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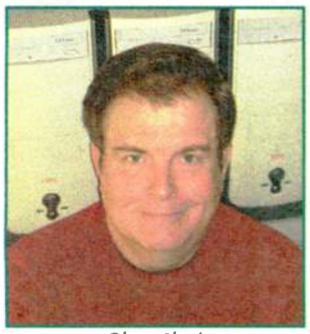
Ira Wilner on the lessons learned during a big panel antenna project in New Hampshire.

Radio World
ENGINEERING EXTRA

June 13, 2007

DESIGNER INTERVIEW



Glen Clark

Processing Vet Trades Audio For Stock

Glen Clark Talks About the Texar Audio Prism, His Thoughts on Processing Today And His Latest Puzzle

by Steve Callahan

Today's broadcasting buzzword is "digital." There wasn't much that was digital back in the early 1980s. However in 1981, an engineer from Sharon, Pa., developed the innovative "digitally controlled" Texar Audio Prism and changed audio processing. During the 1980s, any station looking for

SEE CLARK, PAGE 24

Test and Alignment of IBOC's Blend Time

How Do We Accurately Set Time Alignment on HD, And Does It Work Under Real-World Conditions?

by Michael Bergman and John Kean

This white paper is adapted from a presentation originally made at the NAB Broadcast Engineering Conference, April 2007.

Analog-digital blend is a unique feature of HD Radio. Proper time alignment of the audio chains appears to be a key factor for good performance in signal-fading conditions. Poor alignment leads to audible level shifts, echo and comb-filter artifacts during blend. This paper looks in depth at time alignment measurement techniques and the resulting accuracy, presents IBOC receiver alignment results across several brands and considers audio quality issues.

BACKGROUND

In the United States, and increasingly in other parts of the world, terrestrial digital audio broadcast is done using NRSC-5-A IBOC Digital Radio Broadcasting Standard (the National Radio Systems Committee specification for In-Band-On-Channel transmission). Currently, the only implementation of this is HD Radio, which comes from Ibiquity Digital Corp., the technology's creator. IBOC carries digital audio via Orthogonal Frequency Division Multiplex modulation, but also allows for simultaneous transmission of legacy analog AM and FM.

NRSC-5-A IBOC has the unusual ability to "blend" between analog host audio and Primary Digital audio as reception conditions warrant. For FM in multipath fading environments, the receiver smoothly switches from the OFDM-transported digital audio to legacy FM analog audio until conditions improve; it then blends back to digital.

This blending is accomplished by synchronizing the analog and digital audio waveforms at the transmitter, carefully calibrating the transmitter's analog-to-digital time alignment and taking into account a receiver's standard analog-to-digital time alignment — all to result in a maximum time differential between the analog and digital of 68 µs.

This explanation begs several questions:

- What can be used as a standard reference for calibration?
- How does one calibrate hardware at each end?
- What calibration accuracy is required at each end?
- How does calibration vary with time or manufacturing process?
- What happens if calibration is off?

Through a series of investigations at NPR Labs, quite a bit of detail on these questions comes to light.

CREATING A REFERENCE

Calibration for anything presupposes the existence of a calibration standard. When Ibiquity established its standard for time alignment it was realized that it could not be made traceable back to NIST, as it is a relative, not absolute, standard. Time alignment depends on matching the delay through the analog path to the delay through the digital path. These paths start with the audio feed into the exciter or audio processor, and end with the receiver audio output.

Both paths have to go through the IBOC technology, so there isn't a single fixed reference. The analog path includes exciter processing and a 7 second delay; the digital path includes a great deal of buffering and processing. The only way to have a standard reference is to create one and then ensure that each transmitter and receiver works within specification.

Originally, Ibiquity created a test vector. This vector is a coded, fixed signal that can be played back by a signal generator. The over-the-air RF signal is therefore very consistent and can be used as a fixed reference for

SEE ALIGNMENT, PAGE 12

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BUT THE *MISSION* REMAINS THE SAME

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FROM THE TECH EDITOR

by Michael LeClair

High-Power Directional Array Goes Digital

I recently completed another HD Radio conversion, this one at a directional AM station. Directional arrays present more than the usual run of complications and make HD on FM look positively easy.

I had the good fortune to be working on a station that had been rebuilt from the ground up with digital transmission in mind. The phasor and antenna-tuning units were only about seven years old. Everything was still in excellent shape and it all had been designed for digital.

However, back in 2000, HD on AM was still being tested and some aspects of system design had not been completely figured out. As it turns out the choice of transmitter also is a factor in proper phasor design and adjustment, because the phase rotation of the output amplifiers is different on different models of AM transmitters.

Some changes were needed to the system to go HD. Although the night pattern simply needed adjustment to provide the proper cusp rotation, the day pattern required something more (the station is a DA-2). After a series of measurements, a slope correction network was designed for this station that involved reworking the input and replacing some vacuum capacitors with new ones rated at much higher voltages. Once the new vacuum capacitors were acquired we spent a few hours one night after midnight reworking the input network on the day pattern and mounting the new capacitors.

A very fun part of this phasor modification was using the Ron Rackley-inspired network analyzer rig to adjust the rotation on the input network. If you've done impedance measurements before with a bridge and signal generator it is quite amazing to see how much easier it is to use the network analyzer.

We were able to run a dozen measurements of bandwidth and phase angle in just a few hours until I was completely satisfied we had adjusted everything to meet the Ibiquity specifications, including a nice Hermitian symmetry around the carrier. The symmetry point doesn't necessarily coincide with lowest reflected power on the sidebands so there is some minimal tradeoff here.

With the newly modified network and the proper tools we had the system up and running in one night.

RECEPTION TESTS

Back in February I wrote in this space about reception testing of a non-directional 1 kW AM station, operating on a local channel ("The AM IBOC Digital Conundrum," Feb. 22, 2006). Although we had done little to set up this station properly (no phase rotation networks on that project), the results were still pretty good.

HD reception went out to about the 0.8 mV contour before rapidly falling off. Audio quality was good, although it was possible to hear annoying artifacts in voice material due to the STL, which featured high levels of lossy data compression. Receiver acquisition time was a bit slow also, taking around 7–8 seconds.

For our directional AM at WBUR, which operates at 10 kW both day and night and reaches approximately 1 million people in its 2 mV contour, we decided to invest in doing everything state-of-the-art. It was my hope that with everything done right we would experience even better performance.

I'm happy to report that this is exactly what happened. The results are impressive.

Noise-free and low-distortion audio out to the 0.5 mV contour is an enormous improvement for AM radio.

By using a high-fidelity STL the annoying artifacts largely have been eliminated. Although such comparisons are subjective, the end result on the audio side is that the digital AM sounded very close to FM radio. Not bad considering the very low data rates that AM HD is able to deliver.

Receiver acquisition time runs about 5 seconds. We used the Kenwood HTC-100 tuner to locate where the signal was just able to lock in digital for our tests of the limit of coverage. Digital coverage extends out to the 0.5 mV signal strength as measured by our field intensity meter at the point where coverage dropped off. Noise-free and low-distortion audio out to the 0.5 mV contour is an enormous improvement for AM radio.

Note that AM HD has two reception modes. When there is ample signal strength it will lock in stereo. When interference or low signal levels occur, the radio will fall back to a lower-fidelity mono signal with an increase in artifacts. Finally, when the digital is no longer viable at all, the radio will fall back to analog.

PROBLEMS STILL EXIST

However, not everything is perfect. The AM signal is still subject to relatively large signal fades from overhead electrical lines. Out near the 0.5 mV contour, if you were to drive along a secondary road in a rough circle around the transmitter site, the digital signal would go in and out of lock fairly often due to signal fades.

But on an interstate, where there are no electrical lines, you can get the digital signal with excellent reliability right up to this point. When the signal drops back to analog it is already very noisy and well beyond where most listeners would stay tuned.

A far larger problem is man-made noise and here digital AM is only a partial cure. We tested on secondary roads and the digital would ride through some of the hums and buzzes that are normally encountered on analog AM as long as they were not too severe. Depending on signal strength, the digital signal was more or less robust. In areas with large signal strengths (more than 10 mV) the digital would ride through just about anything.

However, we drove through areas that featured simply epic levels of man-made noise. In some places the noise was so bad the digital signal would drop out even though we could measure 3–4 mV of signal strength. The analog fallback signal also would be unlistenable during these fades; it will take a lot more digital power to run through this kind of interference.

The worst interference seemed to be in built-up commercial districts that had not invested in underground power lines. Small town centers and older strip malls seem to be the typical culprits in this regard. We also found large interference signals coming from traffic lighting systems, some public safety facilities and, strangely enough, the occasional bank ATM. Go figure.

MOVE AHEAD

All in all HD AM has delivered very good results from a technical perspective in the two stations I have converted. With nighttime operations just around the corner, there is no longer any reason to sit back and wait.

Just be warned that in order to get it to work the best it can, you will have to invest in that antenna system and get everything right. This is harder than FM but the payoffs in technical quality are huge.

Tell me about your own experiences. E-mail *rwee@imaspub.com*. ■

IN THIS ISSUE

PROJECT PROFILE

by Ira Wilner

Anatomy of a Large Engineering Project

Vendor Communication, Contingency Plan Played Key Roles in Antenna Project for HD Implementation

Most broadcast engineering projects share common aspects, be they the design and construction of a new studio facility, upgrade of a transmitter facility or planning for a new tower and/or antenna system. Thorough planning is paramount. Managing a project large or small requires the same processes.

For WKNE(FM) it started as a coverage problem. We had a relatively new antenna as a result of our landlord, New Hampshire Public Television, replacing its tower. Unfortunately, the geometry of the new tower interacted poorly at our wavelength creating an exceptionally directional pattern.

Fig. 1: View From Tower of WKNE Shively Two-Bay Antenna

BACKGROUND

WKNE's main transmitter facility leases tower space from New Hampshire Public Television. In order to accommodate a DTV future, the University of New Hampshire, operator of NHPTV, decided to upgrade its tower to accommodate a dual-channel UHF TV antenna. A sturdier tower, the same height as the original, was designed with a significantly wider face.

Management decided to take the opportunity to replace WKNE's aging ERI rototiller antenna with an eye towards improving coverage in a market 30 miles to our north. Thus a half-wave-spaced Shively 6810 was purchased and installed based upon a computer pattern study (see Fig. 1).

When I arrived on the scene it was apparent that reception of the Class B FM signal in our sister city had worsened with the new antenna. I had Shively run additional computer-modeled pattern studies for different antenna mounting options. None of them were acceptable.

