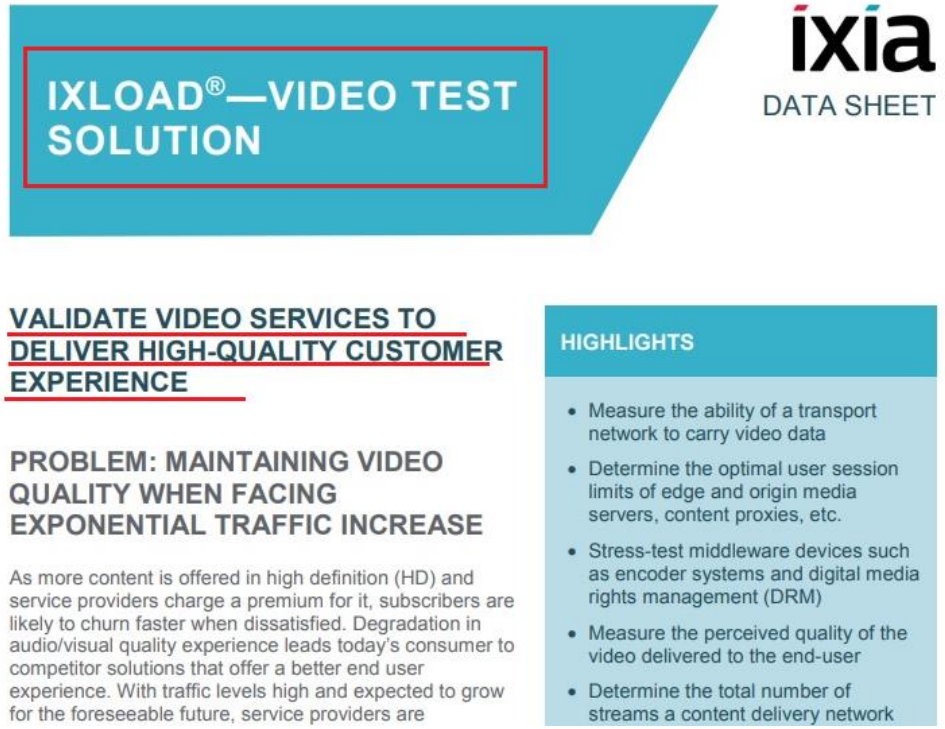
EXHIBIT C

US8970710B2	Keysights - IXLOAD®—VIDEO TEST SOLUTION ("The accused instrumentality")
1. A method for measuring a quality of video, comprising:	The accused instrumentality practices a method for measuring a quality of video (e.g., perceptual video quality estimation provides the measurement of video quality metrics).  IXLOAD®—VIDEO TEST SOLUTION ixia DATA SHEET VALIDATE VIDEO SERVICES TO DELIVER HIGH-QUALITY CUSTOMER EXPERIENCE PROBLEM: MAINTAINING VIDEO QUALITY WHEN FACING EXPONENTIAL TRAFFIC INCREASE As more content is offered in high definition (HD) and service providers charge a premium for it, subscribers are likely to churn faster when dissatisfied. Degradation in audio/visual quality experience leads today's consumer to competitor solutions that offer a better end user experience. With traffic levels high and expected to grow for the foreseeable future, service providers are HIGHLIGHTS • Measure the ability of a transport network to carry video data • Determine the optimal user session limits of edge and origin media servers, content proxies, etc. • Stress-test middleware devices such as encoder systems and digital media rights management (DRM) • Measure the perceived quality of the video delivered to the end-user • Determine the total number of streams a content delivery network https://www.tncenter.com/wp-content/uploads/Datasheet-IxLoad-Video.pdf

Video Quality Assessment for IPTV, VoD

IxLoad evaluates the performance of video services delivered over an IP network and provides a comprehensive solution for testing IPTV networks, video networks, and other devices that carry video traffic. IxLoad emulates true video on demand (VoD), IPTV subscribers, and video servers sending real-time full motion video. IxLoad uses network, transport, and perceptual video quality techniques in real-time to measure the impact of delivering video over an IP network.

