Whitepaper

Video and Audio Quality Assurance

Telestream Sentry IP



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Abstract

In the context of video and audio programming, Quality of Experience (QoE) is assuring that operators deliver pictures and sound that will keep their viewers happy. For many years, operators have focused on monitoring the Quality of Service (QoS) of their video networks. But video and audio quality issues still remain among the top complaints from subscribers. Indeed, independent research conducted with Video Service Providers found that the top customer issues reported were content related: macroblocking; video blackouts; frozen video and silence.

While this challenge is well-recognized in the industry, until recently solving it has proven difficult. The solution begins with choosing and using Telestream's Sentry, which uses innovative technology to allow operators to monitor video networks based on actual customer experience with video and audio services.

Standards like ETSI TR 101 290 (measurement guidelines for DVB Systems) traditionally were the cornerstone of network diagnostics, but effective monitoring of a video service requires much more than these measurements alone. In this paper we discuss standards-based measurements, and the role they play in today's monitoring technology and products. We then investigate Sentry's advanced technology, which enables operators to continuously, automatically, and objectively monitor and measure video and audio quality based on viewers' Quality of Experience (QoE).

We will see how Sentry reliably represents viewer experience while eliminating the individual's subjectivity. Instead of measuring only network health, Sentry also analyses the actual content of hundreds of video and audio streams for impairments in parallel and in real time. This capability enables operators to quickly isolate issues that compromise the viewer's experience, thus reducing operating costs while supporting subscriber retention.

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What are the Limitations of Standards-Based Measurements, Network Diagnostics and Quality of Service (QoS)?

With the industry's increased use of digital transport, the traditional tools for aiding operators' monitoring efforts were introduced: network probes that focused on standards-based "Quality of Service" (QoS) measurements of IP network jitter and MPEG interoperability tests such as TR 101 290. In practice there is often no direct correlation between the adherence to QoS standards and the impact to the end viewer. To put it another way, an individual QoS problem (e.g., a long PAT repetition rate or higher than expected levels of IP jitter) may not result in a customer impacting QoE problem, but a QoE problem (e.g. macroblocking) may indeed be caused by one or more QoS problems (e.g., dropped IP packets causing continuity count errors).

QoS measurements did–and continue to do—an excellent job of alerting operators when programs suffer network jitter or lost or out-of-order packets. Unfortunately, these are not the main reasons behind visual and audio glitches. Relying solely upon QoS based alarms or alerts often leads to overloading network operations staff with non-actionable information. Deluged with QoS alerts such as TR 101 290 errors, operators have little or no ability to determine which are minor, non-recurring issues with no real subscriber impact and which are major, customer affecting errors requiring immediate attention.

The reason for these so-called "false alarms" is that TR 101 290 was designed at the outset as an interoperability standard, to ensure that compliant network elements would be guaranteed to work together. It is important to understand that non-compliance with TR 101 290 does not mean that a system will not operate correctly. Indeed, most systems which are functioning correctly are not 100% compliant with TR 101 290. So taking this interoperability standard and applying it to 24×7 monitoring of video services inevitably leads to many alarms which may or may not be customer impacting.

On the other hand, probes that rely purely on TR 101 290 measurements are unable to determine that other events, such as encoding issues, are occurring. Indeed, it is possible to have a 100% TR 101 290 compliant transport stream that is carrying an entirely non-decodable video or audio elementary stream. A probe relying solely on TR 101 290 measurements would not alert on this condition, even though the service was off-air.

TR 101 290 measurements remain a valuable diagnostic aid, which is why Sentry makes TR 101 290 measurements and stores any resultant errors for 60 days to aid the diagnostic process. Problems arise when QoS measurements such as TR 101 290 are the sole mechanism used to alert an operator that there is a problem.

The key question is "if I am not going to be alerted whenever there is a TR 101 290 error, when should I be alerted?" The answer is that Sentry alerts only when an event is deemed "customer impacting"—an event that would be noticed by a viewer. These events can include macroblock errors, slice errors, serious compression artifacts, frozen and black frames, low or excessive audio levels, silence, clicks, drop-outs, or even missing subtitles. What traditional QoS probes cannot provide is the ability to reliably identify, accurately measure and determine in real-time, the occurrence and severity of these customer impacting events.