Furthermore, the tower was resonant on our frequency such that serious re-radiation was occurring inside the tower, 370 feet below our antenna. Tower riggers with personal RF exposure alarms were not happy being anywhere near or on the tower while we were on the air. So we spent way too many hours operating from our auxiliary tower site to enable the many tenants to maintain their antennas.

Only one type of antenna comes to mind when one tries to remove a tower's influence from the equation: a panel. Panel antennas are large, heavy and expensive. But because they fit around all sides of a tower and use some sort of reflector grid or ground plane to provide electrical uniformity, they solve two problems at once. They produce a far more uniform radiation pattern and they shield the tower in the immediate vicinity from RF.

Fig. 2: Mounting Aperture for Proposed WKNE Panel Antenna

How could we justify the cost especially so soon after buying a new side-mount antenna?

IBOC TO THE RESCUE

Saga Communications is committed to putting a significant number of IBOC signals on the air annually. We had already purchased a new 20 kW transmitter as part of another project to upgrade WKNE's main transmitter facility with minimal interruption of service and it included a spacious, new, fully air-conditioned transmitter hall.

Combined common-amplification tube rigs for IBOC had not yet been demonstrated when we purchased the new 20 kW

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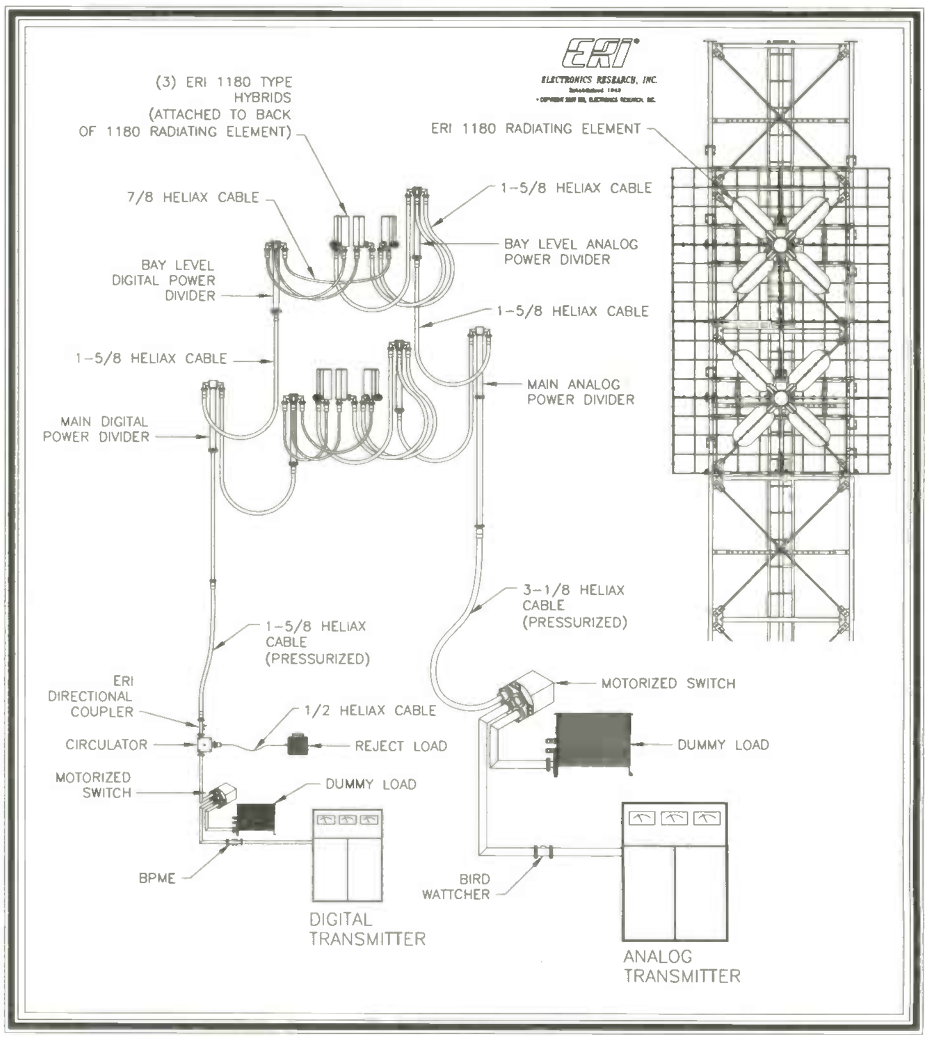


WKNE Panel Antenna Layout

by Cris Alexander

Check Out the Numbers on Those Pesky PCNs

Prior Coordination Notices Offer Broadcasters a Chance to Catch Interference Before It Happens

If you're like me, you regularly get notices in the mail from RF Licensing, Comsearch, Munn-Reese and others.

These notices, called "PCNs" or Prior Coordination Notices, alert the licensees of fixed microwave stations within a specific radius of the technical specifics of a proposed or modified fixed microwave station. The idea is for the recipient to look at and evaluate the technical parameters in the notice and decide whether or not the proposal will interfere with his existing station.

The PCN process went into effect a couple of years ago for broadcast auxiliary stations. It has been in use for years in the non-broadcast (private and common carrier) fixed microwave world.

Prior to this, broadcasters relied solely on local frequency coordinators in their specific markets (usually affiliated with the SBE) to determine whether a proposed operation would interfere with others in the market. In a lot of markets, the frequency coordinators possessed encyclopedic knowledge of the users, frequencies, paths, bandwidths and emission types in use in their areas. Most did an outstanding job of keeping us out of one another's hair, at least on the STL/RPU/ENG frequencies.

But the new PCN process requires us to instead rely on the FCC's ULS database, which is of dubious value. In the "old days" (pre-ULS), the FCC kept very limited records of STL and ICR stations. For a long time, these were kept in a card file at FCC headquarters at 19th and M Streets. Attorneys and engineers would go down there and dig through the dog-eared cards to find who was on what frequency.

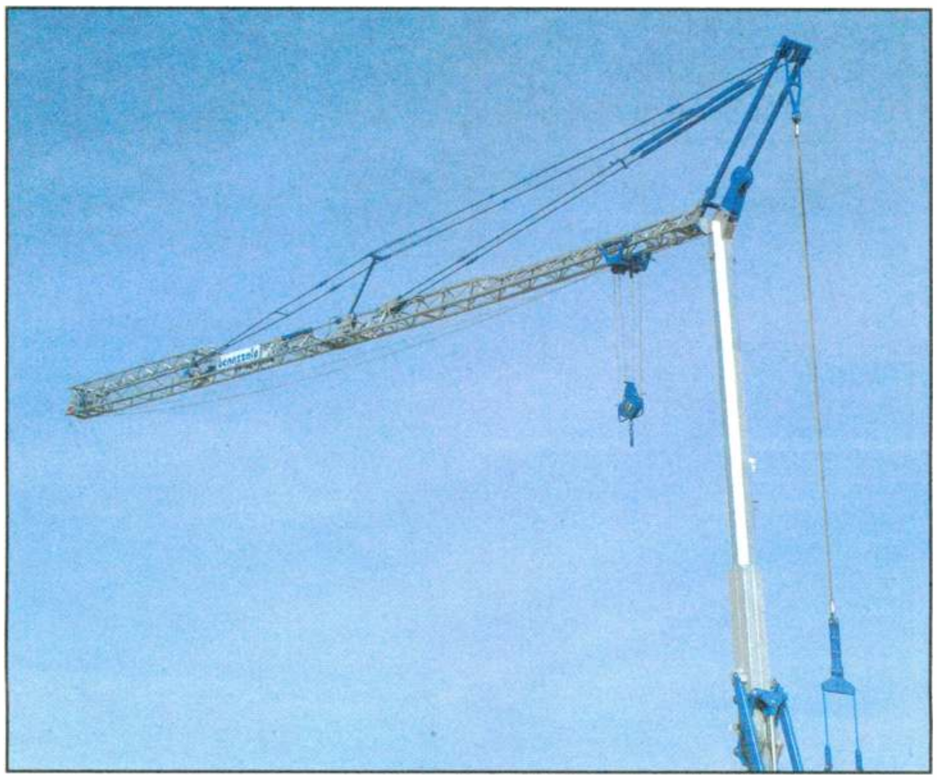
THE PCN PROCEDURE

The new database was created from the information on existing STL/RPU licenses. A lot of old licenses had incorrect or incomplete information. Critical data points missing from virtually all such old licenses were receive site coordinates, receive antenna height and beamwidth. All this information is needed to do a proper engineering analysis of a proposed operation, including a frequency search.

$$L_{bf} = 32.44 + 20\log(F) + 20\log(d)$$

Where:
L_{bf} is the free space loss in dB
F is the frequency in MHz
d is the distance in km

Free Space Loss Formula



Construction cranes can give a directional array fits if located nearby and in the main lobe.

Many licensees (including my company) worked hard to update their ULS records before the PCN requirement went into effect. Those folks recognized that interference protection of their fixed microwave stations was largely dependent on having accurate information in the ULS database. But there are still hundreds of records with incomplete or incorrect information.

Before you can file an application for a new or modified STL/ICR, you must complete the PCN process. You can do this yourself if you have a lot of patience. The mechanics are fairly simple: Identify all the fixed microwave stations within the "keyhole" radius in the band of interest and mail/e-mail/fax the licensees a letter stating what you intend to do and provide them with the technical specifics of your proposal.

It's a lot of work, and in metropolitan areas, you may be looking at more than 100 notices to send. There are companies, such as those mentioned earlier, that are set up to do the notifications, and in my experience it is worth every penny.

Recipients of the notices have 30 days to review the notice and respond if they have an objection. All objections must be cleared before the coordination is complete.

So, what do you do when you get those notices? Do you check the frequency and, seeing that it is not on your STL or ICR frequency, toss it in the trash or delete the e-mail message?

I think that's what a lot of engineers do. Probably more managers or owners who receive the notices skip the frequency check part and just toss/delete them. That's really too bad because it omits a critical step in the coordination process. Those folks don't have a leg to stand on if they suddenly start getting interference on their STL or ICR links. They had their chance to prevent the interference and took a pass.

I have some good software I use to evaluate such proposals. I always check to see if the proposal is on the same or an adjacent channel and if it is, I do two things. First, I calculate my own receive signal (at the receive antenna), then I calculate the signal at my antenna from the proposed station and see what the desired-to-undesired (D/U) signal ratio is.

Equipment manufacturers such as Moseley and Marti can provide specifications for minimum D/U ratio (sometimes called carrier-to-interference or C/I ratio), so it is fairly easy to determine if the proposal will cause interference to one of our STL/ICR stations.

CALCULATING SIGNAL LEVELS

What a lot of folks overlook is that the bandwidth of a station plays a large part in this.

For example, a proposed station's carrier may be 500 kHz removed from your existing station, and on the surface it may appear that the proposal will not cause your station interference. But take another look.

