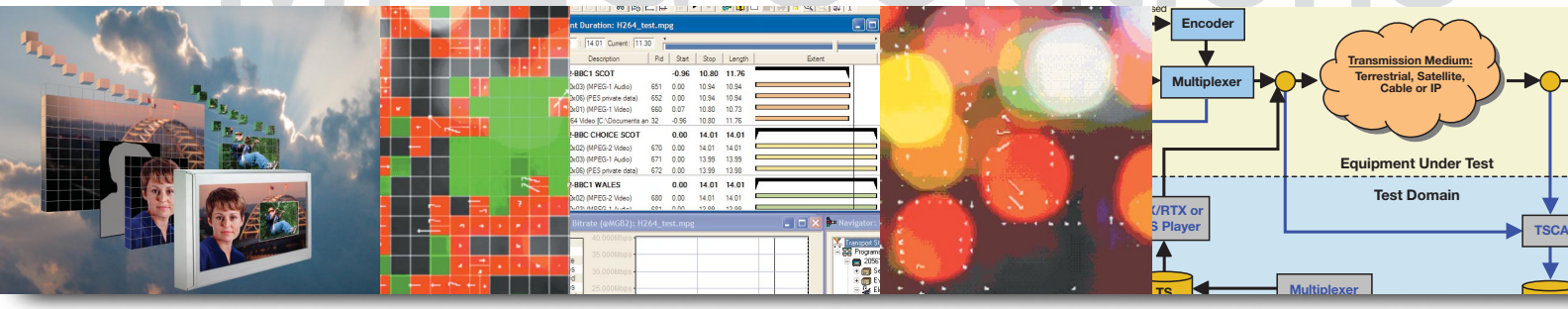
MPEG Solutions



Transition to H.264 Video

Tektronix

Enabling Innovation

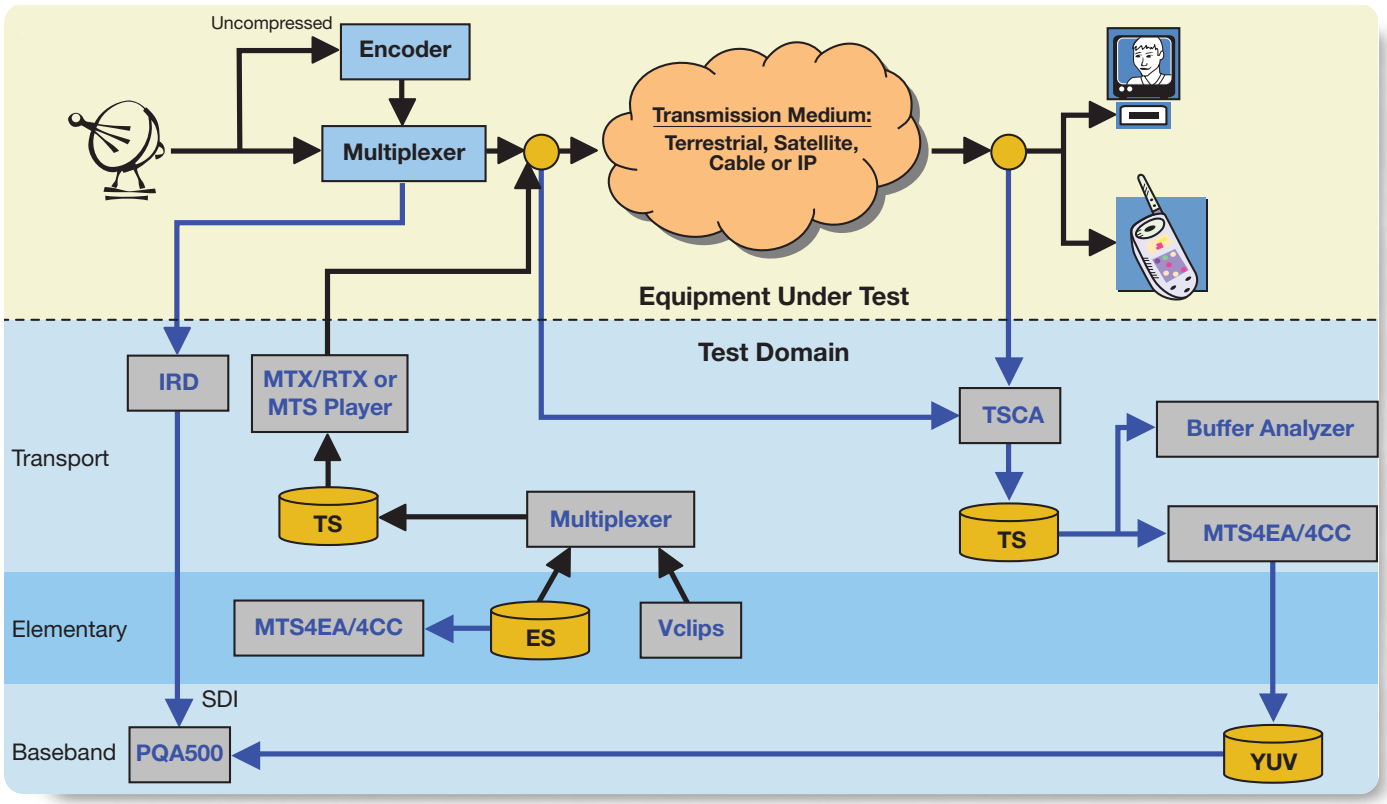
Introduction/Overview

The digital broadcast industry is currently embracing multiple technology advancements, including High Definition, IPTV and Mobile Video. The key enabler for these technologies is the compression efficiencies and therefore lower bandwidth requirements of the H.264/AVC video CODEC. Extensions to the MPEG-2 standard to incorporate H.264, as an additional