WHITEPAPER
IneoQuest Technologies, Inc.

Perfecting 4K Video Delivery

Best Practices to Mitigate Common Pitfalls

IN PARTNERSHIP WITH ELEMENTAL TECHNOLOGIES

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PERFECTING 4K VIDEO DELIVERY

With literally billions of investment dollars going towards serving up premium 4K content, service providers and content owners must ensure that 4K viewing experiences are truly superior. But with the opportunity to provide audiences an immersive experience comes risk. Much of the premium 4K video on offer is high motion, high frame rate content that presents inherently greater potential for visual artifacts than lower resolution video. A careful, comprehensive approach to 4K content preparation and delivery requires capable video processing and measurement platforms, as well as the knowledge to properly configure these tools for optimal results.

This brief identifies the five most common pitfalls of 4K video quality impairments, their symptoms and root causes, and suggests best practices to mitigate or eliminate these issues so service providers and content owners can offer the highest quality 4K video possible.

PITFALL ONE: RULES AND THRESHOLDS FOR HD CONTENT NO LONGER APPLY

With 4K video, there is "no place to hide" visual defects. Any impairment will be much more prevalent in 4K video simply because of the much higher bitrate, greater number of pixels, and larger viewing surface as compared to HD video. 4K content is more likely, at least initially, to be high motion, high frame rate sports content. Not only is this content complicated to properly encode, but the higher frame rate further magnifies the frequency with which errors occur in a 4K vs. HD viewing experience.

Symptoms and Root Cause

Because 4K video is commonly watched on a larger screen, visual defects that occur in HD, including pixilation, macroblocking, and blurring, occur more frequently and more readily in 4K. The larger the visual display surface, the more obvious the visual artifacts and the more magnified the visual defects. The same is true as data rates increase. Rate-based defects, such as pixilation, that may be acceptable for 1080p30 content, occur four to twelve times more frequently with 4K delivery (such as 4Kp120).

Figure 1: Macroblocking

Best Practice

Quality levels must be higher for 4K video to offer a viewing experience equivalent to what users are accustomed to with HD. Establish settings and monitoring thresholds tailored for 4K content.

PITFALL TWO: OVER-COMPRESSION

4K video requires greater processing capacity and greater bandwidth than HD to create a satisfactory viewing experience. Squeezing video resources to maximize video processing and network capacity over existing network resources can create highly visible defects. This may be mitigated by shifting to more efficient codecs, such as HEVC, but may only provide partial benefits when delivering high motion, high frame rate 4K content.

Symptoms and Root Cause

Providing too few network resources inherently degrades video quality. Challenges include limited video processing resources, limited capacity across CDNs, and limited home network access. This is magnified in 4K and can result in an array of impairments including pixilation, macroblocking, and blurring.

Best Practice

Properly design and scale network capacity to deliver crisp and life-like 4K video experiences, especially for high motion sports content.

Figure 2: Pixilation

PITFALL THREE: EXCESSIVELY VARIABLE PACKET AND BITRATE OUTPUT

For all video content, there is a high degree of variability in encoding complexity and processor utilization from one frame to the next, especially at scene changes. This is also true for 4K content, especially at higher frame rates such as 100fps or 120fps. Encoding more complex frames can result in bursts of output traffic, while encoding less complex frames causes decreased output traffic.

Symptoms and Root Cause

Irregular and unpredictable emission of packets can adversely impact video routers and other network elements, and can overwhelm the ability of client devices to render video cleanly. This results in a softening of sharp edges, blurring, blockiness, and stuttering in video playback.

Best Practice

Monitor the maximum peak variable bitrate (VBR) of traffic from the encoder, with notification for significant and fluctuating bursts. With specific network capabilities in mind, operators must balance VBR settings (both maximum and minimum) in the encoder, though this may impact 4K video quality especially at high frame rates. Operators can also choose a statistical multiplexer to more efficiently use available network capacity during real-time fluctuations.