If the emission designator for your station shows 500 kHz bandwidth and the proposed station has 500 kHz bandwidth, the two signals will "touch" at the midpoint between the two carriers, making them essentially co-channel. The proposal should then be evaluated as such. This is

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Notices

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particularly important in digital links, where information will be present at the band edges all the time and not just on modulation peaks.

It's not that hard to calculate the signal levels for your own station and the proposal. It's just a matter of simple arithmetic. Start with the EIRP of your station listed on the license, calculate the free-space loss for the frequency and path length, then subtract the free-space loss from the EIRP to get the receive level.

There may be terrain losses as well, but it takes some specialized software to figure that. For most STL/ICR path interference calculations, free-space loss is sufficient.

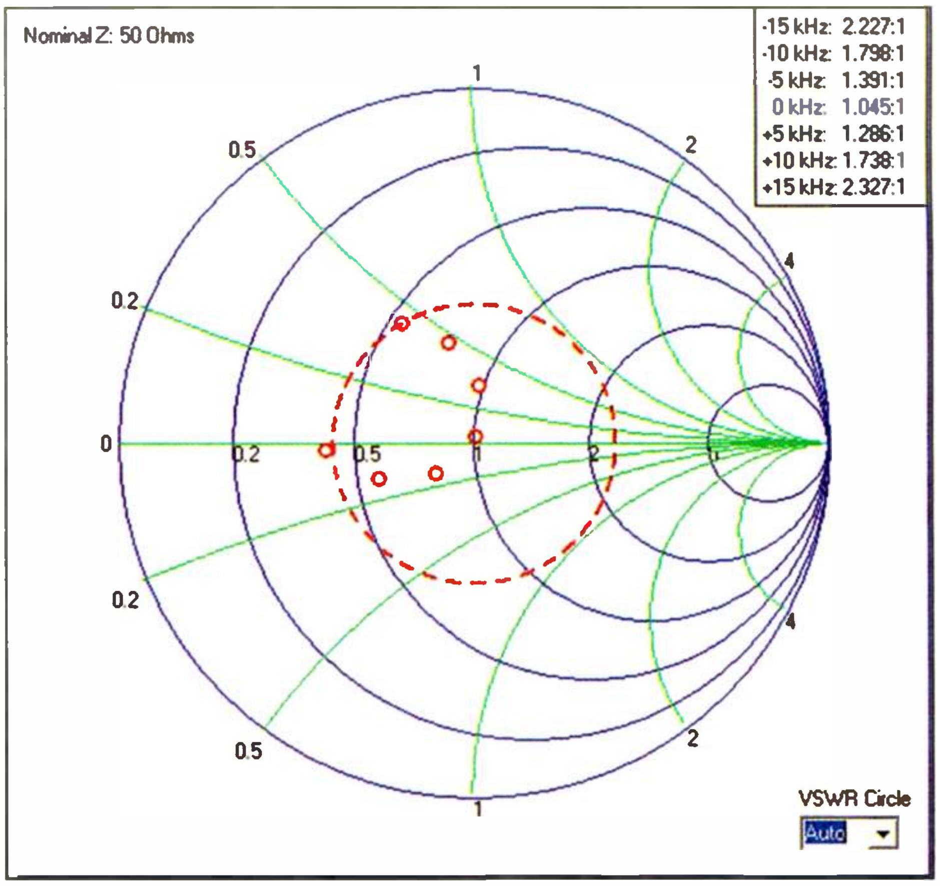
For the proposed station, you do the same thing but you will also need to find the azimuth loss of the proposed transmit antenna and your receive antenna, assuming that the interference will be coming in off-azimuth. Antenna make/model information will be specified in the PCN notice and should also be shown on your license, so it's not hard to go online and get a spec sheet, find the polar pattern and apply the loss figure in your total path calculations.

Again, be sure to do this for both the proposed station's transmit antenna and your station's receive antenna. And if your station is cross-polarized to the proposal, be sure to subtract 20 dB for the cross-pol loss as well.

Probably more managers or owners who receive the notices skip the frequency check part and just toss/delete them. They had a chance to prevent the interference and took a pass.

The difference between the undesired (proposed) and desired (existing station) signal level is what you're looking for. You needn't consider line loss or antenna gain because they affect both the desired and undesired signals more or less equally; the D/U ratio will be the same at the receiver input as it is at the antenna.

The next time you get one of those notices in the mail or your inbox, do a little more than check for frequency. You may save yourself some real grief down the road.



Load cusp orientation is critical for HD Radio performance in less-than-optimum AM antennas.

HOW DO YOU FIX THIS?

I've been dealing with AM directional antennas most of my career. Over the years, I've developed a real affinity for DAs.

I love everything about them — the towers, the tuning units, transmission lines and phasors. I love antenna monitors and field intensity meters. And I really love it when, during the tune-up process, the vectors start making sense and the pattern takes on the proper shape and size.

What I don't love is when a monkey wrench gets thrown into the works. That happens when something beyond my control enters the picture, usually a reradiator, effectively an additional array element over which I have no influence.

We all hear and have stories about wireless towers, monopoles and power line towers. Those I can usually live with because they can be detuned and effectively removed from the equation. It's the other structures, ones that can't be easily detuned, that give me fits.

I recently ran into such a situation with one of our arrays in Colorado. The monitor point field strengths of this until now stable array suddenly became erratic with one null pair going high and the other low. Adjustment of the phases and ratios would sometimes result in the opposite condition, but we could not get all four points (two null pairs in a three-tower inline pattern) below the licensed maxima.

And the field strengths were changing asymmetrically, a clear indicator that there was a reradiator out there somewhere. They also were changing constantly, without any corresponding changes to the antenna parameters.

A little investigation took us to the source of the problem: three portable construction cranes right off the end of the array in the main lobe. These cranes were located at a crane manufacturing business just a couple of thousand feet from the transmitter site property. These cranes were 75 to 100 feet tall with 75 to 100 foot horizontal booms. They were always in motion, the booms swinging in the wind when not in use and at the operator's direction when they were, not to mention the load line going up and down.

The long and short of it is that there will now always be one or more big construction cranes present at this location, each a large-aperture, top loaded reradiator right in the main lobe, presenting a long-term problem for the station. Left with no other choice, the station has had to file for an STA and reduce power to maintain monitor point field strengths below the licensed limits.

The FCC has a mechanism in place for dealing with wireless towers and other antenna support structures. It's even a fairly straightforward process dealing with power line towers, water towers and other non-antenna structures. Heck, I could even deal with a permanently installed crane by detuning. But portable cranes that are constantly moving, changing configuration, being assembled, tested and disassembled? I must admit I'm fresh out of altitude, airspeed and ideas.

So what am I going to do? As I write this, the plan is to augment the pattern. I'll start with some conductivity measurements on the station we're protecting; then we'll let our pattern out a bit and augment. Hopefully we'll get enough breathing room in the nulls that the "crane effect" will no longer be an issue. Stay tuned …

CONVENTIONAL WISDOM

The 2007 NAB spring convention was bigger than ever. I have been attending the convention for many years, and even after all these years I am astounded at the sheer size of the whole thing.

The North or "radio" hall this year had to share space with a lot of non-radio exhibits. The radio exhibits themselves were in the west end of the north hall. This was both good and bad.

Harris, for example, was in the North Hall this year whereas it has traditionally been in the Central Hall, requiring radio folks to trek across the convention center to visit the booth. Having Harris in the North Hall is a good thing.

On the downside, ERI, which has long been a fixture among the radio exhibits, was sort of lost in the east end of the North Hall, away from the bulk of the radio exhibits. Overall, though, things were more conveniently located than in years past.

I only stuck my head in the South Hall

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CONTINUED FROM PAGE 8

for a moment. That room, containing television and multimedia exhibits, was a 120 dB sensory overload of sights and sounds. There was plenty of noise in the other two halls but it was nothing compared to what was in the South Hall.

So what was new this year? There were a few things that caught my eye, but the thing I was focused on was the development of high-power FM+HD transmitters, single-tube units capable of producing 25+ kW of FM+HD RF. These rigs offer higher TPO stations some real options for getting the best digital signal on the air.

A good number of stations, in the first wave of conversions, did whatever was expedient to get a digital signal on the air. Now, after several years of living with that compromise, many of these stations are looking for improvements and these new rigs, essentially modified versions of existing products, are just the ticket.

Beyond the products, though, I found that manufacturers are really listening to broadcasters and developing products to meet their needs. With nighttime AM HD Radio now authorized, many stations that have been waiting to convert are moving forward and stations that have already converted their daytime facilities are now converting their night systems. Manufacturers have responded with a variety of products to make the transition easier.

I had some meetings with transmitter manufacturers to discuss things we are running into in the field. For example, we have found that some AM directional antennas simply cannot be economically improved to provide a load better suited to HD Radio. Despite having +/-15 kHz sideband VSWR values in excess of 2:1, we have made many of these antenna systems work just fine for HD Radio by paying close attention to cusp orientation. The higher the sideband VSWR, the more critical the cusp orientation.

While it is not difficult to set the load orientation initially while the network analyzer and other test equipment are at the site, it is difficult maintaining it. When the array drifts seasonally, from wet to dry, frozen to thawed or with component aging, the engineer makes small adjustments to maintain the operating parameters.

What he can't see without all that test equipment at his disposal is what these adjustments are doing to the orientation of the load. Digital performance can be seriously impaired with slight adjustment of the array. We need tools to deal with this issue in real time, and transmitter manufacturers are listening.

But besides all of this, the best part about the big NAB spring convention is seeing you, my fellow engineers, and discussing the stuff we run into out there in the real world on a daily basis. I love hearing about your trials and adventures, stuff like PCN coordination and construction cranes. And even as I recover from the sore feet and legs of this year's spring show, I look forward to seeing you again this fall in Charlotte for the NAB Radio Show.

Cris Alexander is director of engineering for Crawford Broadcasting Corp., Denver. ■

MARKETPLACE

DR2 Produces Test Signals Up to 192 kHz, 24 Bits

NTI has debuted its Digirator DR2 handheld digital audio signal generator. It produces common audio test signals with sampling frequencies up to 192 kHz and resolution up to 24 bits.

DR2 features a sync input allowing the instrument to be synchronized to audio signals. NTI says a set of surround signals in the formats Dolby D, D+E, Pro-Logic II, DTS and DTS-HR equips the DR2 for coping with the challenges of multi-channel audio applications. Additional functions include transparency- and signal-latency measurements.

A range of digital audio test signals for maintenance, repair and calibration of professional audio equipment is generated. User test signals may be stored as uncompressed WAV files in the Digirator DR2 memory.

