Monitoring Audio-to-Video Delay Errors In a Digital Television Distribution Network

Solution Summary	
Challenge	Verifying audio-to-video delay across an entirely digital network
Solution	AVDC100 Audio-to-Video Delay Corrector

Network TEN's distribution to our five broadcast centers in Sydney, Melbourne, Brisbane, Adelaide, and Perth consists of a 45 mbps, dual path, self-healing telco network. Using Tandberg encoders, we compress standard-definition video to approximately 20 mbps for distribution. We also use an additional 20 mbps to feed promotional material between broadcast centers or to feed a compressed high definition signal to the broadcast centers.

Throughout the broadcast day, there can be several bit rate changes within the distribution network depending on our programming schedule and the needs of each broadcast center. One of the first things engineers learn when working with MPEG-2 compressed video is that codecs and multiplexers can have a detrimental effect on audio-to-video synchronization. Lip-sync errors can occur when bandwidth changes are made or encoding equipment is interchanged and, if not accounted for, can destroy the viewing experience of a program.

Measuring the amount of delay in order to correct for lip-sync errors was a time-consuming and arduous task, especially in Network TEN's older analog systems. With our analog infrastructure, we monitored vertical interval code marking with an oscilloscope to measure the delay of analog-to-digital conversion at our network control center, and telco propagation and digital-to-analog conversion at our broadcast centers. The results of these measurements were largely unreliable. The solution came as we moved to a fully digital infrastructure.

When Tektronix announced their AVDC100 Audio-to-Video Delay Corrector, we immediately placed an order for six units even though production units were not yet available. When we received our AVDC100s in July 2001, we had high hopes.

Today, Network TEN relies on the AVDC100s distributed at each broadcast center (with an extra unit for roaming the network) to automatically measure the amount of lip-sync delay so that we can easily correct any errors.

Initially, the AVDC100s allowed us to benchmark our distribution network and measure the nominal delay within the system. Once that level of delay is known, each broadcast center's AVDC100 is used on a continuous basis to measure changes in the amount of delay. The AVDC100 serves as both an encoder and a decoder. At our network control center in Sydney, the AVDC100 accepts a serial digital (SDI) signal at its input, which can either have embedded audio or external AES/EBU digital audio present. The video is then encoded with a video watermark before it is distributed to the broadcast centers where another AVDC100 decodes the watermark and determines the amount of audio-to-video delay. A quick check of the AVDC100's display compared to the known benchmark delay lets our engineers correct any additional audio-to-video delay.

Since the AVDC100 adds a watermark to the video's active picture area, it is imperative that the watermark be invisible to viewers and that there is no effect to the picture quality. Network TEN is very protective of its distribution signal, as are all broadcasters, because it

represents the network's revenue stream. During extensive testing, viewers could not perceive any noticeable changes in the video.
Our watermark encoder in Sydney is installed in the program chain at the output of network master control, assuring watermarking of the individual program video signals with known good audio-to-video timing relationships. In addition to watermarking audio envelope information for audio-to-video delay correction, each program feed can also be watermarked with a unique source identification code that can be later decoded by the broadcast centers or network control for confirmation that a particular program aired when scheduled.

After processing, the watermarked video and program audio signals are MPEG-2 encoded and multiplexed into a transport stream for distribution via the 45 mbps telco network. MPEG-2 encoding during network distribution has a negligible effect on the AVDC100's watermarking technology, ensuring stable watermark data decoding throughout the program distribution chain.

At each broadcast center, the network programming is received and decoded from its MPEG-2 transport stream into individual video and audio program elements. The video is then routed through a frame synchronizer that can add multiple frames of video delay to the signal path. The video signal and associated audio signal are then routed to an AVDC100 configured for watermark decoding and positioned just after the video frame synchronizer.

> ***"With the Tektronix AVDC100 we have a quick way, without blueprints, to see what the audio-to-video sync relationship is at every point in the network."***
> - Network Ten Engineering Manager

The AVDC100 detects and decodes the watermark from the video, extracting the audio envelope data and any unique source identifier, which was encoded at the network control center. The watermarking hardware continuously compares the audio envelope data, extracted from the watermark, with the program audio envelope data. Timing variations between the data points are calculated and reported on the AVDC100's front panel display as audio-to-video delay.

The AVDC100's audio-to-video delay is then compared to the known network benchmark delay. Any adjustments to the frame synchronizer are made to account for the additional delay.

With our new, fully digital infrastructure and network, we didn't have anything that we could use to verify audio-to-video delay across the entire network — we were really limited to visual and audio tests. The Tektronix AVDC100 Audio-to-Video Delay Corrector was the only device that made these types of measurements possible for us and empirically proved the amount of delay that existed within our program distribution chain, especially since we did not have an audio-to-video sync map of the network. With the Tektronix AVDC100 we have a quick way, without blueprints, to see what the audio-to-video sync relationship is at every point in the network.