Elementary Stream (ES) type within an MPEG-2 Transport Stream (TS), have made it accessible and attractive to Broadcasters and Network Operators.

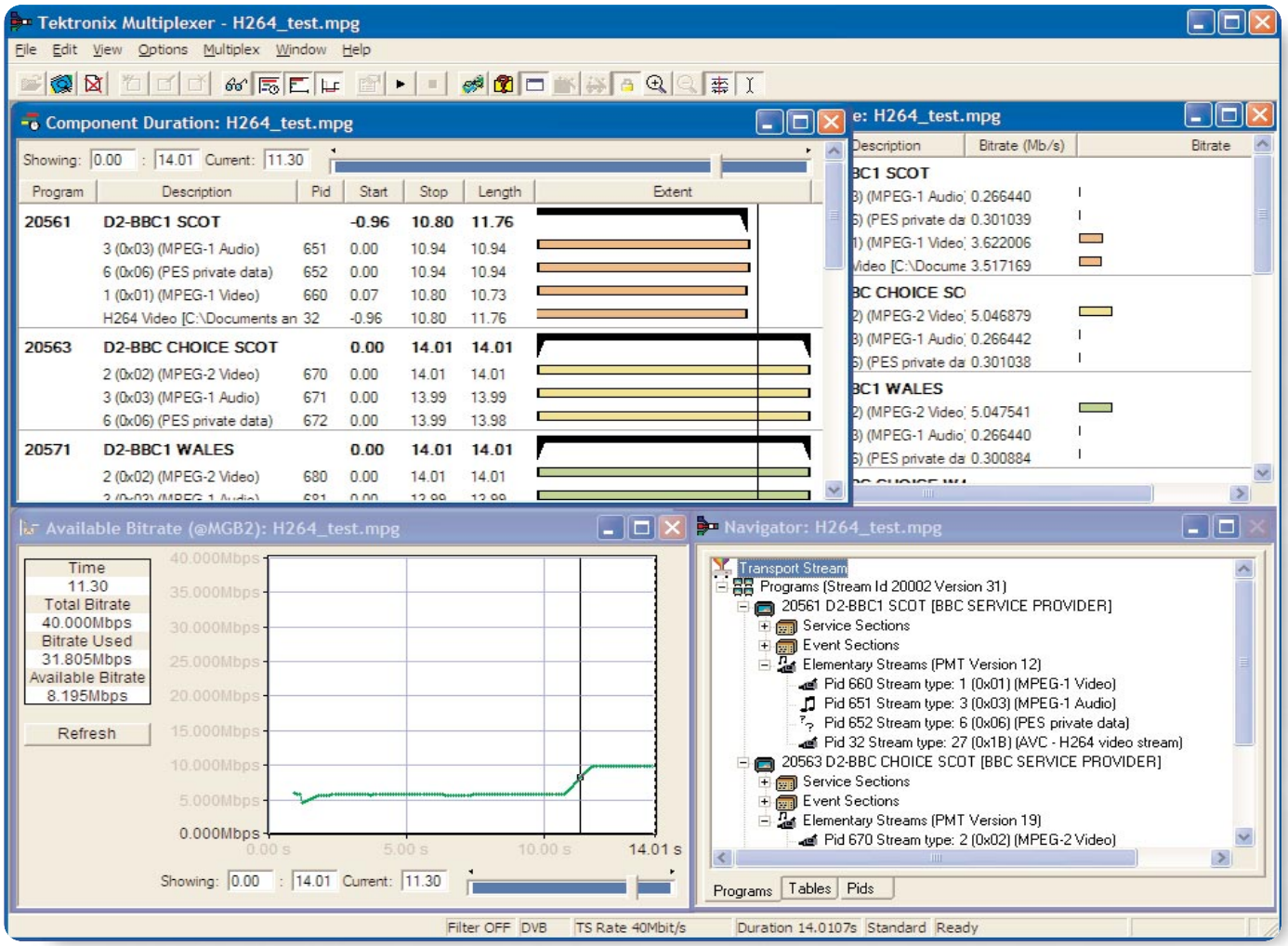
H.264 offers around twice the compression efficiency as compared with MPEG-2 video; however the increase in processing complexity to achieve this gain is also a magnitude of 2. This presents a challenge for not only equipment manufacturers developing H.264 variants, but also for Broadcasters and Network Operators deploying and maintaining H.264 solutions.