The DR2 accepts AES3, DARS and Word Clock synchronization signals. The input impedance of the sync input may be switched between 75 ohm, 110 ohm and High Z.

Channel status information can be generated in professional and consumer format and the most important parameters may be manipulated manually. Display of incoming channel status data also is supported.

Up to 10 instrument configurations can be stored in the internal Flash memory and reloaded for repetitive tasks. The saved settings also may be transferred to other DR2 instruments.

The Digirator DR2 WAV file player plays back multi-channel bit stream files. A set of 5.1 test sequences for the verification and optimization of surround sound equipment and installations is stored on the unit's flash disc.

For more information, contact NTI Americas in Oregon at (503) 684-7050 or visit www.nti-audio.com.

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Alignment

CONTINUED FROM PAGE 1

receiver designers. They used this to calibrate the Ibiquity reference receiver. Next, Ibiquity and Kenwood calibrated the original Kenwood KTC-HR100TR.

With a calibrated receiver reference, the transmitter's analog delay could then be determined. To ease this, many receivers have a special mode that splits the stereo outputs, with the stereo left channel output typically carrying digital audio left channel signal, and the stereo right channel output carrying analog audio right channel signal. Time delay between the digital left and analog right waveforms can then be compared.

THINGS GOING WRONG

This "split-mode" test assumes that the original audio was suitable for a tight calibration. If the digital content does not match the analog content at all, this method will not work. For example, if the analog audio path carries a hip-hop track, and the digital audio track carries jazz, there will be no way to match waveforms. This example is, of course, purely academic, as the FCC's authorization for IBOC requires that broadcasters simulcast the main channel audio on the analog and digital signals.

A more likely example occurs when the audio processing varies between the two paths. Experience with measurement of actual stations indicates this is a common issue. Waveform phase can vary severely if the analog and the digital paths go through the separate processors.

Assuming simulcast audio, and joint audio processing (analog and digital are jointly processed in a way that ensures some level of phase matching), we can then consider calibration of the equipment.

TRANSMITTER CALIBRATION

There are several methods available, each with its own characteristics and with varying accuracy:

1. Calibration by Ear
2. Calibration by Test Vector
3. Calibration by Waveform (i.e., in Split Mode)
4. Calibration by Modulation Monitor (i.e., using an off-air monitor)

The easiest method is calibration by ear. The broadcast engineer simply listens to the audio, forcing blends back and forth. This is not recommended.

The second method, by Test Vector, requires test data from Ibiquity and a signal generator. This is not commonly available broadcast equipment, so the remaining methods, Calibration by Waveform and Calibration by Modulation Monitor, are preferred.

The rest of this paper investigates the method, challenges and accuracy of calibrating using these types of analysis.

WAVEFORM TEST METHODOLOGY

First we calibrated a test Harris Dexstar exciter with a Kenwood KTC-HR100TR IBOC receiver. The method for this was to assume the receiver was already calibrated, which the manufacturer indicates is the case. The procedure included the following steps:

Put the test receiver in split mode. We put the Kenwood receiver into "split mode" (analog out of the right channel, digital out of the left). Split mode on the Kenwood product is enabled with a key sequence available from the manufacturer or in an application note at *www.broadcastsignallab.com*.

Use a L+R tone burst as audio source material. A sinusoidal rectangular burst tone (1000 Hz tone burst, 5 ms duration, 5 sec interval) is a good alignment test signal for HD Radio and analog host FM channels. This audio file is Track 99 of the "NAB Broadcast and Audio System Test CD," available from the NAB Store online.

Capture audio waveforms from the receiver using a high-quality audio input sampler. A Lynx professional PC sound card was used to digitize the analog audio from the receivers under test.

Less-costly PC soundboards (internal, standard line-in hardware) may be usable but must be validated by the user for stability. For example, one laptop's line-in hardware exhibited poor audio SNR in the recordings. One laptop's line-in hardware was mono, not stereo. Some inexpensive audio cards sample right and left channels alternately, not simultaneously.

We therefore concluded that there may be some laptop or desktop PCs with clean stereo line-in hardware, but engineers should not assume that their PC qualifies as such. A CD source with the 1 kHz tone-burst fed directly into the PC should be used to verify that the PC audio system is high enough quality.

Waveform phase can vary severely if the analog and the digital paths go through separate audio processors.

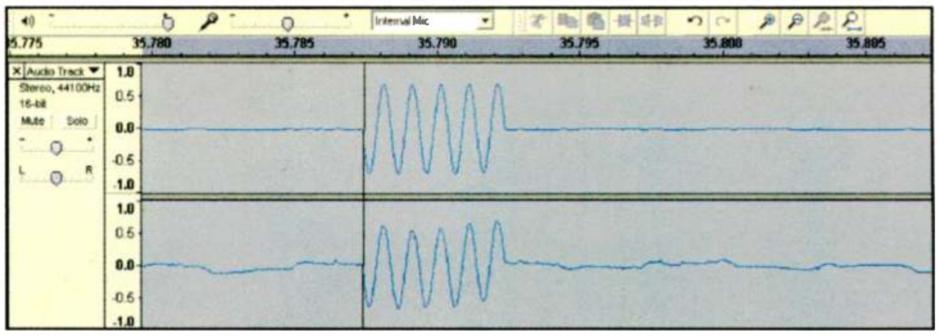


Fig. 1: Digital (upper) and analog (lower) output from a calibrated transmitter-receiver pair.

View the captured audio in a sample-level waveform editor. In our setup, we used Cool Edit 2000 to view waveforms, adjust audio levels and measure timing differences. This overall approach is a good indicator of time alignment, providing resolution down to one sample (1/44, 100th of a second or approximately 22.7 μs).

Make processing as close as possible to real life, but watch for processing-induced issues with testing. We used an Audemat-Aztec FMX410 stereo generator to provide the appropriate 75 μs pre-emphasis and group delay versus frequency in the analog FM channel. We found that the generator's audio processing caused a slight amount of clipping on the tone bursts. The audio processing was turned off to eliminate the clipping.

With the transmitter at a known point relative to a (presumably) calibrated receiver, we were able to begin testing more receivers.

We chose the initial rise-time point of the burst waveform as the place to measure. Ibiquity uses this in its specification for such testing; however, it specifies a digital oscilloscope as mentioned above.

Fig. 1 shows the digital (upper) and analog (lower) channels of a calibrated transmitter-receiver pair. The vertical black line shows the initial rise time point of the waveforms. This is the basis of the "rise-time" method of blend alignment.

RECEIVER-TO-RECEIVER VARIATIONS

We looked for receiver-to-receiver variation in analog-digital blend-time alignment within a single model (manufacturing process variations in alignment). That is, does a single receiver model calibration hold for all the units coming off the production line? We tested four Kenwood KTC-HR100TR units, built over a 10 month period, to see if they had similar calibrations

Model	S/N	Samples analog lags digital
Kenwood KTC-HR100TR	# 30900166	0
Kenwood KTC-HR100TR	# 30900867	1
Kenwood KTC-HR100TR	# 40700143	0
Kenwood KTC-HR100TR	# 40700157	0

Table 1: Receiver-to-receiver variation test results with Kenwood KTC-HR100TR built at different times.

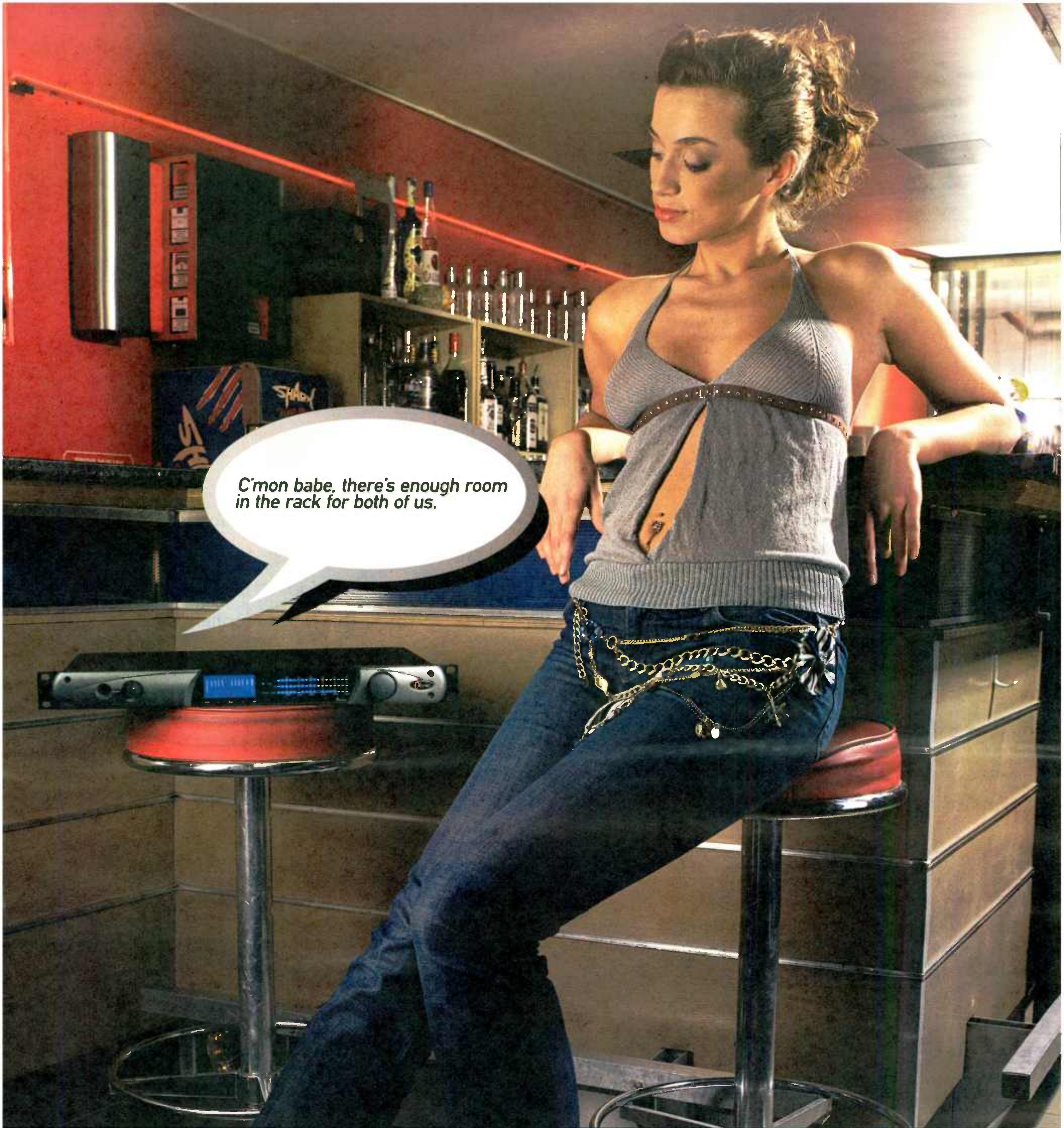
relative to our calibrated transmitter.

