*Digital television broadcast systems based on MPEG can significantly compress video information from hundreds of megabits with very little user perceived picture quality degradation. This is the case as long as everything goes well. However, given the complexity of today's digital television broadcast chain, problems can give rise to poor picture quality being delivered to the end user. This application note explores picture quality assessment and the Pixelmetrix Video Quality Index™ (VQI) – a component of the Electronic Couch Potato™ (ECP).*

Background

Digital television broadcast systems based on MPEG can compress video information from hundreds of megabits per second to only a few mega with very little user perceived picture quality degradation. This is the case as long as everything goes well. However, given the complexity of today's digital television broadcast chain, problems can give rise to poor picture quality being delivered to the end user.

Objective picture quality measurement tools like the Video Quality Index™ (VQI) on the Electronic Couch Potato™ (ECP) can be used to monitor these problems, set alarms on specific thresholds, and alert operators to investigate and isolate fault in the network.
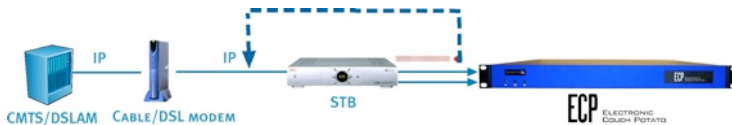
In addition to the alarm thresholds, one can configure VQI on the ECP to periodically log picture quality over a user-defined interval. For each measurement interval, the minimum, maximum and average picture quality points are recorded. Finally, with a click of the mouse, graphs of picture quality can be created for long-term trend analysis.
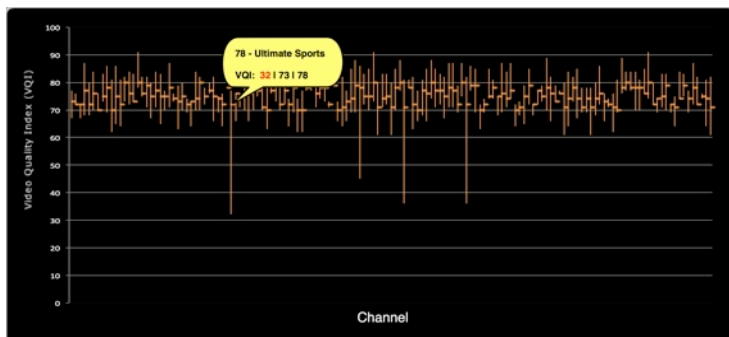
In all, picture quality assessment tools augment the other important components of a total broadcast quality management system, namely RF signal monitoring, MPEG-2/H.264 Transport Stream monitoring and Broadcast Content Validation.

What is Poor Video Quality?

The MPEG-2/H.264 video codec (compression and decompression) model exploits spatial and temporal redundancy in video to reduce the amount of information required to describe moving pictures.

Spatial redundancy is the picture property where horizontally and vertically adjacent pixels have a very high probability of being of the same intensity (luminance) and/or color (chrominance). Temporal redundancy is the picture property where similarly located pixels of sequential pictures also have a very high probability of being of the same luminance and/or chrominance.

MPEG-2/H.264 uses discrete cosine transforms (DCT) to modify the pixel spatial data representation to a frequency domain representation. The frequency domain data is quantized (less visible features are truncated and thrown away) and the remaining bits are compressed using highly efficient lossless compression. All pixel data are DCT converted based on fixed 8 x 8 blocks in MPEG-2 and an assortment of variable sizes in H.264.

Temporal redundancy is exploited through using *difference between* coding and motion vectors.

When things go wrong, the most typical visual artifact is tiling or blocking. This tiling effect comes from an imperfect restoration of the original image through the inverse DCT. As information is removed after the DCT is performed, the artifact preserves the shape of the original data that went into the DCT.

Tiling is not only the most common type of video defect in MPEG-2/H.264 systems, it is also the defect that is most noticeable and annoying to viewers. Thus, a system that can measure the severity of tiling can be used as an effective objective picture quality measurement tool.

Pixelmetrix
c o r p o r a t i o n

Video Quality Index™

The main task of the Pixelmetrix Video Quality Index (VQI) is to find tiles and/or blocking and measure its visibility within each video picture frame.

The VQI on the ECP scans each picture to evaluate the received video, and identify common picture artifacts such as macro-blocking, tiling and pixelization. Results are combined to a single, integrated score in the Video Quality Index from 1 to 100. While scanning, historical min, max and average VQI values are maintained for each channel, and alarms can be set on exceptions.

The picture quality at the receiver end is influenced by various factors. Video Quality Analysis algorithms are assigned to detect those distortions and calculate a Video Quality Index describing video quality level.

Considering those elements that might cause picture quality degradation, the complete television delivery path consists of three main components or activities: encoding, transmission and transcoding. The Pixelmetrix VQI algorithm considers common visual artifacts created by typical impairments within each one of those components.

Specifically, soft blocking impairments related to encoding or transcoding are most often caused by setting the bit rate too low on MPEG-2 encoders.

As an improvement over MPEG-2, the H.264 toolset contains specific technologies to limit the impact of soft blocking impairments. The result, however, is that the picture becomes blurry. Such blurring artifacts are the direct consequence of setting the bit rate too low on H.264 encoders.