Where do Tektronix Products Fit in the Network?

Tektronix is able to support an end-to-end H.264 solution, encompassing the 3 main phases, Design, Deploy and Manage and is able to address key questions that arise when transitioning to H.264.



▶ **Figure 1.** *Test Equipment Connectivity within a Typical Broadcast Network.*



▶ **Figure 2.** *Multiplexer.*

Key Questions to Ask When Transitioning to H.264

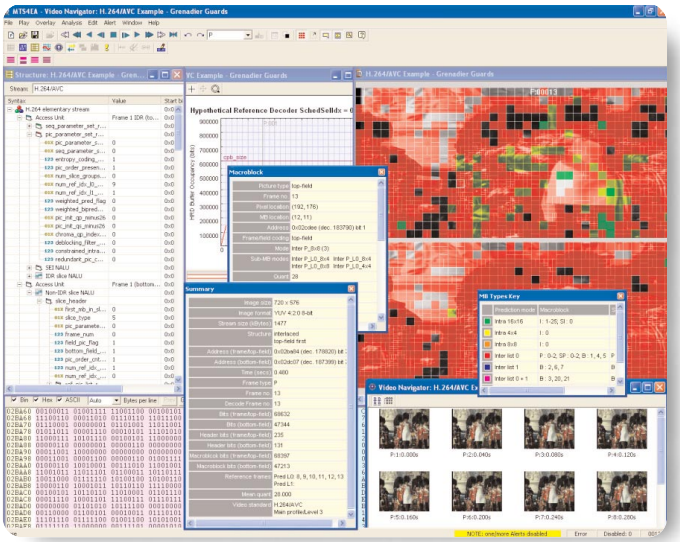
1. How can I obtain a representative set of H.264 test streams?
2. What picture quality do I have and how does it vary with bitrate?
3. Will my H.264 stream be decoded successfully by all Set Top Boxes in the marketplace?
4. T&M analysis tools seem targeted at R&D labs; what about device and equipment verification, installation and support?
5. How can interoperability be guaranteed between various equipment vendors?
6. How does H.264 impact channel change (zap) times and what are the consequences?

Design

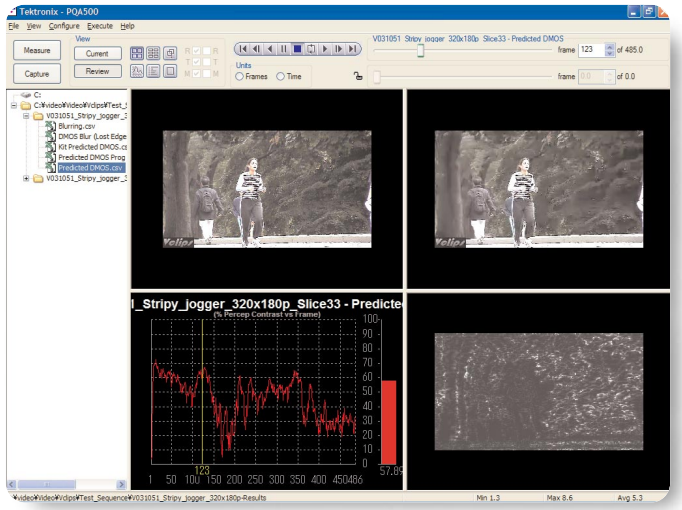
1. How can I obtain a representative set of H.264 test streams?

