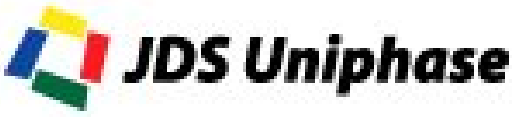

Testing Video over IP

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Testing Video over IP

Internet protocol (IP) was introduced as a means for operators to migrate to higher bandwidth transport technologies. Although it offered much more efficient and intelligent storage and routing of digital data, it was soon apparent that IP could not provide the timing and quality of service necessary for acceptable digital broadcast. The need for a new set of standards led to the formation of the Moving Picture Expert Group (MPEG) in 1987. The group had essentially one charter—figure out how to digitize audio and video signals to ensure they maintained their quality at the receiving end of the broadcast. This objective evolved into the development of MPEG-2 transport protocol, which was created from concepts based in IP. Now, nearly 20 years later, broadcasters have adopted MPEG-2 transport protocol as a universal standard for synchronization, timing, and service provisioning quality..

Today, the trend is to converge satellite uplinks and cable head-ends into IP networks so that voice, data, and video services are carried over the IP backbone to the network edge, where digital signals are modulated for an RF carrier to distribute over the last mile. When the signals reach the set-top box or receiver, they are demodulated, tuned, and decoded. Needless to say, this convergence of technologies has resulted in significantly more complicated systems and equipment, and, as a consequence, changed operators' testing needs when building and maintaining networks.

To test video over IP, all of the traditional test requirements for MPEG-2 transport still apply. These tests can be grouped into two main categories: timing and program specific information (PSI). A test to ensure that the downstream IP network can effectively support and deploy the MPEG-2 transport stream also is required.

Timing

The MPEG-2 transport protocol goes to great lengths to ensure that audio and video signals are in synch for every program. This is accomplished by synchronizing every receiver's or decoder's internal clock to the internal clock of the encoding device. The encoder includes time stamps, called program clock references (PCRs), for every program, which the receiver uses to sync its clock. This establishes a reference clock for the presentation and records decode time stamps within the actual audio and video streams.

In a simple closed system this works very nicely. In a real network, however, programs, are added and dropped from digital streams at multiple points in the broadcast chain, and the stream is carried over various transport mediums such as ASI, (or SMPTE-310) QAM, QPSK, VSB, GigE, etc. As these streams pass through each piece of equipment and every new transport medium, there is an increased opportunity for delays to be introduced or losses that impair the timing data stored in these programs. The impairments to quality may produce pixelization or macroblocking, black-outs, and freezing in addition to others, and the degree to which service is affected depends on the quality of the receiving device.

A good MPEG-2 test device will take detailed measurements of all the time stamps and timing elements in the stream. This includes PCR spacing, PCR accuracy, jitter, and drift. Although MPEG has gone to great lengths to define how timing and synchronization is implemented by broadcast equipment, there is no standard for how timing measurements are

actually taken. Thus, one MPEG-2 test instrument may give different timing measurements than another. In such circumstances it is often helpful to know what test devices the encoder manufacturers themselves use to validate their equipment. This is particularly useful when the companies are known for manufacturing higher-end products that may implement more complex or better-quality timing.

PSI Test

An MPEG-2 transport stream is comprised of an endless stream of 188-byte packets, the majority of which carry the digital audio and video payloads. Each transport stream has at least one and often multiple programs. Because there are millions of packets that must sorted through to pull out the appropriate audio and video for each presentation, a map of the contents of the transport stream is required. This map is implemented through PSI tables, which are the program association table (PAT) and program map tables (PMT). Every element within an MPEG-2 transport stream is assigned a packet ID (PID). The PAT lists the programs within the stream, and the PID numbers for the PMTs of each program. The PMT, in turn, lists the PID numbers for the audio, video, and PCR components of each program.

While this is the minimum required PSI data in an MPEG-2 transport stream, a conditional access table (CAT) that lists information related to subscription and pay-per-view options, as well as various ATSC or DVB tables containing data used for electronic program guides (EPG) may also be included.

IP Complications

One downside of broadcasting MPEG-2 transport over IP networks, is that there is no provision for quality of service (QoS) within IP. In the traditional IP environment, this is acceptable because the transferred data is being transferred from one point to another and is not intended for real-time decode. Once the transfer is complete, the data is no longer relevant to the IP transport process. For instance, a user downloading a document does nothing with the document until the download is complete. Once downloaded, the user processes the document with any application desired. If data is lost, for instance, through packet collisions between upstream and downstream traffic, this can be noted and the lost data can be resent until it is successfully received. This, however, will not work in a broadcast environment where the data must arrive in enough time for the decoder to identify it, filter out the appropriate components, rebuild the audio and video, and broadcast the program in the time it takes to turn on the television or change the channel. As a result, MPEG-2 transport streams sent over IP often suffer significantly from increased numbers of dropped packets and increased jitter or PCR problems.