Industry Needs and Quality of Experience (QoE)

The need to ensure that subscribers enjoy the best possible viewing experience has become so important to the video industry that the term "Quality of Experience" (QoE) has been adopted from a concept originally developed by Telecommunications Operators to better manage customer experience.

Having probes with this QoE measurement capability enables engineering and operations personnel to focus on major customer impacting issues—video and audio impairments—with threshold-based alerting and reporting capabilities, rather than treating all errors as having equal severity or not knowing what to do about them. Fortunately, Sentry can tackle this problem and provide operators with the ability to not only identify every possible error, but measure and report the actual impact of each error along with the underlying reason for the error. Operators can consistently test, measure, and monitor their systems, networks, and services objectively based on the actual subscriber viewing experience.

Why QoE Is Necessary for Effective Video Network Monitoring

Alerting when there is a QoE issue and reporting this along with the underlying reason for the problem is a more effective and accurate way to monitor and evaluate the performance of video services, because it is based on customer experience rather than standards compliance.

Video and audio QoE must be measured and reported in real time on as many channels as practicable by a single probe, with the operator able to set alerts to monitor service quality based on the experience and expectations of his or her viewer base. To identify these issues it is necessary to analyse the actual video and audio content, which in itself requires that the content must be decoded.

In a modern video network there may be hundreds of programs that all must be decoded and analysed simultaneously in real-time. Due to both complexity and the use of entropy bit-stream encoding, H.264 content requires 7-10 times the computational resource required to decode MPEG-2, which itself is computationally complex to decode. As a result QoE monitoring solutions that analyse the video content

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in real-time have in the past been limited to monitoring just a few programs, or have used polling techniques, making them expensive and not scalable to deploy.

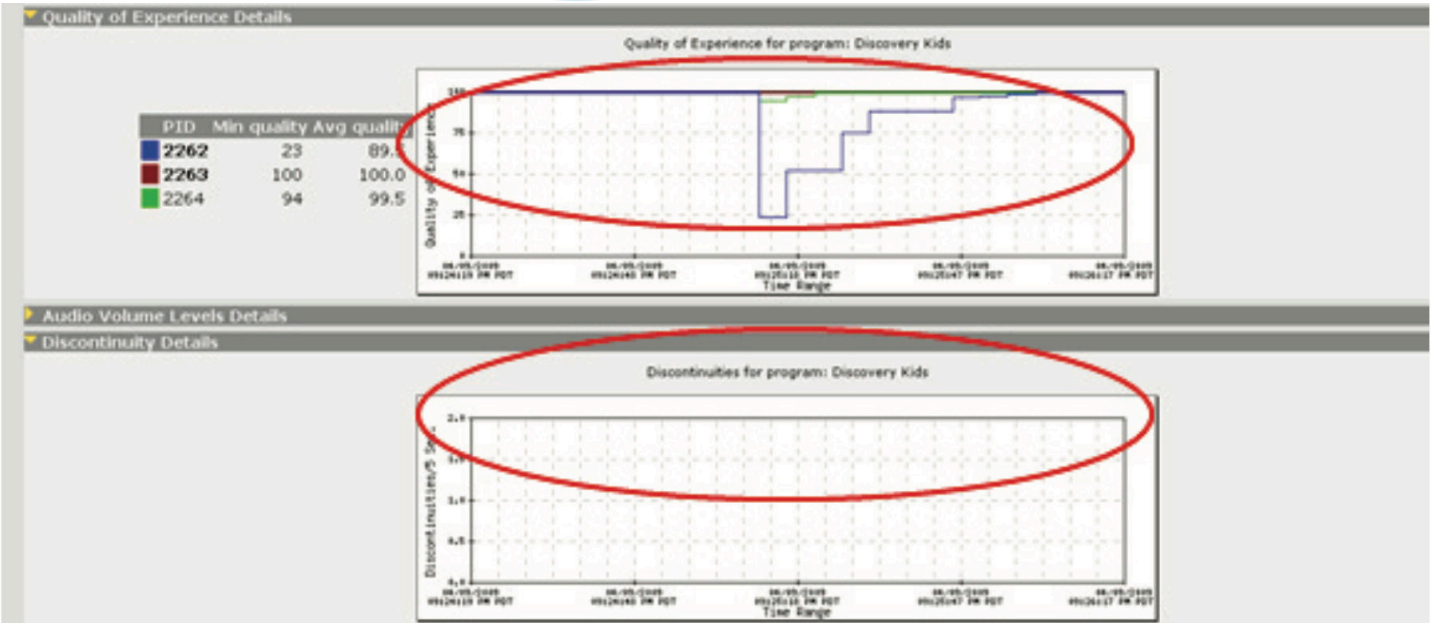
Sentry's unique advanced architecture allows it to monitor the actual video and audio content of hundreds of programs simultaneously and in real-time without resorting to polling techniques. By using such an efficient, high-performance architecture this advanced probe is also able to monitor and alert on a broad range of customer impacting issues that are not specifically video or audio related. These include: subtitle and teletext presence; carousel cycle times & events; and splicing issues.