Tektronix offers a diverse set of short video clips, known as Vclips to test video encoders and decoders to the limits. The clips cover a range of formats including 720p and 1080i. The clips cover difficult subjects such as: Fine detail; high contrast and bright colours as well as effects including strobing, grids and moiré patterns. These are delivered as uncompressed YUV and compressed ES (Elementary Stream) files.

ES clips and other files can be incorporated into Transport Streams for testing network elements or set-top boxes using the Multiplexer, which handles H.264 ES files both with and without the optional SEI (Supplemental Enhancement Information) timing information. The Multiplexer is also useful for modifying existing Transport Streams that may be missing vital components or System Information (SI).



▶ **Figure 3.** *MTS4EA.*



▶ **Figure 4.** *PQA500.*

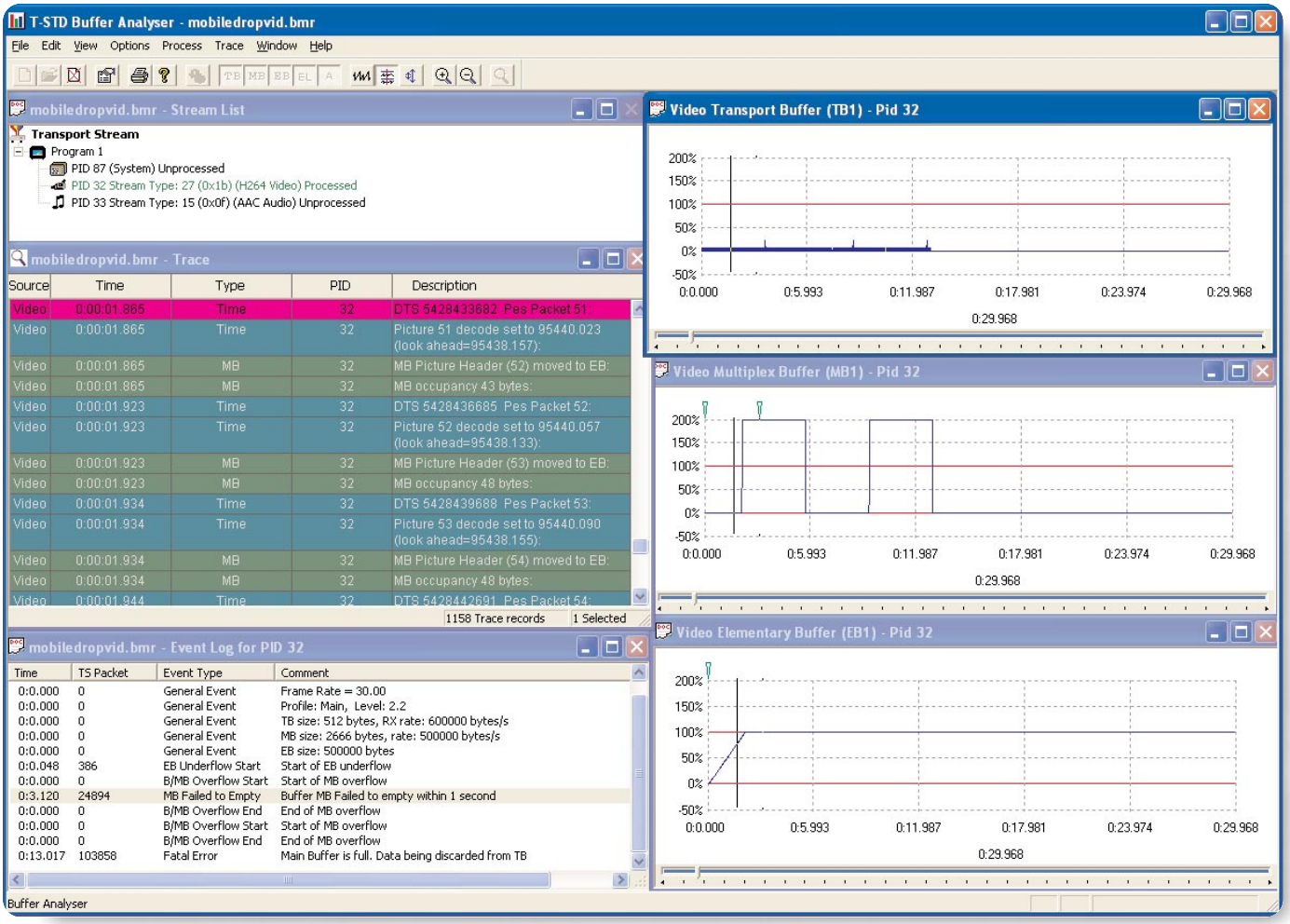
2. What picture quality do I have and how does it vary with bitrate?