Table 1 shows the results when the calibration of a single model receiver is checked over multiple units at a given time. This tight match was repeated three times during testing. In this table, "Samples analog lags digital" refers to how many 44.1 kHz samples (about 22.7 μs) that the analog audio is behind the digital. The Ibiquity specification for alignment is 68 μs; this is about three audio sample times.

In this test, we are not comparing receivers tested hours apart due to concerns about transmitter jitter (see later). For a particular point in time, receivers from a common design remain within one 44.1 kHz sample of each other.

Of course, this is not exhaustive testing. However, Ibiquity maintains that the receivers should be identical, so this was simply confirmation that receivers do not

SEE ALIGNMENT, PAGE 14


C'mon babe, there's enough room in the rack for both of us.

Alignment

CONTINUED FROM PAGE 12

vary across production lots.

MANUFACTURER-TO-MANUFACTURER VARIATIONS

We next looked for manufacturer-to-manufacturer variations in receiver blend-time alignment. That is, are all manufacturers calibrating to the same standard? In addition to the Kenwood model, we tested models from JVC, Boston Acoustics and a professional receiver from DaySequerra.

Table 2 shows the summary results for five receivers and a monitor. Each of the receivers was well within the Ibiquity specification of 68 µs (three samples).

Model	S/N	Samples analog lags digital
Kenwood KTC-HR100TR	# 30900166	0
JVC KD-HDR1	# 119X0336	0
JVC KD-HDR1	# 139X0172	0
Boston Acoustics Recepter	# AFQ 5D001544	-1
Boston Acoustics Recepter	# AFQ 5D002623	0
DaySequerra M4	# D70002	0

Table 2: Receiver-to-receiver variation test results between different manufacturers and models.

We concluded that for the receivers tested there is no significant manufacturer-to-manufacturer variation. As a result, any of these receivers could be used for calibration.

TRANSMITTER TIMING JITTER

Table 2 is a summary of the "typical" results. What is not shown in Table 2 is that occasionally — albeit rarely — we did see up to +/-2 samples, rather than the worst-case value of -1 in the table. That is, we would sometimes see a value of +2 or -2 in our testing.

At certain times during the day, all receivers would shift one or two samples to the right or left. This added variation appears to be due to the exciter. That is, the receivers remained quite consistent to each other, but all would simultaneously shift one or two samples. As a result, the data varied slightly during the day, even for a single receiver tested in the morning compared to the same receiver in the afternoon. This was observed on two separate days.

Because all receivers of that design behaved the same way at any particular time, we concluded that most likely the transmission chain has one or two samples' worth of delay variation, or large-scale timing jitter, exhibited over a span of hours.

RECEIVER ABSOLUTE LATENCY

The tested receivers had consistent RF-in-to-audio-out latency. That is, assuming the delay through the transmitter was consistent, the delay through a receiver was always the same. However, different receivers were not equal in this respect. In fact Kenwood and the Boston Acoustics (BA) Recepter Radio HD differed by 5,120 samples (116 ms). This measurement was very repeatable; three successive tests were run.

The first (baseline) test involved measuring the RF-audio latency between the Kenwood (digital) audio out, left channel; and the BA (digital) audio out, right channel. The second test was identical to the first, except that the BA was powered down and back up before running the second test. The third test was identical to the second, except that the Kenwood was power-cycled first.

In all cases, the difference between the Kenwood and BA receivers was the same: exactly 5,120 samples.

We did not find any variations in receiver latency from boot to boot, based on comparing the Kenwood to the BA. However, absolute latency through a single receiver is not guaranteed in general — only the relative latency from analog to digital (i.e., blend-time alignment) is guaranteed. This means that it is inadvisable to compare a receiver in digital mode to an identical model in analog mode for blend-time alignment testing. Instead, the test should be performed with one receiver in split mode.

CALIBRATION BY MOD MONITOR

Ideally, the broadcaster would like to be able to monitor blend-time alignment in real time, off the air. Several monitor makers have incorporated correlation-based time alignment monitors into their products. We tested the Audemat-Aztec Goldeneagle FM-HD and the Belar FM-HD1 modulation monitors.

Our first tests were to verify the monitors under lab conditions. We began with minimal processing enabled, a stereo music source and a calibrated Harris Dexstar HD exciter. We observed the effect of changes in blend-time alignment on the Belar FM-HD1.

It appears that even small adjustments in timing offset (performed by adjusting the Dexstar) such as 0.16 ms (about 7 samples) were sensed by the Belar. Moreover, it took the Belar only a few seconds to resolve these small errors. The Audemat performed almost identically in all cases.

Frankly, this was not a real-world challenge. The program material was an unprocessed solo cello performance, which provided identical audio for both HD and analog. Processing was minimal. There were no channel artifacts, as this was a lab test with no impairments. The next test was to introduce real-world conditions.

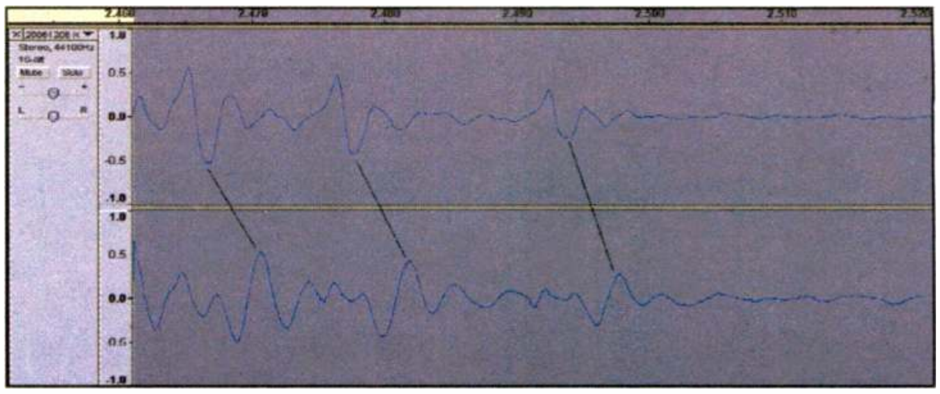


Fig. 2: Off-air captured sample, in split mode (left is digital, right analog), with three possible points of comparison, all with different offsets at the sample level.

The easiest method is calibration by ear. The broadcast engineer simply listens to the audio, forcing blends back and forth. This is not recommended.

OFF-AIR ALIGNMENT METHODOLOGY

Previously, we described a test methodology for lab alignment, using a tone burst mono signal. To consider off-air alignment, we needed to modify this procedure to look at stereo, processed audio from real stations.

We chose the following approach:

Put the receiver in split mode;

Capture audio with a PC and a professional quality sound card (must sample both channels each sample time);

Examine the difference between waveforms, left (digital) and right (analog), at the sample level, to determine the blend time alignment offset.

Compare the results with the reading from the modulation monitor.

MOD MONITORS AND OFF-AIR ALIGNMENT: THE REAL WORLD

Using an outdoor antenna, we scanned the Washington, D.C., metro area airwaves for HD Radio stations. Although the reception conditions were not optimal, we were pleased to find six stations with good digital signals.

We next verified the blend time alignment for each station in three ways: off-air capture of waveforms, then examination with Cool Edit 2000; using the Belar FM HD1; and using the Audemat-Aztec.

A first conclusion: the Belar and Audemat-Aztec consistently produced nearly identical results, but only for five of the six stations. For those five stations, we had excellent matches between these three methods.

However, the last station proved to be challenging. For the last station, with a talk format, it was nearly impossible to reliably compare the waveforms on the PC. Fig. 2 shows one example. The upper trace is digital; the lower is analog. There are three peaks or troughs marked with straight lines as possible points for comparison.

The first issue found is that the station has phase inversion between analog and digital. This was not observed with any of the other stations. But as a result, for this station we had to compare the troughs of the digital waveform with the peaks of the analog, and vice versa.

With that established, we looked at the points of comparison. Again referring to Fig. 2, a detailed comparison of each of these points yielded offset values that dif-

SEE ALIGNMENT, PAGE 16

You're looking at a complete audio-over-IP routing system.

(Just add Cisco.)

Administer this • The beauty of the Web is that you can get information anywhere. Same thing with Axia: you can set up and **administer an entire building full of Axia equipment** (audio nodes, consoles, virtual routers, whatever) from your own comfy office chair. All you need is a standard Web browser (PC or Mac, we like 'em both). Put an Internet gateway in your Axia network and you can even tweak stuff remotely from home or anywhere there's a Net connection. Hey, isn't it time for a Mochachino?

It's not rude to point • Little kids tell mommy what they want by pointing — a pretty intuitive way of doing things. PathfinderPC software gives talent the same convenience. You can **build custom "button panels"** to execute complex operations with just one click. You can map these panels to controller modules on Element consoles or to turret-mounted controls, place mini-applications on studio computer screens, even run them on touchscreen monitors.

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Nothin' but Net • Did you know you can plug a PC directly into an IP Audio network to exchange audio? Can't do that with a mainframe router. Well, you *could* add more input cards to the mainframe, buy high-end audio cards and run more wiring... but with Axia you just install the **IP-Audio Driver** on any Windows PC to send and receive pure digital audio right through the PC's Ethernet port — no sound card required or additional router inputs needed. The single-stream version is great for audio workstations; the multi-stream version lets you send and record **16 stereo channels simultaneously** — perfect for digital automation systems.

Put that in your pipe • How many discrete wires can a CAT-6 cable replace? Well, a T-3 data link has 44.7 Mbps of throughput. But Axia networks' Gigabit Ethernet links give 1000 Mbps of throughput between studios — more than 22 times the capacity of a T-3; enough for 250 stereo channels per link — the equivalent of a **500-pair bundle on one skinny piece of CAT-6**. Use media converters and optical fiber for even higher signal density. Think that might save a little coin in a multi-studio build-out?

Jammin' on the mic • Radio studios and microphones go together like Homer Simpson and donuts. Unfortunately, so do preamps, mic compressors, EQ boxes, de-essers — let's face it: most studios house more flying saucers than Area 51. Axia helps clean up the clutter by including mic preamps with our Microphone Nodes; not bargain basement units either, but **studio grade preamps** with headroom enough to handle Chaka Kahn. Phantom power, too. And if you choose to use Axia Element consoles in your studios, you'll find world-class mic processing built right in: vocal dynamics (compression and de-essing) from the audio processing gurus at Omnia, plus three-band parametric EQ with SmartQ, available on every mic input. Rap on, Grandmaster.