From a test standpoint, it is necessary to augment an existing data test portfolio with equipment that can view the MPEG-2 transport streams and measure critical components in the MPEG-2 stream particularly the timing elements, in real time. The real-time aspect is critical because problems that are pushed down to the MPEG-2 level from the IP transport may only be apparent in real time. By extracting the MPEG-2 transport streams from the IP and examining them offline, the presence and accuracy IDs and MPEG-2 PSI data can be confirmed. This, however, provides little information on the actual timing of the received items, and it does not provide PCR and jitter measurements.

Interoperability

Interoperability is vital for operators to deliver digital broadcasts. Within any given network, there are often more than a dozen vendors of encoders, multiplexers, modulators, receivers and other broadcast equipment. With MPEG over IP, routers and switches are added to the mix, while video on demand (VOD) adds content servers and edge devices,. The problem is further compounded as the operator must figure out whose problem it is, and so begins the finger pointing. While the operator plays mediator to the associated equipment manufacturers, the call center is ringing off the hook with complaints.

MPEG-2 testing should begin in the labs and test beds prior to launching digital video services. Operators should evaluate equipment proactively by testing interoperability, defining thresholds, etc. Lab-grade MPEG-2 test equipment captures and plays back MEG-2 transport streams, creates MPEG-2 transport streams for test scenarios, and analyzes MPEG-2 transport streams in real time or offline. Additional testing can be conducted to validate the encoder quality as well as to perform extensive analysis of the audio or video streams.

Business practices require operators to reduce their equipment inventory. Consequently, operators need to conduct tests on the network equipment to verify interoperability and validate that output is compliant to MPEG-2, DVB, or ATSC standards using their lab-grade test equipment.

This holds true for troubleshooting problems once the system is live. Although testing performed in the test beds, labs, and during installation significantly reduce the occurrence of problems, it is inevitable that some problems will surface. It is under these circumstances that test speed is most crucial because delays in identifying and correcting problems will exacerbate customer dissatisfaction and increase churn.

What to test?

In a network testing and monitoring is best performed as close to the end of line as possible because this is the closest point to where subscribers receive the programs.
Troubleshooting typically begins as far downstream as possible, moving back up the broadcast chain so that MPEG-2 traffic going in and coming out of each section of the broadcast chain can be compared. Once the problem has been isolated to a specific section of the chain, which typically is the transition point between two broadcast devices, more detailed analysis is performed to identify what the problem is and where it originated. If the problems is the result of specific equipment, the manufacturer may be contacted. This eliminates finger pointing and delays in fixing the problem..

Along with MPEG-2 standards, there are a set of recommendations called ETR-290 issued by the Digital Video Broadcasting (DVB) group describe how an MPEG-2/DVB stream should operate for a quality broadcast. Highly ranked MPEG-2 analyzers have default measurements that correspond to ETR-290 recommendations, but also allow the user to adjust the error criteria for the system under test so is the results are accurate. These analyzers also list the ETR-290 performance of a transport stream, so that the operator has a general idea of the “health” of the transport stream. Results are categorized into three different levels,

- Priority One indicates errors that directly impact a receiver's ability to make the program presentation.
- Priority Two indicates timing errors likely to have a negative impact on picture quality .
- Priority Three indicates problems with the data being sent for the EPG.

Some higher-end analyzers list additional classifications of errors that are not included in the ETR-290 but are relevant to determining the health of the stream. Additionally, this equipment may also present versions of ETR-290 data from the Advanced Television Systems Committee (ATSC), in the Monitor view.

Users can check the ETR-290 (or Monitor) views for an overall status of the digital transport stream. From there they can progress through various views in the analyzer depending on the nature of the problem and check that the valid PIDs are in the stream at the expected data rates, check the MPEG-2 PSI tables, and verify the accuracy of the data They also perform detailed timing analysis (particularly in an MPEG over IP environment). When problems are isolated to specific equipment, operators can capture the transport streams that contain the evidence of the problem and send it to the implicated equipment manufacturers or content providers, who then may use their own MPEG-2 test equipment for further analysis and diagnosis.