Bad Encoding or Transcoding

MPEG-2 and H.264 encoders have a tremendous number of complex settings which must be properly configured for optimum picture quality. While advances have been made in encoder control systems, full understanding of all the settings remains the domain of a limited set of experts. Furthermore, material originally encoded at higher quality MPEG-2 is often transcoded to much lower bit rates using H.264 for internet or IPTV delivery. In that case, recompression of the content can create additional impairments.

Transmission Errors

Whether the encoders are MPEG-2 or H.264, the television transport mechanism has been standardized on the MPEG-2 transport stream. Video is encapsulated in MPEG-TS packets, which in turn are sent over the physical media – whether that be an RF link (eg satellite, terrestrial, cable) or over an IP transport. All physical media transport types suffer from numerous interference, impairments and corruption. That corruption will invariably cause the loss of MPEG packets.

Visual impairments caused by packet loss during transmission have their own unique characteristics – which are captured and analyzed by the Pixelmetrix VQI™.

Monitoring Line Up

The **DVStation** is a single self-contained monitoring station that

can analyze thousands of parameters within hundreds of digital television signals. Through the use of plug-in modules and parallel processing, it can monitor all these parameters real-time, simultaneously and continuously.

The **DVStation-Remote** is a compact version of the flagship DVStation, ideal for smaller-sized facilities. Consisting of one to four book-sized Pod modules and a single 1U rack-mounted Remote Controller, the system is

operated through a LAN or dial up telephone, allowing database or user access from a personal computer.

The **DVStation-Mini²** provides a compact and cost-effective way for terrestrial, cable and satellite operators to maintain visibility of network quality and performance. It offers comprehensive TS monitoring and is optimized for remote site deployment.

The **DVStor²** is an ASI/IP self-contained, recording and playback system. In addition to the standard Record and Playback functions, the new Delay feature makes it perfect for Disaster

Recovery or Network Delay. It also offers one of the highest storage densities in the industry. RAID-6 and redundant power supplies further protect archived content.

The **DVShift** is ideal for delayed rebroadcast across time zones and provides stable, user-programmable delays from seconds to days. It is a great improvement over the conventional approach of utilizing separate audio/video delay equipment which simply does not work with the advent of multi-channel audio, multiple subtitles or closed captioning, and especially so with multimedia content such as MHP.

The **DVProbe-S2** is a compact, future-proof monitoring solution for satellite networks, while the **DVProbe-C** is developed for CATV networks, and connects directly to the QAM RF cable network.

IPTV Solutions

The **DVStation-IP³** offers a one-stop monitoring engine for IP and Transport Stream Analysis, detailed service visualization and IP Headend Output verification for IPTV networks. It provides, on all

services, MPEG-2 and H.264 main profile thumbnails, Media Delivery Index (MDI) which allows packet loss and jitter measurements as well as video presence, freeze or blackout displays.

The **Electronic Couch Potato™ (ECP)** is a "programmable test robot" deployed after the STB. It uses a built-in IR controller and

analyzes the decoded signal to fully and truly evaluate the report the end users' experience for delivered video services.

The **IPGen** is a high-performance, cost-effective tool for the evaluation, compliance testing and verification of networks, monitoring and equipment analysis.

Network Management Solutions
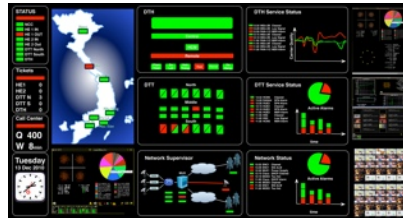
Consolidator™, a scalable enterprise grade network management platform, provides centralized access to all data and visibility to key fault and performance information. Combining data from different monitoring points within the network, the Consolidator tracks all probes in real time, thus facilitating faster response time for resolving faults and improving QoS.

StationView™ is a simple and effective monitoring tool that consolidates alarms and status from up to 15 remotely located DVStation probes. Packaged in a convenient ready-to-go appliance, the StationView utilizes the power and flexibility of SNMP without the complexity and hassle of heavy network management systems.

About Pixelmetrix

Pixelmetrix Corporation is the global expert in Preventive Monitoring for digital, cable and IPTV networks. The company provides equipment and network intelligence systems to television broadcasters for the management and monitoring of quality of service and quality of experience. Headquartered in Singapore, Pixelmetrix has offices in the United States and Europe.

Pixelmetrix has been conferred the Cable & Satellite International Highly Commended Product of the Year Award 2010, Frost & Sullivan Industrial Technologies Award 2009, C+T Technology Development Award 2009, Engineering & Technology Emmy® Award 2007, Broadcast Engineering publication Pick Hit Award 2005 and 2008, TV Technology publication STAR Awards (Superior Technology Award Recipient) 2000, 2004 and 2007, BIRTV Product of the Year Award 2006, Cable-Satellite/Mediacast Product of the Year Awards 2003 and 2004, as well as the Peter Wayne Award 2000, for Best Design and Innovation.

For More Information

To learn more about our Test, Measurement & Monitoring solutions, request a demo, or learn how Pixelmetrix might help you optimize video network integrity, contact us today!

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