Sentry also reports the underlying problem causing a drop in QoE. This latest development in QoE monitoring technology can provide—in addition to the traditional test and measurement metrics—information on digital content and a set of "scores" reflecting exactly how good (or bad) subscribers' video and audio experiences are while watching TV. Operators can use these measurements to generate useful reports for troubleshooting, problem isolation, and root-cause analysis to improve service quality based on customers' perceived quality.

How QoE Scoring Works

Figure 1 is an example screenshot from Sentry showing how video and audio can be continuously scored based on subscribers' experiences with a particular program. The quality of experience detail chart can be viewed as a subscriber "satisfaction meter" which continuously tracks how subscribers respond to the video and audio quality, as shown in the first red circle. The lower score indicates a lower satisfaction level, and the stepwise curve trending back up simulates subscribers' regaining confidence with the service quality after the quality returns to good/normal.

Figure 1. Sentry example showing how video and audio can be continuously scored based on subscribers' experiences with a particular program.



It is important to note that traditional monitoring metrics which rely on using "MPEG discontinuities" to identify errors will miss content-related errors, such as encoding errors, which impact subscribers. For example, the discontinuity chart on Figure 1 above (second red circle in Figure 1) shows that the subscriber-impacting issue was not caused by a transport stream discontinuity. This exemplifies how relying solely on traditional metrics will fail to detect and report many video macroblocking and audio disruptions.

Figure 2. Shows an event (in the red circle) where the subscriber's experience was impacted over a longer time, such as two weeks.



Figure 2 shows an event where the subscriber's experience was impacted over a longer time (two weeks) in the first red circle. Note that there are no discontinuity events detected in the second red circle, which again shows that traditional, standards-based monitoring methods will completely miss alerting and reporting on these customer-impacting events.

As can be seen in the preceding graphs, Sentry's video and audio QoE measurements are easy to understand and very user friendly. Instead of looking at partial information and a dozen different measurements to try to work out perceived video and audio quality, operators now can confidently understand how good or bad the video and audio quality is based on Sentry's video and audio QoE numerical values (i.e., 0 being worst, 100 being best) as they directly correlate to customers' experiences.

Macroblocking and temporary frozen video are two of the best-known issues associated with digital video compression and transporting video over IP. These problems may occur when the video decoder

cannot decode the compressed digital video and put it back together correctly because of syntax errors in the video. As a result, viewers see macroblocking and/or temporary frozen video on their TVs or other viewing devices.

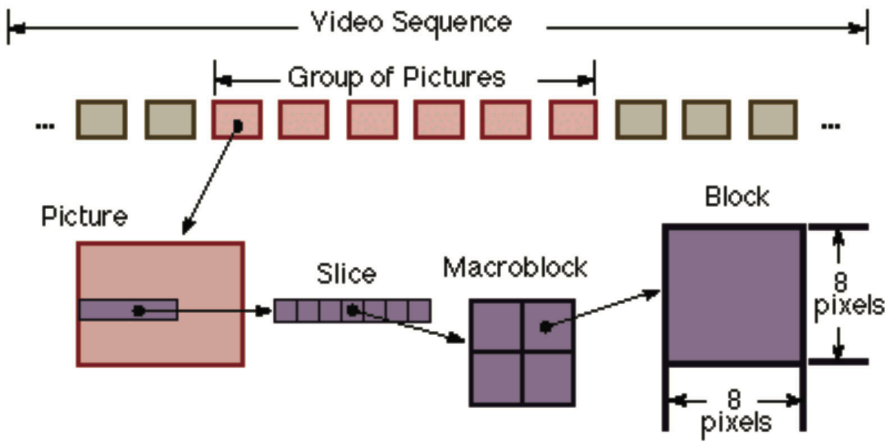
Figure 3. Example of how Video QoE score (in blue) gets reduced to indicate dissatisfaction.