Very logical, Captain • Routing logic with audio used to be as hard as performing the Vulcan Mind Meld. But Axia makes it simple, converting machine logic to data and pairing it with audio streams. So **logic follows audio throughout the facility** on Axia's switched Ethernet backbone. Eight assignable GPI/GPO logic ports, each with five opto-isolated inputs/outputs, are built into every Element power supply, so you can control on-air lights, monitor mutes, CD players, DAT decks, profanity delays, etc. Got more than eight audio devices? Add a GPIO node like this one wherever you've got gear.

Level headed • These green, bouncing dots built into every Axia Audio Node are confidence meters. One glance and you know whether an audio source is really active — or just playing possum.

AES yes • You like your audio to stay digital as much as possible, right? We get that: our AES/EBU Audio Nodes let you plug AES3 sources right into the network. Studio-grade sample-rate converters are inside; anything from **32 kHz to 96 kHz** will work. Oh, and there are 8 AES ins & 8 AES outs in each node. Digital distribution amp, anyone?

Heavyweight champion • This Axia StudioEngine works with our Element Modular Consoles (the fastest growing console brand in the world, by the way) to direct multiple simultaneous inputs and outputs, mix audio, apply EQ, process voice dynamics, and generate multiple mix-minuses and monitor feeds on the fly. To make sure it delivers the reliability and ultra-low latency broadcast audio demands, we powered the StudioEngine with a fast, robust version of Linux — so fast that **total input to output latency is just a few hundred microseconds**. How can one little box do so much? There's a blazingly fast Intel processor inside, with enough CPU muscle to lift a small building. Strong *and* fast. Ali would approve.

Push to play • Axia Router Selector Nodes are **really advanced selector and monitor panels** that you can put anyplace you need access to audio streams. Like newsrooms, dubbing stations, or even the station's TOC, so you can monitor any of the thousands of audio streams on your network at a moment's notice. The LCD screen scrolls through a list of available streams; the eight Fast Access keys let you store and recall the streams you use most. There's even an input, for convenient connection of an analog or AES device. Sweet.

Brains in the box • The typical radio jock cares for studio equipment about the same as a five year old cares for a puppy: haphazardly, if at all. That's why we **took the CPU out** of our Element modular console and put it in here, with the power supply and GPIO ports. That means a greatly reduced chance of being taken offline by a Coke spilled into the board. Because we know that you have better things to do on a Sunday night than trying to dehumidify circuit boards with a hair dryer.

You got to have friends • Dozens of industry-leading broadcast brands like ENCO, Prophet, BSI, RCS, RadioTouch, DAVID Systems and more all have products that **work directly** with Axia networks. So do hardware makers like AudioScience, International Datacasting, 25-Seven, Telos and Omnia. Check out the whole list at AxiaAudio.com/partners

Quick Connect • Axia I/O is presented on RJ-45 and adheres to the StudioHub+ standard. A couple of clicks and you're done.

A TELOS COMPANY

AxiaAudio.com

Routing

Alignment

CONTINUED FROM PAGE 14

fered from the Belar, from the Audemat and from each other.

The reason is that the compression and audio processing chains are not phase-coherent, analog to digital. We are looking at the tail of some speech component in Fig. 2 — phase differences between analog and digital are changing the results.

We looked instead for isolated impulses in the off-air waveform. Isolated impulse energy appeared to be easier to verify. However, it is by no means a certain result. Fig. 3 shows just how difficult this is.

In Fig. 3, we can see an impulse that appeared during a moderate pause in the audio; it is fairly isolated and easy to examine by itself. This helps solve the problem of trying to find which sinusoidal peak corresponds to which. However, it still isn't clear. The analog appears to be ringing a

We concluded that for the receivers tested there is no significant manufacturer-to-manufacturer or lot-to-lot variation.

bit, and one cannot determine with certainty where to compare.

Worse, the Audemat and Belar both chose 46 samples offset for this waveform; we recorded the monitors' levels during this waveform capture. The shaded area in Fig. 3 shows what the Belar and Audemat thought was the offset. There is no way to match the visual of this impulse (apparently 71 samples) with the reported value of the monitors (46 samples).

We note that Ibiquity also examined these waveforms in detail and came to different conclusions. We could not reach consensus on whether the off-air monitors had the correct calibration, or the rise-time method was correct.

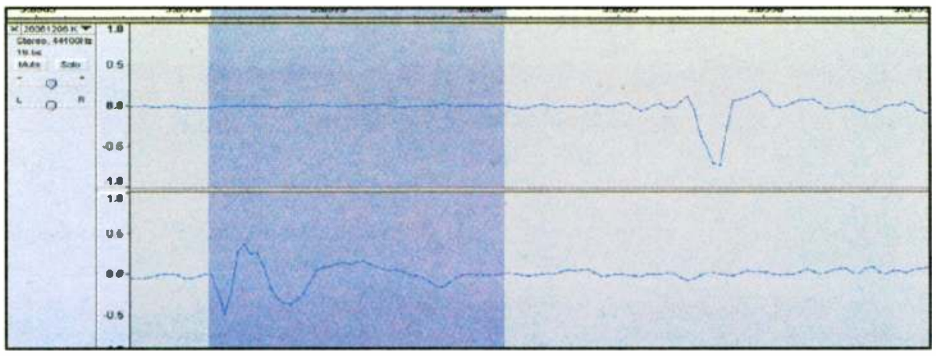

Fig. 3: An isolated impulse in digital (upper trace) and analog (lower trace), with an apparent 71 sample offset (analog lags digital). The shaded area represents 46 samples offset, which was measured by the Belar and Audemat during this capture.

Another puzzle was that the modulation monitor calibration appears to work, considering the sound produced — just as the split-mode technique does. If both methods work, why could we not match the results down to the sample level?

Perhaps one possibility is that the natural periodicity of the audio waveforms allows for more than one "perfect" blend time alignment. If the two audio sources were really identical, this should not happen, but these were separately processed. Regardless of whether this speculation is correct or even possible, both split-mode and modulation monitor calibration are recommended. Why they both work, but don't agree, is an area for future investigation.

The underlying issue, that a single station could be so difficult to verify either with the monitors or by hand, highlights a key point. The reason this station is so difficult to calibrate off-air is that they have separate processing for analog and digital, and that processing is heavy enough to make the waveforms quite different. Therefore, if a station uses separate processing for analog and digital, waveform differences between analog and digital can make it very difficult to reliably determine blend-time alignment.

We were not able to determine the effect of the phase inversion on the blend-time alignment. It may be that correcting the phase would put everything in order. Unfortunately, the logical step — phase-coherent joint audio processing for analog and digital — is not really practical for many stations.

CONCLUSIONS

We investigated commercial receivers to see how stable the receiver industry's blend timing is in practice, and found that commercial receivers consistently show identical results. However, the exciter exhibited some jitter over a period of hours.

We found that modulation monitors and split mode testing matched excellently in the lab, when there are few or no impairments and the audio sources are well matched. Off-air, modulation monitors matched split-mode results, unless the station uses separate audio processing for analog and digital.

In the case of separate processing, it is not yet possible to verify the off-air modulation monitor result to the split-mode result using this approach.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the help of Jeff Detweiler of Ibiquity Digital, Tony Peterle of Audemat-Aztec and Mark Grant of Belar Labs.

Michael Bergman is vice president, new digital technologies, Kenwood Corp. John Kean is senior technologist, NPR Labs, National Public Radio. ■

MARKETPLACE

BE Adds 50 kW FM+HD Option to FMi T Series

Broadcast Electronics debuted the combined 50 kW version of its FMi T series transmitter line, which adds to its FMi T series consisting of the FMi 17T, FMi 21T and FMi 25T transmitters, offering 50 kW FM+HD Radio output with better than 55 percent overall efficiency.

FMi T systems include BE's FXi FM+HD Radio exciter and ESP correction technology throughout the RF chain for spectral performance not previously accomplished with HD Radio tube transmitters, according to the company.

Additionally, the FMi T series line includes BE's folded half-wave cavity.

BE also offers a line of transmitters for analog as well as HD Radio conversion options, including the solid-state FMi line, providing low-level combined power levels of 28 kW or less.

For more information, contact Broadcast Electronics in Illinois at (217) 224-9600 or visit www.bdcast.com.

DaySequerra Program Upgrades Existing Monitors

DaySequerra is offering a Factory Upgrade Program, which allows M2 modulation monitor owners to upgrade existing units to the full M2.2R feature and capability set.

M2.2R

M2.2R features include bargraph metering of HD Radio and analog programming; multi-function vacuum florescent display; metering of FM Pilot and SCA injection levels that includes an MPZ output connector; 20 preset stations for AM and FM bands; and HD Radio digital-to-analog signal, time, level and phase alignment.

Additionally, a front-panel control lockout feature prevents unauthorized changes to setup.

Similarly, M4 HD Radio tuners also can be upgraded to include the features of the M4.2R model.

The M4.2R displays RBDS data, PAD data, signal strength and multipath on its vacuum fluorescent display. LEDs indicate left and right audio signal present, and peak level. The use of Split Mode through the Class A biased, low-distortion headphone amplifier eases time alignment between analog and HD signals.

For more information, contact DaySequerra in New Jersey at (856) 719-9900 or visit www.daysequerra.com.

JUST ENOUGH TEST

Is your bulky bench analyzer more test than you use and more weight than you want?

Sophisticated Minstruments from NTI give you just enough test capability, plus functions not even available on their larger siblings...
and these flexible instruments fit in the palm of your hand

ML1 Minilyzer
Analog Audio Analyzer

The ML1 is a full function high performance audio analyzer and signal monitor that fits in the palm of your hand. The comprehensive feature set includes standard measurements of level, frequency and THD+N, but also VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external sweeps of frequency response generated by the MR1 or other external generator.

With the addition of the optional MiniSPL measurement microphone, the ML1 also functions as a Sound Pressure Level Meter and 1/3 octave room and system analyzer. Add the optional MiniLINK USB computer interface and Windows-based software and you may store measurements, including sweeps, on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.

- Measure Level, Frequency, Polarity
- THD+N and individual harmonic measurements k2→k5
- VU + PPM meter/monitor
- 1/3 octave spectrum analyzer
- Frequency/time sweeps
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- Measure signal balance error
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DL1 Digilyzer
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With all the power and digital audio measurement functions of more expensive instruments, the DL1 analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as the embedded audio. In addition, the DL1 functions as a smart monitor and meter for tracking down signals around the studio. Plugged into either an analog or digital signal line, it automatically detects and measures digital signals or informs if you are on an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a sophisticated event logging capability.