Quality of experience (QoE) refers to the overall effectiveness of a service or product. In the case of video content delivered to the home by cable operators or new Telco service provider entrants, it includes all aspects of the video delivery. And as more content is offered in high definition (HD) and providers charge a premium for it, the audio/visual quality experience increasingly plays a key role in customers subscribing to and keeping the services. As a result, assessing video quality as part of service pre-deployment testing is a cornerstone for success in the market.

header information

- Automatic detection of group of pictures (GoP) structure, bit rate, and frame information
- Comprehensive frame-level analysis, including IPB frames, I-Frame gap
- Uses frame-based loss analysis to provide accurate measurements than loss alone
- Video scene analysis gives indication on the nature of content (detail, motion, panning)

Due to its computational efficiency, IxLoad supports hundreds of simultaneous users and active video streams. MOS for video, audio and multimedia are produced for each stream.

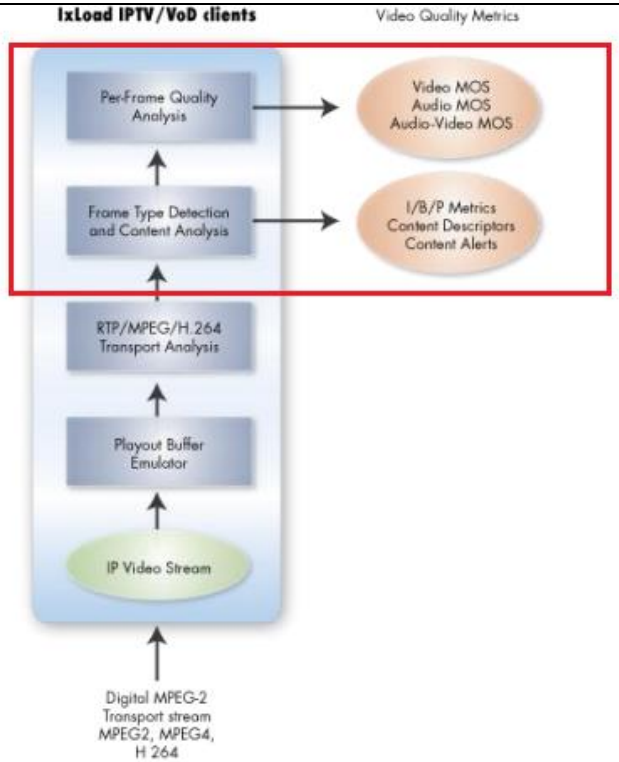
Conducting Perceptual Video Quality Analysis

Ixia recommends using a no-reference (NR) perceptual video quality estimation technique to evaluate the QoE performance of video services delivered over an IP network. Using this estimation technique provides a highly correlated and accurate performance measurement of hundreds of video streams simultaneously.

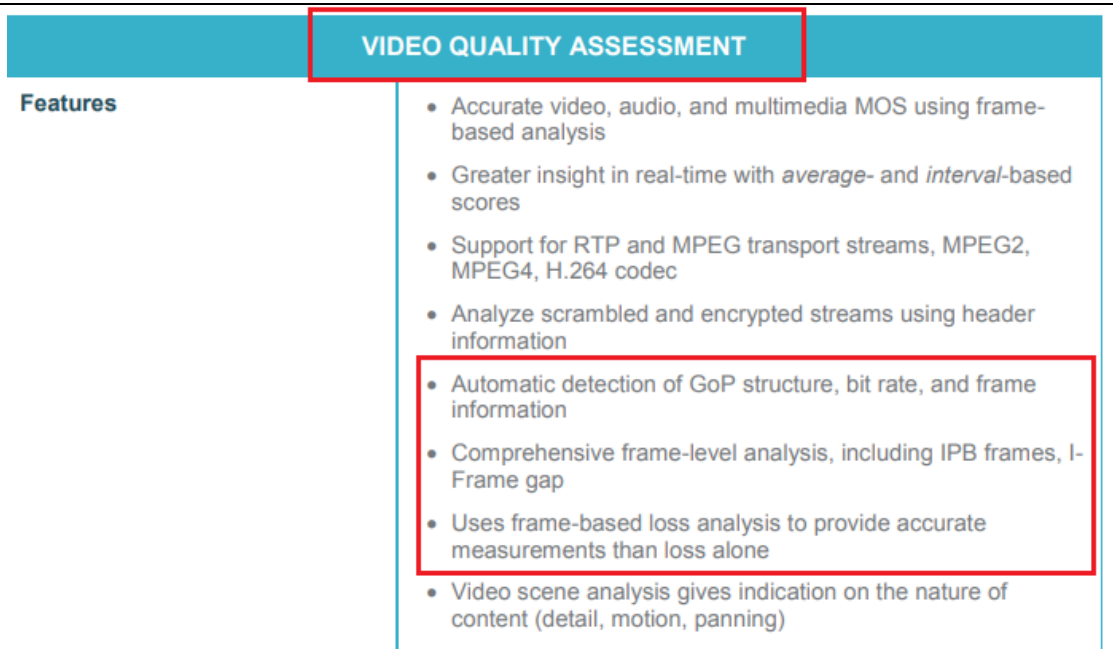
It is important to first establish a baseline of key video quality metrics for video sequences in a controlled environment. A controlled environment is a steady-state/constant utilization period where the video sequences are played over the shortest and most efficient transmission path. This environment allows for finding the "best" average video quality scores.

