicated to stream content efficiently. Early streaming platforms like Netflix had to announce which platforms their services would be supported on instead of streaming on widely available devices, making it difficult to reach maximum users and increase its user base. To support a single proprietary technology, video has to be transcoded into many supported formats, which increases operations and technology costs.

To expand their revenue and user base, these companies had no choice but to support a plethora of proprietary technologies to stream content on any device, thereby increasing operations costs.

1.2 Video is getting significantly larger and difficult to manage

Most of today's video content is shot at extremely high quality. Video stream sizes are getting bigger and bigger. High Definition (HD) content size is almost twice as large as Standard Definition (SD) content. Similarly, 4K content is almost four times the size of High Definition (HD) content.

If features such as HDR are added (providing richer color), it will add even more to the file and stream sizes, making it more expensive to deliver/stream high-quality content.

Once 4K and 8K become widely accepted, platforms need to support massive infrastructure and delivery costs to run the business efficiently.

Video Streaming Protocols

In this section, we will describe the various areas where we can optimize costs if we make strategic technology choices.

Today's audiences expect buffer-free, good quality video delivery irrespective of their location, bandwidth constraints, etc. Selecting the proper streaming protocol is a good place to start because different protocols determine the video delivery latency, stream quality, and playback across supported devices.

What are network and streaming protocols?

A network protocol is an established set of rules that determines how data is transmitted between different devices on a network.

A streaming protocol is no different. Whenever video or audio is streamed, streaming protocols are used to deliver that video/audio (data) over the network. Essentially, a streaming protocol defines a specific method for delivering "chunks" of data from one device to another and a method for "repackaging" these chunks into playable content on the user's end.

Some popular Streaming Protocols

Real-Time Messaging Protocol (RTMP), Real-Time Streaming Protocol (RTSP), Dynamic Adaptive Streaming over HTTP (MPEG-DASH), Microsoft Smooth Streaming (MSS), HTTP Dynamic Streaming (HDS), HTTP Live Streaming (HLS).

The two most common streaming protocols are HLS and MPEG-DASH, which are both adaptive bitrate-based streaming protocols.

Adaptive HTTP-based streaming protocols

Adaptive bitrate (ABR) streaming is a video streaming technique over HTTP protocols in which content is encoded at various bit rates. Each bit rate stream is segmented into small multi-second parts. HTTP-based protocols deliver the best video quality and viewer experience possible across devices because they can adapt to the user's bandwidth. The two most common and popular HTTP-based protocols are Apple's HLS and MPEG-DASH.

Apple's HLS

Apple's HLS supports adaptive bitrate streaming and is now supported by major browsers like Google Chrome and Safari, as well as Android, Linux, and Microsoft operating systems. Several set-top boxes, smart TVs, other players, and macOS devices can play streams delivered using HLS.

MPEG-DASH

The Moving Pictures Expert Group (MPEG) is an international body that developed Dynamic Adaptive Streaming over HTTP (DASH), which supports adaptive bitrate as an alternative to HLS.
DASH supports all Android devices after 2012; televisions by various OEMs like LG, Xiomi, Samsung, Philips, Panasonic, and Sony; and Chrome, Safari, and Firefox browsers. It is not supported by iOS or Apple TV.

Some important qualities of a good streaming Protocol

Protocols differ in the following areas:

- Scalability
- Latency
- Quality of experience (adaptive bitrate enabled)
- Use (first-mile contribution vs. last-mile delivery)
- Playback support
- Proprietary vs. open source
- Codec requirements

Best Practices: For direct-to-consumer VOD business, it's better to use HLS and MPEG-DASH as they will cover most devices. It's best to stick to the same protocol from capture to playback. These are widely supported and tested ABR protocols, which are better for both user experience and cost savings.

Video Transcoding

What is video transcoding?

Video transcoding refers to the process of re-encoding video with a different codec or video settings.

With video transcoding, you can create a set of time-aligned video streams, each with a different bit rate and resolution. This group of streams is made to adjust to the user bandwidth at the client's end, thereby avoiding buffering, etc.

Transcoding is critical when you want your content to reach more end users. Important parameters to consider for transcoding are CODEC, resolutions, frame rate, pass-throughs, and bit rate. Let's discuss each of these.