Figure 3: Blurring and Smearing

PITFALL FOUR: VARYING QUALITY OF ADAPTIVE BITRATE OUTPUT STREAMS

Adaptive bitrate (ABR) streaming has become increasingly popular for delivering video content to multiscreen devices, particularly over unmanaged or third party networks for over-the-top (OTT) delivery. This allows client devices to request, on the fly, higher or lower resolutions and bitrates in response to changing network conditions to ensure faster video playback starts and an uninterrupted video flow.

An encoder produces 6-10 variants of each input stream to create ABR output profiles. A single input "channel" might produce two 1080 output profiles, two 720 output profiles, and two or more SD output profiles, each with different bitrates. This ensures that the client device may request a lower bitrate to spontaneously adapt to network conditions without interrupting the video stream. As network conditions improve, the client device may request a higher bitrate to ensure the highest possible resolution and quality. There may be differences in quality from one ABR stream to another, which may be considered a second pitfall.

Symptoms and Root Cause

Improper encoder settings may create noticeable quality differences as a player switches from one ABR stream to another. GOP misalignment of the output streams may be perceived by the viewer as jumps or stutters in video playback.

Best Practice

Fortunately, this pitfall is uncommon. Monitoring the quality of each stream and GOP alignment is important to detect errors or problems with individual ABR output profiles and will eliminate visible video playback stutters.

Figure 4: Variance in ABR Output Stream Quality

PITFALL FIVE: GOP MISALIGNMENT ACROSS ABR OUTPUT STREAMS

4K encoding is processor and resource intensive. Even with the most robust 4K encoders, the number of output streams that the encoder is physically able to encode is far more limited than the number of HD or SD streams that the same encoder could generate. To produce a complete, high-quality ABR bouquet – for example, two 4K profiles, two 1080p profiles, two 720p profiles, and two to four SD profiles – an operator may typically split the encoding across two devices to manage processor load. In this example, each encoder would produce one each of the 4K, 1080p,

720p output streams, and one or two of the SD profiles. This more evenly distributes the processor workload and provides redundancy. If one of the encoders fails, the operator is still able to deliver at least one output stream in each resolution. However, dividing the encoding workload may potentially introduce mismatched output timing.

Symptoms and Root Cause

When a client device switches from one ABR profile to another, even within the same resolution, GOP misalignment may be visible as jumps or skips forward or backward in playback. This is caused by mistimed output streams across multiple encoders.

Figure 5: Misalignment across Video Output Streams

Best Practice

Fortunately, this pitfall is uncommon. Monitoring the quality of each stream and GOP alignment is important to detect errors or problems with individual ABR output profiles and will eliminate visible video playback stutters.

SUMMARY

Since 4K video was unveiled as the centerpiece of the Consumer Electronics Show in 2014, it has been at the forefront of industry innovation. Yet, as with any new technology, there is a process to fully realizing its potential so customers can experience it as it was envisioned. 4K video is in a period of refinement, where companies across the video ecosystem have the opportunity to optimize the viewing experience for customers.

Because of the higher resolution of 4K video, physically larger viewing space, and higher frame rates, consumers are more likely to perceive visual defects in 4K playback. To provide the most seamless experience for viewers, operators must understand optimal encoder settings and recognize the unique settings that each network configuration requires for encoding, packaging, and delivery. This is key to mitigating and preventing pitfalls, such as those outlined here. Additionally, a critical layer of defense includes a robust automated video quality monitoring solution to detect impairments in real time. The ability to make real-time corrections will ensure the highest quality 4K experience.

Service providers and content owners alike share a vested interest in demanding a higher quality experience from 4K content to maintain a competitive edge with differentiated product and ensuring an appropriate return on 4K capital investment.

LEARN MORE

IneoQuest provides the world's leading media companies and service providers the critical insight needed to keep viewers engaged on any device, across any network. IneoQuest is recognized as an industry leader with patented solutions that set the standard for measuring video quality and viewer behavior. To learn more about how IneoQuest is redefining the video experience, visit www.ineoquest.com.

Software-defined video solutions from Elemental provide the flexibility, scalability and performance required to transform high quality video into new revenues streams via on-premises, cloud-based and virtualized deployment models. Visit www.elementaltechnologies.com to learn how Elemental can help power your 4K video experience.

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