After establishing baseline values, transfer the video clips to any real environment and their performance can be measured by obtaining video quality scores. Compare the real-world video quality metrics to the baseline scores obtained from the controlled environment. The score comparison provides understanding as to the network or device-under-test's impact on the video and QoE performance. A test tool should also provide relevant debug information so as to suggest the reasoning for the MOS.

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	 https://www.tncenter.com/wp-content/uploads/Datasheet-IxLoad-Video.pdf
generating a frame loss pattern of the video by recording, in sequence, a status for every successive frame in a group of frames and establishing for each such group of frames an arrangement indicating whether each frame in the group is lost or successfully transmitted relative to all frames in the group	The accused instrumentality practices generating a frame loss pattern of the video by recording, in sequence, a status for every successive frame in a group of frames and establishing for each such group of frames an arrangement indicating whether each frame in the group is lost or successfully transmitted relative to all frames in the group. As shown below, the frame loss pattern is determined by recording statistics corresponding to each frame upon detection of group of pictures (GoP) denotes different frames such as I frame, B frame, P frame. The statistics includes the status of each frame such as successfully received frames and lost or impaired frames.

	ixia DATA SHEET The video quality algorithm provides a comprehensive list of metrics. The following reference section details video measurement statistics and how they are used. VQmon/HD reports Relative Mean Opinion Score -Video (MOS-V) and Absolute MOS-V scores. Average scores account for all packets from the start of a stream. Interval scores account for packets since the previous statistic collection. **Relative MOS-V** is an estimated perceptual quality score that considers the effects of codec/quantization level, the impact of IP impairments (such as packet loss) on the group of pictures (GoP) structure and video content, and the effectiveness of loss concealment methods. It does not consider the image size/resolution, frame rate, or scanning method (interlaced vs. progressive). **Absolute MOS-V** is an estimated perceptual quality score that considers all the above-mentioned factors *as well as* image resolution, frame rate, and the use of progressive vs. interlaced scanning. Some video formats offer inherently higher perceptual quality than others. For example, in unimpaired conditions, the quality of an HD broadcast will be higher than that of SD, 1080p better than 1080i or 720p, and 60 frames per second (fps) better than 30 fps. VQmon/HD's Absolute MOS-V score takes these factors into consideration, and provides an accurate estimate of "overall" perceptual quality by considering all aspects that can impact visual quality. https://www.tncenter.com/wp-content/uploads/Datasheet-IxLoad-Video.pdf

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Conditional Statistics – Video Description

Statistic	Conditional Views	Description
Codec Type	User	The video CODEC type for the video stream.
GOP Structure	User	The GOP structure expressed as a series of 'I', 'B', 'P' characters describing the frame type series in the structure.
Avg GOP Length	User	The average GOP length, in frames.
Avg Inter I Frame Gap (Frames)	User	The average gap, in frames, between I frames (excluding the I-frames)
Frame Width	User	The video frame image width, in pixels.
Frame Height	User	The video frame image height, in pixels.

Source: IxLoad.pdf

Conditional Statistics – Frame Statistics

Statistic	Conditional Views	Description
I Frames Rcvd	User	The number of video I-frames received.
I Frames Impaired	User	The number of video I-frames impaired by packet loss or discard.
P Frames Rcvd	User	The number of video P-frames received.
P Frames Impaired	User	The number of video P-frames impaired by packet loss or discard.
B Frames Rcvd	User	The number of video B-frames received.
B Frames Impaired	User	The number of video B-frames impaired by packet loss or discard.
SI Frames Rcvd	User	The number of video SI-frames received.