Applying the right codec

Codecs are software instructions to compress video and audio. The primary aim is to reduce file/stream size without losing image quality. In video streaming, lossy codecs take the original file and reduce the visual information as much as possible while still maintaining the look of the original.

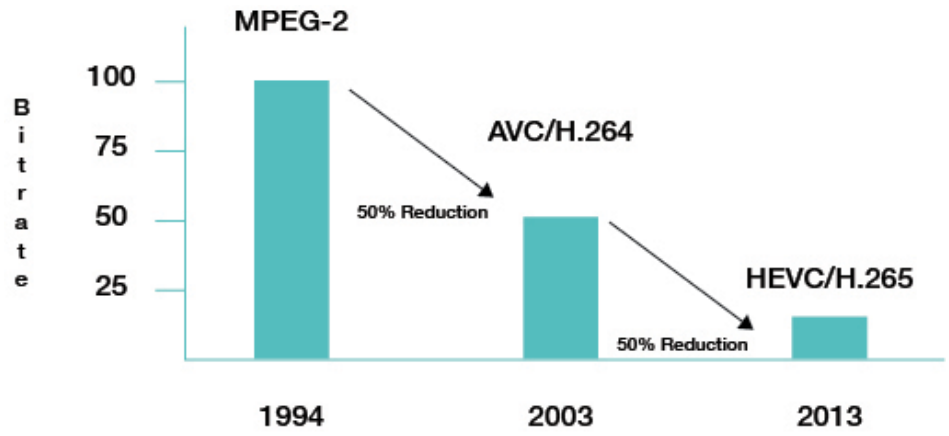
In the last ten years or so, the most popular codecs for internet delivery have been H.264 (Mpeg-4 part 10).

In 2013, H.265 (Mpeg-H part 2) was launched and is quickly catching up because it's more suitable for 4K distribution over the internet.

Best Practices: Platform owners should always analyze their distribution platform and end users' device compatibility before choosing any particular codec to stream. For example, if you have a large percentage of users on Android 5 or iOS 11 or a browser with no support for H.265, consider delivering using H.264 codec. Also, make sure your video players can support it.

Comparison of codecs in bandwidth savings

Why does codec matter, and how does choosing the right codec save a significant amount of bandwidth? Each new codec has achieved average savings of 40-50% bandwidth over its predecessor.



Popular video codecs

Why does codec matter, and how does choosing the right codec save a significant amount of bandwidth? Each new codec has achieved average savings of 40-50% bandwidth over its predecessor.

Codec	Benefits	Limitations
H.264/AVC	Widely supported, easy to implement	Widely supported, easy to implement Does not supports 8K resolutions
H.265/HEVC	Supports 8K resolution	Costly to process as encoding time is 4 times that of H.264/AVC
VP9	Open-source	IE & Safari has limited support. It has been extended to AV1
AV1	Open-source	Limited support

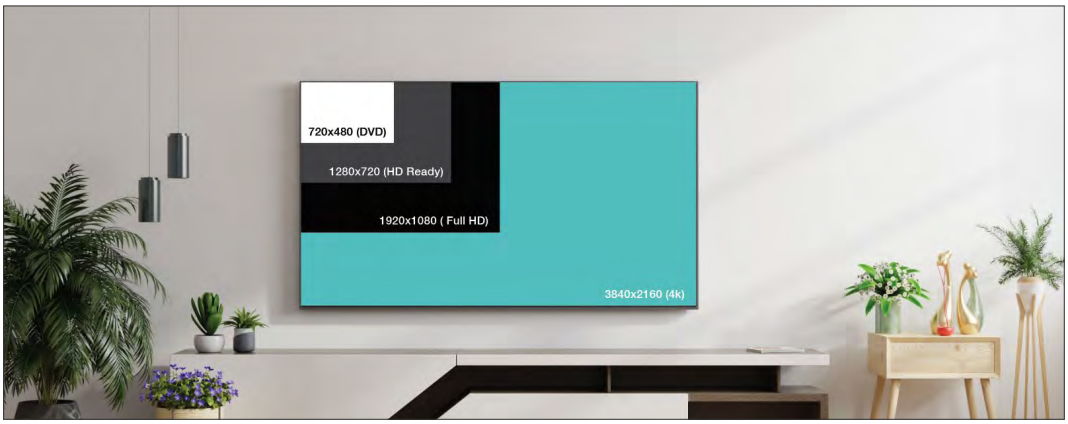
Insights:

1. Whenever your competitor delivers better video quality with significantly less bandwidth consumption, it means they are using better compressions (codec) techniques. Netflix can serve HD quality content within 3 GB of bandwidth.