- AES/EBU, SPDIF, ADAT signals
- 32k to 96k digital sample rates
- Measure digital carrier level, frequency
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- Event logging
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- Monitor DA converter and headphone/speaker amp

AL1 Acoustilyzer
Acoustics & Intelligibility analyzer

The AL1 Acoustilyzer is the newest member of the Minstruments family, featuring extensive acoustical measurement capabilities as well as core analog audio electrical measurements such as level, frequency and THD+N. With both true RTA and high resolution FFT capability, the AL1 also measures delay and reverberation times. With the optional STI-PA Speech Intelligibility function, rapid and convenient standardized "one-number" intelligibility measurements may be made on all types of sound systems, from venue sound reinforcement to regulated "life and safety" audio systems.

- Real Time Analyzer
- Reverb Time (RT60)
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MR2 & MR-PRO Minirators
Analog Audio Generator

The MR2 & MR-PRO are the new standards for portable audio generators - the behind-the-scenes stars of thousands of live performances, recordings and remote feeds. Both pocket-sized analog generators include a new ergonomic instrument package & operation, balanced and unbalanced outputs, and a full set of output signals.

- Sine waves - Swept (chirp) and Stepped sweeps
- Pink & white noise
- Polarity & delay test signals

Plus the MR-PRO adds:

- User-stored custom signals & generator setups
- Phantom power measurement
- Impedance, balance measurement & cable tester
- Protective jacket

MiniSPL
Measurement Microphone

The precision MiniSPL measurement microphone (required for the AL1 Acoustilyzer and optional for the ML1 Minilyzer) is a precision reference mic for acoustics measurements, allowing dBSPL, spectrum and other acoustical measurements to be made directly.

- 1/2" precision measurement microphone
- Self powered with automatic on/off
- Omni-directional reference microphone for acoustical measurements
- Required for the Acoustilyzer; optional for the Minilyzer

MiniLink USB interface and PC software

Add the MiniLINK USB interface and Windows software to any ML1 or DL1 analyzer to add both display and storage of measurement results to the PC and control from the PC. Individual measurements and sweeps are captured and stored on the instrument and may be uploaded to the PC. When connected to the PC the analyzer is powered via the USB interface to conserve battery power. Another feature of MiniLINK is instant online firmware updates and feature additions from the NTI web site via the USB interface and your internet-connected PC.

- USB interface fits any ML1 or DL1
- Powers analyzer via USB when connected
- Enables data storage in analyzer for later upload to PC
- Display real time measurements and plots on the PC
- Control the analyzer from the PC
- Firmware updates via PC
- MiniLINK USB interface is standard on AL1 Acoustilyzer

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by Rolin Lintag

Plan for Natural Calamity at the Tx Site

No amount of preparation can guarantee that our transmitter site will withstand a severe natural calamity, as experienced with Hurricane Katrina. However, some preparation is better than none at all.

While this article is not meant as an omnibus contingency plan, it can serve as an "ice-breaker" when you sit down to prepare one for the station.

The goals you may want to consider should include first of all the safety of personnel and the public in general. Next is to minimize (if not prevent) the loss of or damage to company property and the loss of airtime. Finally, make it a priority to restore the broadcast to normal operations immediately.

Fig. 1: Batteries and chargers should be checked regularly and should not be lying on the floor.

Fig. 2: Equipment racks should be securely bolted down to the floor during the construction phase of the project. See to it these racks would not sway or fall even during a mild earthquake.

The above-mentioned goals, if stated clearly with their boundaries, can guide the preparation process in the right direction. Keep in mind that the major limitation to this plan will be the cost of implementation, in terms of money, time and manpower. There is only so much you can do to prepare but it is best to identify what you can do given your present resources.

CUSTOMIZED PREP

Next is to decide what calamities might happen at your particular location, prioritizing the ones that are most likely. Your station may not be at risk for hurricanes, but you may be in an earthquake or lightning zone. Plan for what suits your particular location.

Nátural calamities can include hurricanes that bring strong winds and floods, as well as earthquakes that topple anything standing out of the ground or break underground gas pipes, causing fires. Snowstorms can be considered calamities if they have the potential to overload towers and buildings and block access to sites that may need fuel for their generators.

Natural calamities bring their own set of problems: security concerns (looting), depletion of resources like fuel or food and health risks. It comes down to preparing for the mitigation of the following problems should these calamities occur:

• Extended power failures that will put the generator system on undue stress. This assumes that the generator will work on full load during emergencies. However, are you sure your present generator system can operate continuously on full load for up to two weeks? This is not just about the size of the fuel tank but about the type and capability of the generator itself.

• Rain or floodwater getting into your electrical equipment, shorting out circuits that can cause fires or further damage to the equipment (see Fig. 1). Electronic equipment that gets wet can be dried up and still work fine. However, energized equipment that gets wet or soaked under water can be damaged for good. An example of this is a power transformer with internal capacitors or rectifiers that is enclosed in a cabinet. A short on any of the external connections or wiring can produce an internal arc across the transformer windings or excessive currents that damage the insulation and the transformer as a whole.

• Strong winds or quakes that can cause horizontal or vertical movement of any hanging appurtenances, from the towers to ceiling-mounted filters/combiners and equipment racks. Anything that can fall or move horizontally can be a hazard to personnel and property. Although little can withstand a 7.0 earthquake, floor-bolted racks and secured transmission lines stand a better chance of staying where they should be (see Fig. 2).

• Fires resulting from these calamities, which can be a hazard to both personnel and property. Remember that even fumes can knock anyone unconscious, and fire will rob you of the same oxygen you need to breathe. Fires also can spread faster with the air ventilation working and in the presence of flammable materials in the building like cartons, paints and cleaning alcohol (see Fig. 3).

• Inaccessibility for fuel deliveries and repair personnel. Access to the site is important to keep broadcast operations on the air. Alternate routes, possible sources of transportation (aerial, amphibious or farm equipment) and emergency contacts should be planned for and decided upon before such a problem occurs.

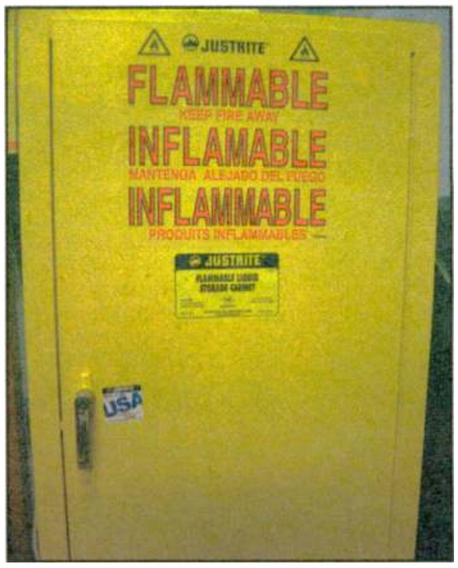


Fig. 3: Secure all flammables and chemicals in a separate cabinet outside of the transmitter building.

Fig. 4: Be prepared with spare fuses and surge suppressors inside the building.

This list can be expanded and tailored to your location and needs as you work with your team.

It will help to consider the following tips as you make your plans.

ELECTRICAL POWER NEEDS

Your generator should be able to supply continuous power to the station for at least two weeks — an arbitrary time frame but not at all a bad guess — during a calamity. The generator may require extra cooling, or the exhaust piping may not be able to withstand the extended vibration and other things that only a generator specialist may be able to elaborate for you.

It is possible that up to this time, the longest your generator has operated on full load was not more than a day. Make preparations for the generator to run much longer than that.

Check to see that the fuel tank and its pipes are protected from any falling ice or debris. You may not be able to save it from a falling tower but it is definitely vulnerable to falling ice if there is not even an ice shield for the pipes.

Make sure that you have spares for big fuses, surge suppressors and circuit breakers that may be hard to get when you need them the most (see Fig. 4). You may be thankful you got to the site to do the repairs, but frustrated soon enough when you still can't get on the air due to a blown fuse on the generator building.

Your UPS is only as good as the batteries you connect to it. This is important if you have your STL, remote monitoring/control system and communications facility connected to it. Should your generator burp during an extended power failure, you don't want to lose communications to the site.

SEE CALAMITY, PAGE 20

Calamity

CONTINUED FROM PAGE 18

HAZARDS INSIDE THE BUILDING

Hanging fluorescent lamps may not be the best fixture choice inside the building if you expect to be visited by earthquakes. Consider lighting systems that can stay put during a horizontal shake (see Fig. 5). The same goes for emergency lighting systems that may be just sitting on top of a platform. Anything that can fall should be secured to the ceiling or the wall.

Inspect ceiling-mounted combiners or filters and transmission lines. Are they properly secured to the ceiling or wall mounting? It may be too much to ask but is the mount to the ceiling secure?

Are all the equipment racks bolted to the floor? Is all equipment bolted to the rack? It is possible that the Integrated Receiver Demodulator, for example, is just lying on top of a monitor. Big CRTs, like computer monitors, can easily implode so make sure to secure them where they stand.

Are all chemicals, flammables and corrosive substances inside the transmitter building safely locked inside a metal cabinet? Corrosive chemicals used for cleaning condensers and heat exchangers may spill on the floor and eat up metal parts like the ground strap of equipment racks. Flammables like alcohol for maintenance, fuel for grass cutters, paints and thinner can definitely make fire hard to contain. The transmitter building is simply not a safe place to store these substances.

Are holes into the building, particularly where transmission lines come in, sealed from outside torrential rain? Rain due to storms may be coming in horizontally and can flood the inside of the building in minutes (see Fig. 6).

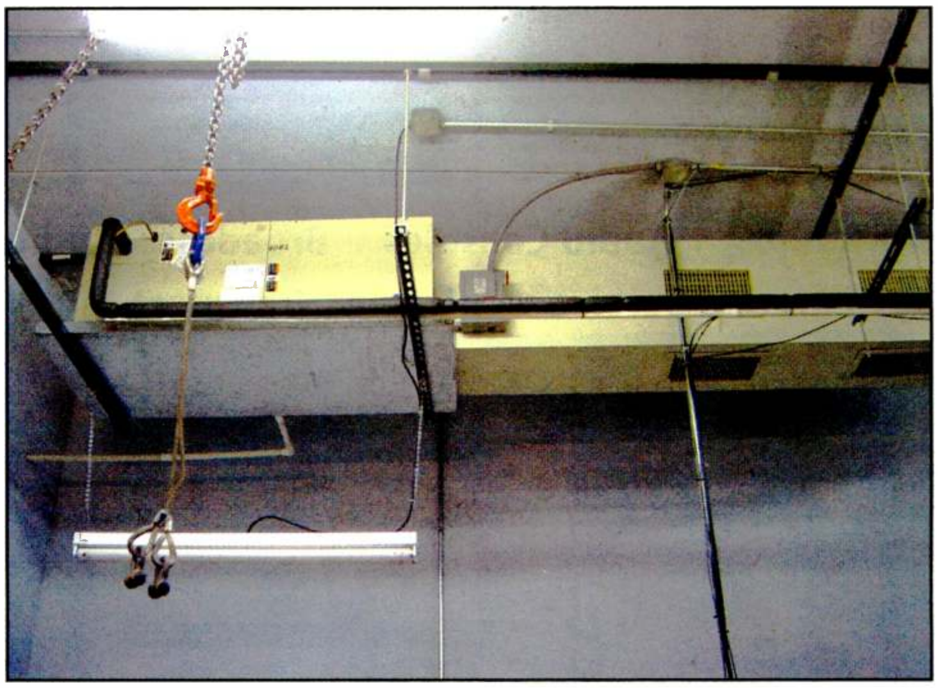


Fig. 5: Refrain from hanging lamps on the ceiling of the building. They can sway and fall during even a mild earthquake.