In such a scenario, Sentry's video QoE score will drop accordingly to simulate a viewer's dissatisfaction level based on how the picture looks on the screen. The score takes into account the location and size of the impairments as well as their duration and frequency. **Figure 3** shows how the video QoE score (in blue) gets reduced to indicate customers' dissatisfaction with the video quality, while the audio QoE score (in red) gets reduced to indicate bad audio quality.

It is worth noting that not all products' QoE measurements can be regarded as accurately representing the viewer's experience. For example, a system performing a statistical level estimate of quality at the GOP (Group of Picture) level will not be able to score the QoE as accurately as Sentry, which analyses (makes actual measurements) at the slice, macro block and block level. **Figure 4** shows the relationship among GOP, Picture, Slice, Macroblock, and Block.

Figure 4. Relationship in video sequence.



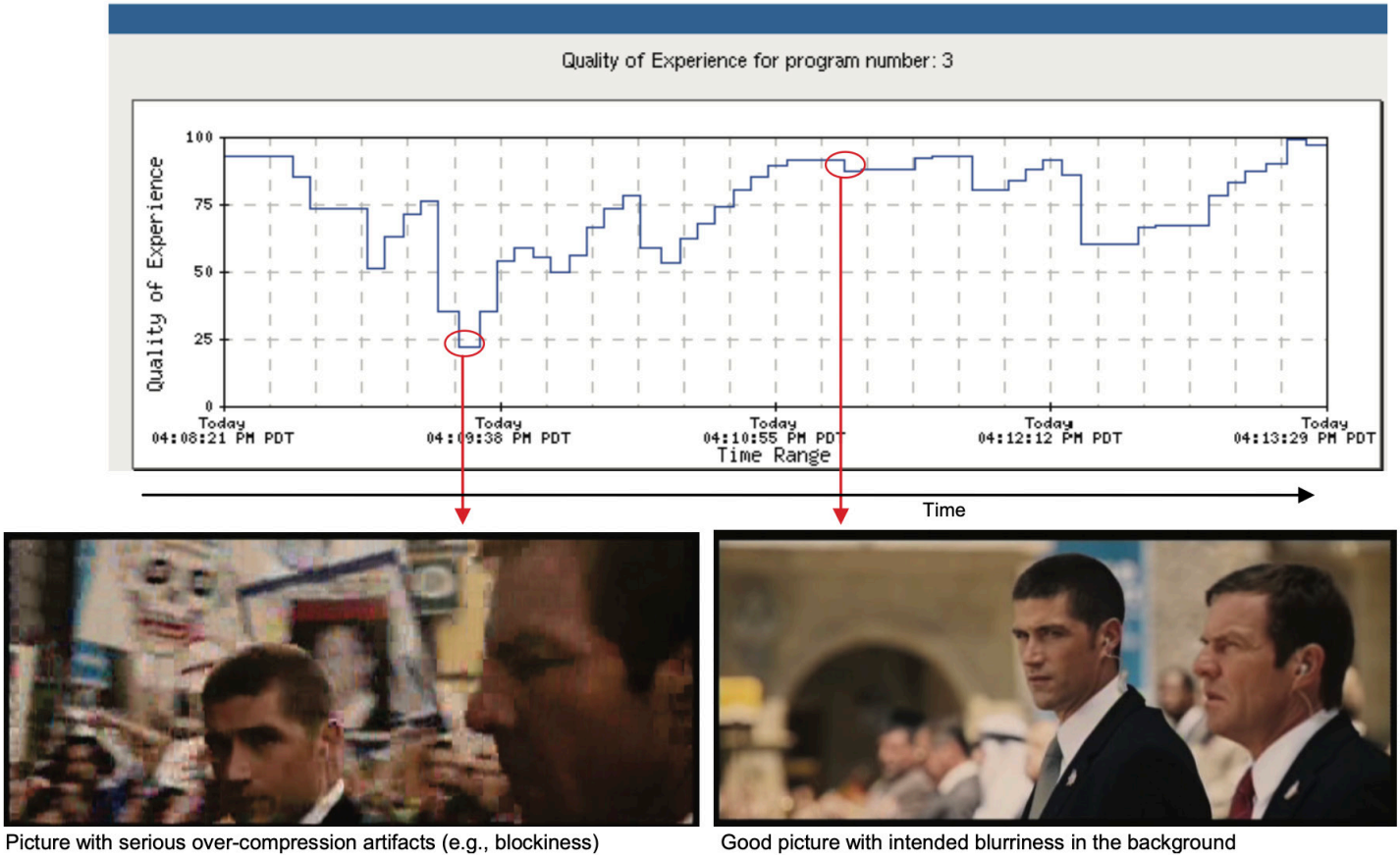
Over-Compression Artifacts and Perceptual Video Quality (PVQ)