2. To encode content in H.265/HEVC, the processing time and cost associated are almost double compared to its predecessor H.264/AVC. Encoding is a one-time activity but in the longer run, the savings from delivering content using HEVC far outweigh the initial cost savings on AVC.

Resolution

Image resolution is the detail an image holds, expressed in width and height in pixel units. The more pixels in the given dimensions, the closer it will match the original image.



Best Practices:

Resolution	Usage guidelines
360	Use this if you want to save bandwidth delivery costs for low-end devices. The visual quality will be low and primarily used for mobile-only delivery.
720	Use this when your end user's average bandwidth is around 4-5 Mbps. The image is much clearer, sharper, and more "real." The cost of delivering to this format will be double that of 360p.
1080	Use this for your premium content or premium users. The minimum bandwidth required for end users is 5 Mbps. On average, one hour of HD video will require 8 GB of storage. Make sure delivery links are protected, as any compromise can lead to large unplanned streaming costs.
2160	The end users require a bandwidth of 15 Mbps at the minimum. 4K-capable viewing devices are very limited. Use this for your premium content or premium users. If your user base is not at this premium segment, it makes sense to avoid this format for now. The cost of delivering to this format will be double that of 1080p.

Frame rate

Video pictures do not actually move but are a series of images that give the illusion of motion when played. Frame rate per second (FPS) determines the smoothness of the motion.

Above 30 FPS is the industry standard for sports content. This image comparing 60 FPS vs. 120 FPS is only shown to illustrate the difference.

Industry readiness for 4K & 8K content and its frame rate support

The frame rate required for 4K is up to 60 FPS and for 8K content it requires up to 120 FPS. The number of pixels and frames per second for 8K means that it requires much more bandwidth (100 Mbps) to deliver compared with 4K (25 Mbps).

From a delivery perspective, 4K services have already been successfully deployed for both VOD and live applications, and once 5G comes into the picture, 8K will soon get its foot in the ecosystem.[6]

Insights:

For VOD services and most broadcasts, 24 FPS is the industry standard. Sports content of 30 FPS is common. An extra 6 FPS gives a smoother feel for continuously moving frames.

Bit rate

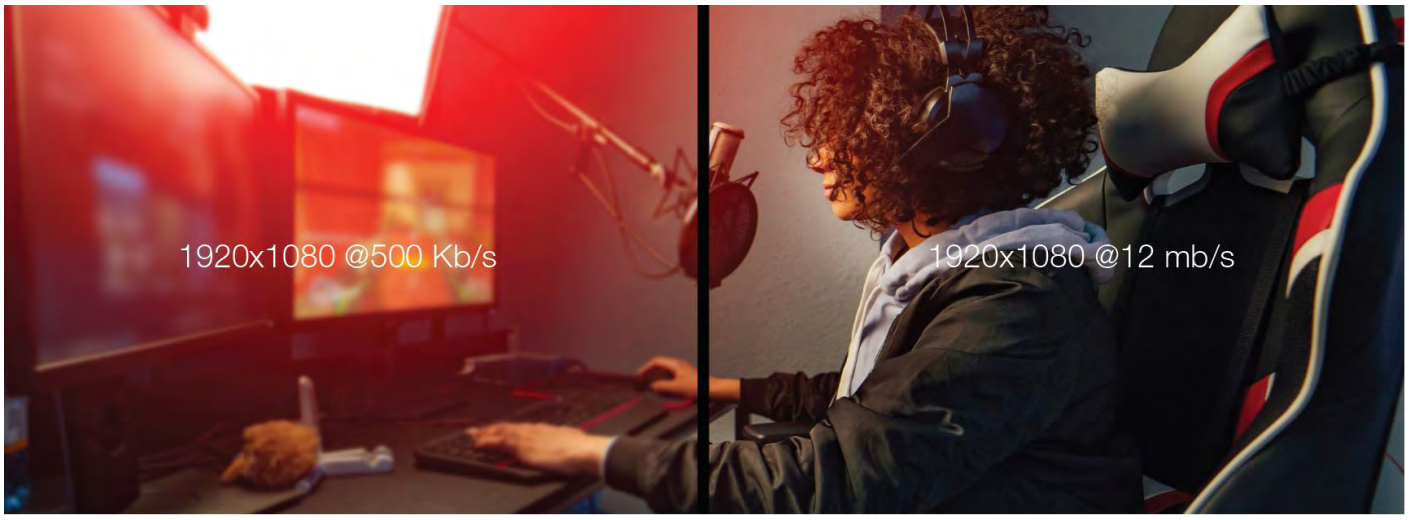
The higher the bit rate, the better the video quality but it also adds to the file and stream size. Similarly, reducing the bit rate can reduce the file size but can reduce the quality as well, so balance is required.