Source: IxLoad.pdf

<table>
<tr>
<td></td>
<td>
<u>Custom Reports for Video Quality</u>
Global Video Performance Metrics
<table>
<tr><th>Video Frames</th><th>Stream Throughput</th></tr>
<tr><td>Total I-Frames Received
Total P-Frames Received
Total B-Frames Received
Total I-Frames Impaired
Total P-Frames Impaired
Total B-Frames Impaired</td><td>Average Video bandwidth
Average I-frame bandwidth
Average P-frame bandwidth
Average B-frame bandwidth</td></tr>
<tr><td>Relative MOS</td><td>Absolute MOS</td></tr>
<tr><td>Average Complete MOS V</td><td>Average Complete MOS V
Average Complete MOS A
Average Complete MOS AV</td></tr>
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Source: IxLoad.pdf
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<tr>
<td>evaluating the quality of the video as a function of the generated frame loss pattern</td>
<td>The accused instrumentality practices evaluating the quality of the video as a function of the generated frame loss pattern.

As shown below, the statistics of successfully received and impaired frames provides evaluation of the quality of video in the form of mean opinion score (e.g., MOS V score).</td>
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</table>

	ixia DATA SHEET The video quality algorithm provides a comprehensive list of metrics. The following reference section details video measurement statistics and how they are used. VQmon/HD reports Relative Mean Opinion Score -Video (MOS-V) and Absolute MOS-V scores. Average scores account for all packets from the start of a stream. Interval scores account for packets since the previous statistic collection. **Relative MOS-V** is an estimated perceptual quality score that considers the effects of codec/quantization level, the impact of IP impairments (such as packet loss) on the group of pictures (GoP) structure and video content, and the effectiveness of loss concealment methods. It does not consider the image size/resolution, frame rate, or scanning method (interlaced vs. progressive). **Absolute MOS-V** is an estimated perceptual quality score that considers all the above-mentioned factors *as well as* image resolution, frame rate, and the use of progressive vs. interlaced scanning. Some video formats offer inherently higher perceptual quality than others. For example, in unimpaired conditions, the quality of an HD broadcast will be higher than that of SD, 1080p better than 1080i or 720p, and 60 frames per second (fps) better than 30 fps. VQmon/HD's Absolute MOS-V score takes these factors into consideration, and provides an accurate estimate of "overall" perceptual quality by considering all aspects that can impact visual quality. https://www.tncenter.com/wp-content/uploads/Datasheet-IxLoad-Video.pdf

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P Frames Impaired	User	The number of video P-frames impaired by packet loss or discard.
B Frames Rcvd	User	The number of video B-frames received.
B Frames Impaired	User	The number of video B-frames impaired by packet loss or discard.
SI Frames Rcvd	User	The number of video SI-frames received.

Source: IxLoad.pdf

Custom Reports for Video Quality

Global Video Performance Metrics

Video Frames	Stream Throughput
Total I-Frames Received	Average Video bandwidth
Total P-Frames Received	Average I-frame bandwidth
Total B-Frames Received	Average P-frame bandwidth
Total I-Frames Impaired	Average B-frame bandwidth
Total P-Frames Impaired	
Total B-Frames Impaired	
Relative MOS	**Absolute MOS**
Average Complete MOS V	Average Complete MOS V
	Average Complete MOS A
	Average Complete MOS AV

Source: IxLoad.pdf

Per Stream – Absolute and Relative Mean Opinion Score (MOS)

Statistic	Description
Average Absolute MOSV	Absolute MOS for the video stream, averaged over the statistics Update Interval configured on the video client Statistics Options tab.
Average Relative MOSV	Relative MOS for the video stream, averaged over the statistics Update Interval configured on the video client Statistics Options tab
Average Absolute MOSA	Absolute MOS for the audio stream, averaged from stream start to the current time.
Average Absolute MOSAV	Audio/video (multimedia) MOS for the stream, averaged from stream start to the current time.
Interval Absolute MOSV	Absolute MOS for the video stream, averaged over the statistics Update Interval configured on the video client Statistics Options tab.
Interval Relative MOSV	Relative MOS for the video stream, averaged over the statistics Update Interval configured on the video client Statistics Options tab.

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