Unlike macroblocking, which is induced by errors in picture content, over-compression artifacts can take place even though the video has no syntax errors in the payload and the picture is structured correctly for the screen. Nevertheless, the picture quality seems degraded to the viewers. This phenomenon often takes place in video with high motion and complex scenes when there are not enough "bits" available in the compressed video to present the details needed to deliver a high quality picture.

Sentry is also able to accurately detect these non-error-related video artifacts and score them as "eMOS", or effective MOS, which ranks video quality in a way similar to the Mean Opinion Score (MOS) used for Voice over IP. eMOS can evaluate the perceptual video quality in the compressed domain when there are no technical non-compliance errors in the transport stream. This sophisticated, important analysis allows operators to detect over compressed video and take appropriate corrective action.

Figure 5 shows Sentry correctly scoring the picture on the left (with compression artifacts) and the picture on the right (with no compression artifacts but intended lack of focus in the background).

Figure 5. Sentry correctly scoring.



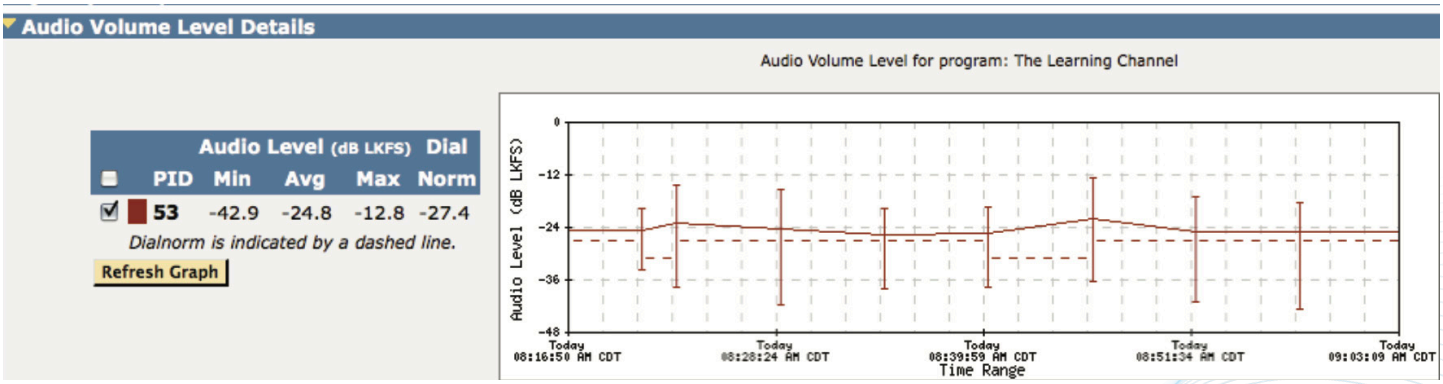
Picture with serious over-compression artifacts (e.g., blockiness)

Good picture with intended blurriness in the background

Audio

Another important QoE consideration is audio. **Figure 6** shows Sentry's audio level detail chart (which illustrates how a subscriber's perceived audio level changes through time: the lower the level of the solid line (audio mean value), the quieter the audio is). The candlestick indicates the minimum and maximum audio volume for that time period, with the Dolby AC-3 dial norm value shown in a dotted line.