Best Practices: Changing a bit rate to match users' bandwidth is tricky as it will also scale down the resolution, which can give a very choppy video and increase dropouts. A good practice is to calculate the maximum bit rate by taking the average and adding 30 to 50%. This creates a consistent stream while still taking advantage of a variable bit rate.[6]

Best practices: Finding the right balance and reducing costs

Here are ideal bit rate settings for video streaming:

16:9	4:3	Ideal bit rate range guidelines
3840x2160 (4K)		8,000-14,000 Kbps
1920x1080 (1080p)		6,000-8,000 Kbps
1280x720 (720p)		3,750-5,000 Kbps
1024x720 (iPad)		3,750-5,000 Kbps
640x360	640x480	1,350-1,800 Kbps
480x270	480x360	600-800 Kbps
320x180	320x240	600-800 Kbps



Video Packaging

Packaging is one of the most important parts of the video content workflow. At this stage, content is wrapped and packaged in a container (also known as the format) to reach the maximum number of customers. The packager prepares content for delivery “over the top” (OTT) via the internet.
There are various ways to package videos, such as CMAF (Common Media Application Format), Transmuxing and JIT (Just-in-Time packaging).

Video Containers

The transcoded and compressed video needs to be put into a single container so its related files (audio, video, manifests, thumbnails, etc.) can be played by the client device. Commonly used containers are .MOV, .TS, and .MPG.

Issues with video containers

Any video platform business expecting to reach a wide range of users on both Apple and Microsoft devices must encode and store the same audio and video data two or three times depending on the number of formats they want to support.

To reach both an HLS- and MPEG-DASH-supported device, the streaming server must encode and store the same video and audio twice, wrapped in both .TS and .MP4 containers. To solve this problem, Microsoft and Apple have agreed to support standardized transport containers called CMAF.

Why CMAF is the ultimate cost saver

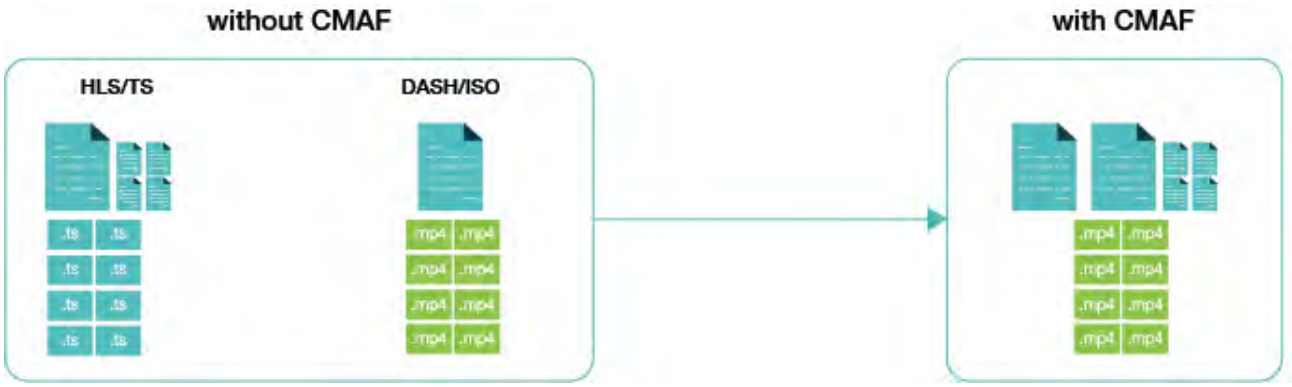
CMAF is an emerging standard intended to simplify delivery of HTTP-based streaming media. Apple hardware running iOS 10.0, macOS 10.12, and tvOS 10.0 or later OS versions support CMAF content. CMAF isn’t a presentation format; it’s a container format that can contain one set of audio/video files with manifest files for multiple presentation formats and multiple DRMs.