The Tektronix MTS4EA ES Analyzer verifies the compliance of the encoded picture to the H.264 standard (ISO 14496 part 10). It also allows the user to play out the stream through a reference decoder and step through artefacts frame-by-frame.

As the bitrate is reduced the quantisation levels applied increase in order to reduce the macroblock sizes. On screen overlays allow the user to correlate quantisation and other metrics directly with individual picture segments.

If the source uncompressed video is available for reference then the MTS4EA is able to produce fidelity analysis measurements, such as PSNR, to further quantify degradation of the original picture.

The PQA500 Picture Quality Analyzer measures picture quality based upon the Human Vision System. It provides the predicted DMOS (Difference Mean Opinion Score) in accordance with the ITU-R BT.500 methodology for subjective television quality assessment. In addition, it allows the user to configure conditions to suit a specific application. An example might be the display and viewing environment to simulate a mobile device in sunlight.



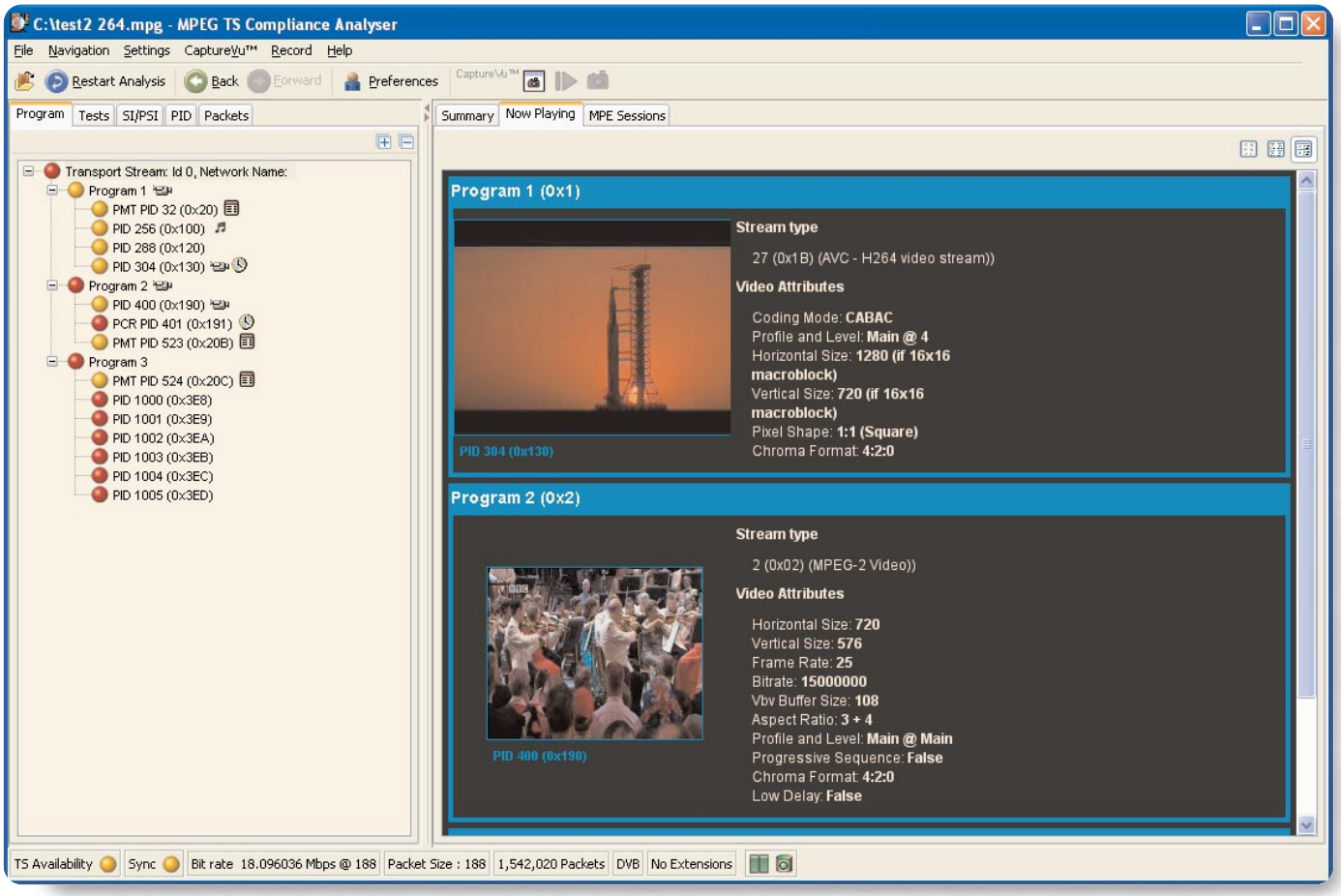
▶ **Figure 5.** *Buffer Analyzer.*

3. Will my H.264 stream be decoded successfully by all Set top boxes in the market-place?

The MTS4EA ES Analyzer and MTS4CC ES Compliance Checker both use the industry standard JM reference decoder. It is optimized to provide both complete analysis results and the minimum playout quality of any decoder that claims to comply with the H.264 standard. That is, it does not make a best effort display, which of course could mask defects displayed by some STB decoders.

STBs are very sensitive to buffer under and overflows, which can cause blocking, stuck frames or a crash. Parameters within the stream signal to a decoder which of 2 buffer models should be used, the HRD (Hypothetical Reference Decoder) or T-STD (TS System Target Decoder). The HRD model is determined by parameters contained within the ES, whereas the T-STD is determined by DTS values within the PES header. Analysis of both buffer models is available, the HRD model within the MTS4EA and MTS4CC and the T-STD model within the Buffer Analyzer.

Also important is correct SI information. The Tektronix TSCA TS Analyzer will verify compliance of all contained SI, including correct signalling of H.264 streams. The TSCA may be operated in either deferred time on a file input or in real time upon a live stream input from an ASI, IP or RF source. A thumbnail display of each video stream is included for confidence purposes, which is particularly important for real time operation. The thumbnail display also includes ES header information such as profile, level, frame rate, resolution and aspect ratio.



