Testing and evaluating sychronisation methods of audio and video over traditional and IP based video systems

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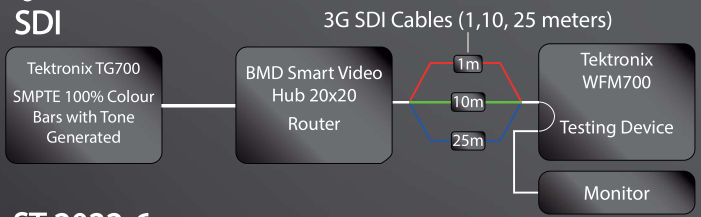
Abstract

The introduction of IP based broadcast systems (ST 2022 & ST 2110) have led to a transition from SDI systems to IP. With this transition comes a change of synchronisation methods with SDI and IP systems using incompatible methods. Using Industry Standard equipment (PHABRIX Qx and Tektronix WFM 700) the aim was to test the synchronisation of streams within SDI and IP domains. By measuring the 'eye' waveform of an SDI signal (Figures 1 and 2) and the Packet Interval Timing (PIT) of IP packets (Figures 3 and 4), there was a clear result. While the Tri-level Sync Pulse of an SDI signal works effectively and consistently, the increased accuracy of PTP allows ST 2022-6 and ST 2110 data packets to be precise and remain in the correct order.

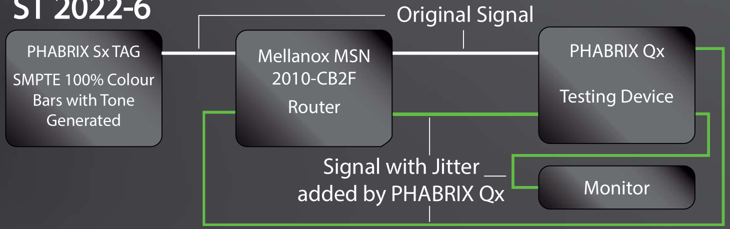
Method

Two separate systems were created to test SDI and IP (ST 2022-6 & ST 2110) Signals.

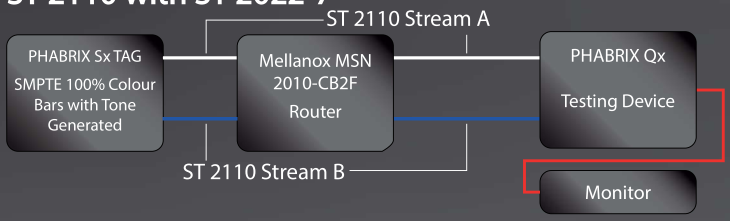
SDI



ST 2022-6



ST 2110 with ST 2022-7



Results

As the cable length increased, the timing accuracy of the SDI signals were affected by jitter (Figure 2). This is due to the Tri-level Sync Pulse being affected by timing jitter as the eye waveforms edges start to blur and go from an 'open' eye to a 'closed' eye (Phabrix 2020).

The jitter added to the ST 2022-6 signal caused the Packet Interval Time (PIT) range to increase from 0.013µs to 5.971µs (Figure 3). The increase of 5.958µs shows how significantly timing jitter can affect a signal even in ST 2022-6 signals. In the test however, the Qx device was capable of receiving and reordering the packets with no lost packets recorded.

The ST 2110 video signals with ST 2022-7 (Figure 4) recorded values over both SFP inputs (A & B). The PIT graph recorded two spikes of packets being received. Both spikes had a range under 3µs independent of the other. This hints at the signal path for both paths having to change.No packet errors were recorded so the PTP time stamps allowed the Qx to re-order all received packets. While SFP B recorded a smaller mean PIT value at 9.245µs, the Path Differential (PD) times disagree. The Most Positive PD value was 72ns while the Most Negative PD was -2.89µs. This reveals how packets sent over Path B arrived later than the identical packet on Path A.

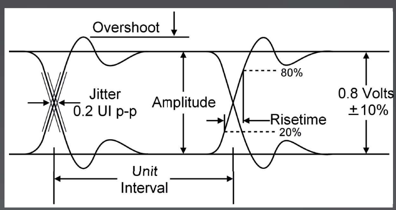


Figure 1-SDI Waveform Measurements (Derived from SMPTE 259M)

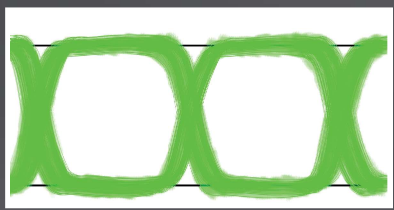


Figure 2-Eye Waform from 25M SDI Test

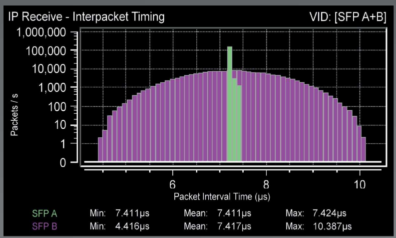


Figure 3-ST 2022-6 PIT Graph

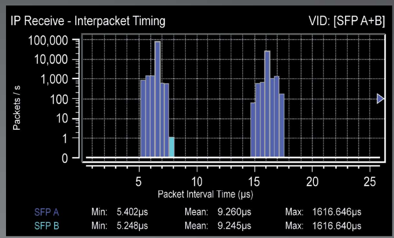


Figure 4-ST 2110 (with ST 2022-7) PIT Graph

Conclusions

The ST 2082 Standard upgraded SDI to handle 12G UHD signals, but the limitations of the Tri-level Sync Pulse lead to major signal loss through jitter at all resolutions that SDI can support.

ST 2022-6 and ST 2110 broadcast systems benefit from increased timing accuracy through the implementation of PTP.

The PTP timestamps in the headers provide receiving devices with sub-microsecond accuracy for synchronising the audio, video and ancillary data packets. PTP is also reliable as no packets errors or lost packets were recorded and packets that arrive out of order can be rearranged.

Given the mission-critical nature of broadcast infrastructure, the accuracy that PTP provides alongside the redundancy of ST 2022-7 (when used with ST 2022-6 or ST 2110) allows for a sychronised output with minimal errors (Kero and Kernen 2019).

Acknowlegments and Citations

Many thanks to Nicola Milburn at PHABRIX for doing an Online Demo of the PHABRIX Qx Device and providing screenshots of the results

KERO, N. and T. KERNEN, 2019. Enhanced Redundancy of ST 2059-2 Time Transfer Over ST 2022-7 Redundant Networks. SMPTE Motion Imaging Journal, Jul, 21-29

PHABRIX, 2020. 3G-SDI Signal Quality & Compliance Testing.

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