Issues addressed by CMAF

Of the two most accepted streaming protocols, HLS stipulates the use of TS (transport stream) file containers, while MPEG-DASH in practice stipulates the use of ISO Base Media File Format (ISOBMFF). To reach both an HLS- and MPEG-DASH-supported device, the streaming server must encode and store the same video and audio twice, wrapped in both .TS and ISOBMFF containers.

This doubles the cost of packaging, storage at origin and CDN, thus reducing the delivery efficiency and significantly impacting operations costs.

Microsoft and Apple have now agreed to reach audiences across the HLS and DASH protocols using a standardized transport container: ISOMFF in the form of fragmented MP4. This means content distributors and platform owners can deliver content using only the .mp4 container. [7]



Best Practices: Legacy devices and browsers that aren't upgraded will still require unique container files for playback. If you are catering to android and iOS versions and devices launched after 2013, you are good to go with CMAF as it will cover most devices, thereby saving a good percentage of your delivery cost.

Transmuxing

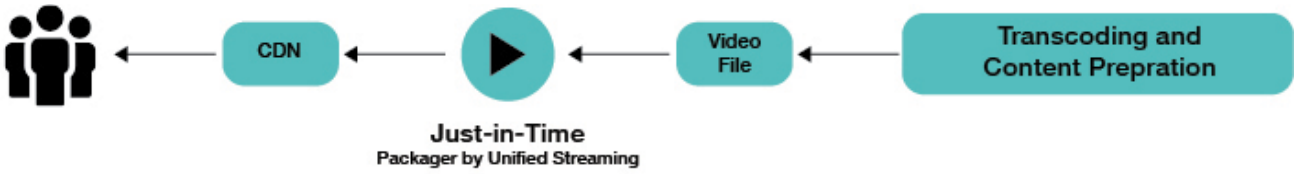
Transmuxing is another method for repackaging the already compressed file into a different delivery format. The advantage here is that fewer computer resources are required, and it takes less time compared with traditional encoding to "HLS Variant" because it is not changing the resolution, bit rate, etc. This is typically done on pre-encoded files that need to be delivered to a device that does not support the delivery format.

Just-in-Time packaging

Another technique content and platform owners can leverage to improve efficiency is Just-in-Time packaging (JIT). Leveraging JIT allows content owners to achieve greater device reach, reduced storage costs, and CDN flexibility and security.

4.4.1 How JIT works

JIT inputs a single set of MP4 files (live or video on demand) and packages on-the-fly for the needs of each viewer. This means one set of MP4 files (not two) and no transcoding is required. [8]



Benefits of JIT

Reduced storage costs

With a plethora of end user devices, it is impossible to serve all devices with a single pre-encoded file that can support a variety of formats like MPEG-DASH, HLS, HSS, HDS, and MP4. Content owners will have to store many instances of the same video to ensure compatibility, which means more cost for storage at origin and CDN.

JIT can generate a range of formats on-the-fly that are compatible with almost any device. No extra storage is used, which can significantly reduce your storage budget.

Format future-proofing

The HTTP-based streaming protocols in use today are still evolving. Using JIT eliminates the need to prepackage VoD libraries when these formats change. Changes in formats can be addressed as needed.

Conclusion

When “content is king,” content distributors and OTT platform owners should focus more on content and user acquisitions rather than worrying about new technology and operations costs.

In this white paper, we have tried to show the different areas of streaming technology where cost optimization and user experience enhancement is possible. Leaders should continuously strive to optimize video workflows and not make any myopic decisions for short-term gain. For example, do you remember the videos that were created for QuickTime, or the AVIs that are no longer fit for consumption? Each streaming protocol, codec, and format has an upside and a downside, depending on the specifics of your situation. By prioritizing the above considerations, it’s easy to narrow down what’s best for you.

Any questions, additions, or ideas? Please feel free to reach out to us.

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Aftab is an SME and Director of Digital Product Engineering at GlobalLogic, India. He focuses on techno business challenges and how to solve them. He has spent over a decade helping top-ranked broadcasters and businesses build digital video platforms using AVOD, SVOD, and live streaming-based products that leverage BrightCove, Kaltura, Ooyala, WOWZA and various open-source tools and technologies.

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