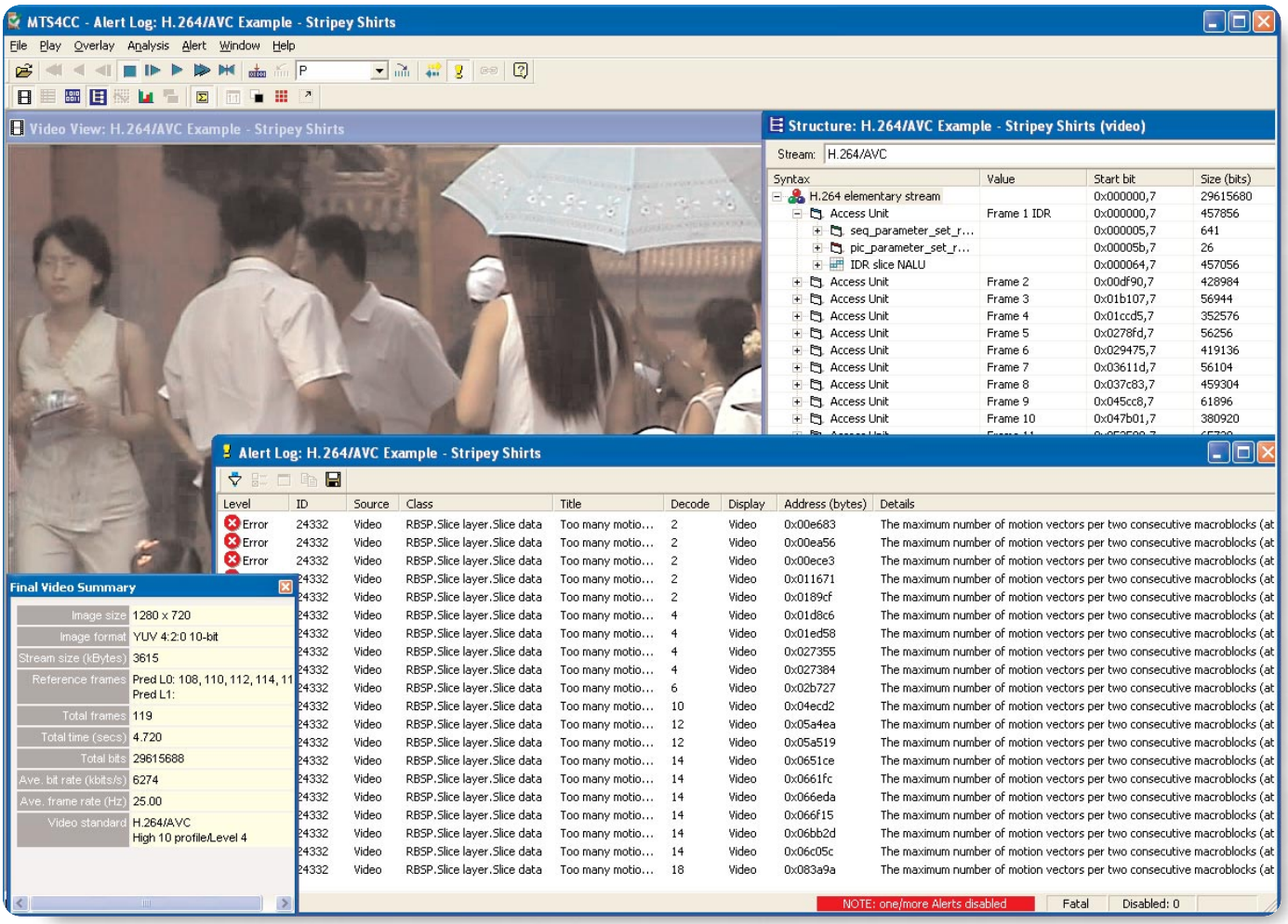
▶ **Figure 6.** *TSCA Thumbnaill.*

4. T&M analysis tools seem targeted at R&D labs; what about device and equipment verification, installation and support?

The MTS4EA is an in-depth Elementary Stream analysis tool that allows design engineers the ability to decompose a stream to determine decisions made by the encoder. Not everyone needs such a powerful tool, but they do need to verify standards compliance. The MTS4CC Compliance Checker includes identical compliance capabilities to MTS4EA, but without the advanced diagnostics capabilities.

Tektronix offers both the MTS430 Test System that includes most applications that engineers will need, and also the MTS400 Test System with minimal installed applications, which allows customers to optionally purchase only those tools that are required. Both Test Systems include real time TS input as standard.

If deferred time only analysis is preferred then all of the tools may be purchased individually as MTS4SA, MTS4EA and MTS4CC stand alone software applications for installation on the user's own PC.



▶ **Figure 7.** *MTS4CC Alerts.*

Deploy

5. How can interoperability be guaranteed between various equipment vendors?

This is a major concern for any engineer involved with migrating to a new CODEC. There is a problem somewhere in the network, but what is to blame? The key is standards compliance; if the various network components are compatible with ISO 14496 part 10, then interoperability should not be an issue. The MTS4CC is specifically designed to verify compliance of an Elementary Stream file. Combined with an MTS430 for capturing, playing and analyzing Transport Streams, this provides a powerful solution for interoperability testing both at the ES and TS layers.

Manage

6. How does H.264 impact channel change (zap) times and what are the consequences?

Zap times are mainly affected by two factors, delivery mechanism and stream Group Of Picture (GOP) length. The non-deterministic nature of IP networks can have a large impact on Zap times, in particular, the effect on IGMP Join and Leave requests.

GOP length is the number of frames between successive I frames. The drive towards HD and lower bitrates for IPTV and Mobile video, leads to encoding with longer GOPs. The consequence of using a longer GOP is that the STB has longer to wait for an I frame before it can display the first picture. The MTS4EA and MTS4CC allow the picture types and GOP length and therefore decode times to be analyzed.

The real time thumbnail display and picture display capabilities of the TSCA (as part of an MTS430) are also likely to be useful in a network monitoring and diagnostic capacity.

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