Figure 6. Sentry audio level detail chart.



Different types of content need monitoring in different ways and to different levels. Sentry's innovative program groups and alert templates allow users to group, monitor and set alert thresholds specific to content type (HD, SD, long-tail); content provider; or content destination. This allows operators to monitor to their own internal standards or those of their business partners, making Sentry an ideal tool to assist with Service Level Agreement (SLA) verification.

Setting Up Alerts Based on QoE Scores

An important parameter of Sentry's video and audio QoE scoring capability is that a user can customize the alert trigger conditions by how bad the subscriber experience (i.e., the QoE score) becomes, based on the duration and the frequency of each occurrence.

Once an alert is set up, operators can objectively evaluate their service quality across other systems and networks at different locations. The goal is to make sure that severe subscriber-impacting issues can be quickly identified, isolated, and resolved.

Deciding what QoE alerts to set, the thresholds to use, and where to place monitoring products in the network will vary from operator to operator, but in each case is based on the expectations of their customers rather than on a set of theoretical standards.

Ideally, operators should consider QoE video and audio assurance monitoring after any video and/or audio processing network element (i.e., post encoding, transcoding, rate shaping, stat-muxing, and splicing), as far out on the network as possible. Obviously, users can also monitor other places in the network, such as content acquisition points, to get fast alert correlation, problem isolation, and troubleshooting.

The benefits of using Sentry for QoE monitoring can be quickly realized. The 24×7 real-time monitoring capacity, reporting capability, ease of use, and key feature upgradability of Sentry leads to fewer calls from subscribers and fewer truck rolls, resulting in substantial reductions in operating expense.

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Conclusion

Standards-based measurements such as TR 101 290 are necessary but not sufficient for a complete video network monitoring solution. Real-time QoE monitoring using Sentry allows users to concurrently monitor the quality and performance of the video and audio QoE, audio loudness, Transport Stream, MPEG and IP statistics and digital ad insertion events. Traditional tools in almost all cases monitor only a subset of these important quality metrics and often require different products and multiple probes to do even that. Telestream's Sentry provides comprehensive video quality monitoring in a single, integrated and scalable solution.

Key success metrics of the service and key performance indicators of the operation should be based on subscribers' perceived quality and their experience with video services. It's difficult for operators to manage the business without a reliable, repeatable, and automated method to measure actual subscriber experience, because they do not know which problems to prioritize and focus valuable resources on. Sentry's subscriber experience-based monitoring enables operators to continually measure subscriber QoE in an understandable, easy-to-track, and cost-effective way. This represents a significant competitive advantage that operators must consider. The benefits of using Sentry to assure video and audio quality can be quickly realised, with lower call centre loading, reduced MTTR, fewer truck rolls and better managed Service Level Agreements, all resulting in OPEX reductions - and happy viewers.

Glossary of Terms

DVB – Digital Video Broadcast is a series of internationally accepted standards, relating to digital television systems.

ETSI – European Telecommunications Standards Institute is a standardization body for telecommunications systems in Europe, although many of these standards, such as the GSM mobile standard have been adopted elsewhere.

GOP – Group Of Pictures is a series of successive pictures within a coded video stream. The GOP structure defines the order in which successive frame types are contained within each GOP.

HD – High Definition is any video system with higher resolution than Standard Definition (SD) video which commonly has resolutions of 480i or 576i. The most common HD resolutions are 720p and 1080i.

OPEX – Operational Expenditure occurs when an organization spends money in maintaining its ongoing operations.

MOS – Mean Opinion Score is a subjective test methodology for obtaining a customer view of the operational quality of a network or service. MOS scoring was originally developed in the telecommunications industry to score telephony voice quality.

QoE – Quality of Experience is a measure of the overall level of customer satisfaction with a vendor.

QoS – Quality of Service is a measure of network and system performance against pre-defined standards.

SLA – Service Level Agreement is the part of a contract between a supplier and a customer that defines the level of service to be maintained.

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About Telestream

Telestream is a globally recognized leading provider of innovative solutions that enable the creation, processing, and delivery of digital media. The company's media workflow and measurement technologies are designed to drive efficiency and scale across the media supply chain through AI.

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