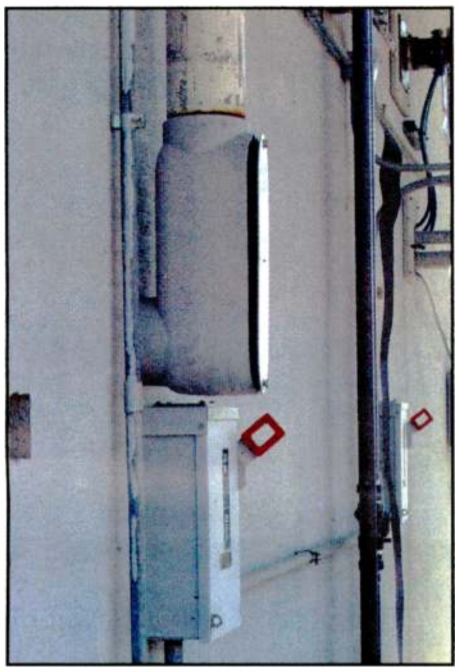
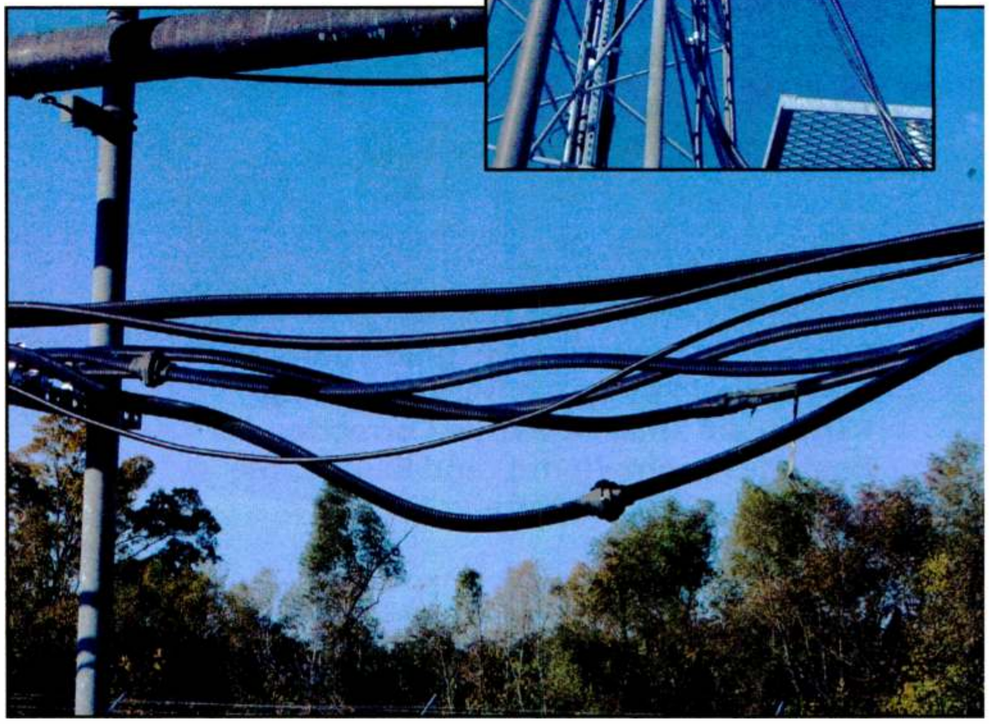


Fig. 6: Ensure that electrical wiring outside the building is free from water entry. Torrential rains can possibly short out the wirings inside this conduit.



Figs. 7 and 8: Coax cables hanging loosely on the tower need to be fixed. A strong wind can make them act like a whip and bring down the other appurtenances on the tower.

HAZARDS OUTSIDE THE BUILDING

When was the last time the tower was inspected by a qualified tower inspector?

Are you inspecting the guy anchors yourself on a regular basis?

A large part of what can bring the tower down, even at wind speeds it was specified to withstand, can be caught on the ground. This includes but is not limited to a corroding anchor-rod, loose turnbuckles, rusted cotter pins, corroding tower base and the like. You want your tower to be at its best shape when calamities happen.

Are the transmission lines properly secured and grounded to the tower (see Figs. 7 and 8)? Winds can cause transmission lines to beat against the tower and knock off hangers one after the other until the whole transmission line falls down. You don't need a Katrina for this to happen. Taking pictures of your tower when it is standing tall can possibly help you in making claims later on.

Do you have a flood level sensor outside of the building to tell you when to shut down all electrical equipment? Should flood waters rise beyond what your facility was designed for, the best thing to do is shut down all electrical equipment to prevent further damage so that you can resume operations ASAP when the waters recede.

STUDIO TO TRANSMITTER LINKS

Is the STL antenna securely mounted on the tower? Even moderately strong winds can move an antenna out of its line-of-sight orientation with the studio causing a loss of on-air program.

Are all antennas protected by ice shield?

Are all connectors weatherproofed?

Do you have an emergency antenna you can install on the tower should the one in use become out of service?

Do you have an alternative means to get your signal to the transmitter if the STL fails?

COMMUNICATIONS

It is possible, and it did happen during Katrina, that mobile phone and landline telephones went out of service for a long while. Do you have other means of communicating with personnel on the road and at the site? You don't want any of your staff caught in the middle of a rising flood, risking harm and requiring emergency rescue.

It should be clear to all, particularly to the management, that human life is far more important than getting the broadcast back on air. The safety of your personnel should never be compromised.

PERSONNEL PROVISIONS

MREs (Meals Ready to Eat), first aid, warm blankets, raincoats, spare batteries, safety helmets and flashlights should be made available on-site at all times. It is not a bad idea to have a bag of clothes (in sealed zip-locks) and personal effects in the transmitter building.

Detailed protocols for personnel to follow should be written up and disseminated to all. These protocols will address what each one must do during and after a calamity. Things like escape routes, emergency numbers, alternate "office" venue upon resumption of operations, petty cash, help for staff families, response from sister stations (or corporate office) can be decided upon prior to calamities and ease what can otherwise be pandemonium.

The old adage "Fail to Plan, Plan to Fail" is never more useful than in times of emergencies and calamities.

For more help in planning, download the "Local Radio Station Model Vulnerability Assessment Checklist" developed in 2004 by the Toolkit Working Group for the Media Security and Reliability Council. Go to www.fcc.gov/MSRC/documents/RadioVulnerabilityChecklist.pdf

Rolin Lintag is chief RF engineer for Victory Television Network in Little Rock, Ark. ■

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by Gary Stigall

A New FM Array at Mt. Soledad

CBS and Clear Channel Partner on San Diego Multiplexed Antenna Project

A new multiplexed FM antenna on KGTV's Mt. Soledad, La Jolla, Calif., site is open for business and radiating.

John Rigg, San Diego market director of engineering for Clear Channel Communications, says that his stations KMYI 94.1 MHz, KIOZ 105.3 MHz and CBS Radio's KSCF 103.7 MHz have been on the four-port system since April 5.

ERI designed and built the system, an SHPX-10AC-HW center-fed 10-bay half-wave spaced array with approximately 5 dB gain. John says "ERI was chosen because their SHPX series antennas present less weight and wind load than comparable antennas from other manufacturers. Their combiner is more modular and easier to install in tighter places, specifically the attic space above the transmitters."

PARTNERS

Clear Channel and CBS have partnered before on a similar project on the site. KIOZ and KSCF have been combined on an adjacent tower for several years. The main tower owned by McGraw-Hill Broadcasting now hosts the new community antenna.

Two site developments motivated the participants to build the antenna: the need for a reduction in RF radiation at ground level due to a new residence to the west of the site, and the steep rise in rent at neighboring towers owned by Midwest Television, KFMB(FM/TV).

The new array now occupies a position just below the tower top-mounted KGTV VHF-TV antenna, but sharing the aperture of the KGTV-DT UHF array. John says that they did extensive modeling before construction to assure little interaction between those antennas. In fact, the modeling resulted in the fabrication of antenna mounting brackets out of non-conductive materials.

The quest for the master antenna began after completion of a new home two lots away, adjacent and northwest of the neighboring fire station on Via Casa Alta, the street separating the KFMB and KGTV properties.

Consultants Hammett and Edison studied ground-level radiation at the home and determined a particular hot spot at a steel column that wasn't going to go away unless a substantial rearrangement of radiators took place.

RFR laws state that any contributor of more than 5 percent of the maximum permissible exposure (MPE) is equally responsible for mitigating the problem regardless of the contribution percentage. KFMB and its tenants KIFM and KYXY were farther away and had just completed their new combining array with low downward radiation values, so they were let off the hook.

SEE SAN DIEGO, PAGE 35

ERI Combiner

Clark

CONTINUED FROM PAGE 1

the loudest processing combination would have Texar Prisms and an Orban 8100 in its racks.

I met Glen Clark back in 1982 when he personally delivered a pair of Texar Prisms to me in Providence, R.I., then set them up using only a Simpson 260 VOM and the Prism's internal pink noise generator. I was impressed by both Clark and the Audio Prism.

He first became interested in radio in the eighth grade, and that interest grew into Texar Inc., a company he founded in Pittsburgh. He later sold Texar to Gentner and started Clarkcom, a consulting firm that now specializes in computer-designed AM directional-antenna patterns.

Clarkcom has designed some of the most challenging AM directional upgrades in the country including WWJ, WFDF and WXYT in Detroit; WCBM and WWLG in Baltimore; WMVP, Chicago; and WMAL and WMET in Washington.

For fun, Clark also uses his supercomputer — yes, he owns one — to dabble in stock market trading. He takes us back to the "loudness wars" of the 1980s and what led to the development of the Texar Audio Prism.

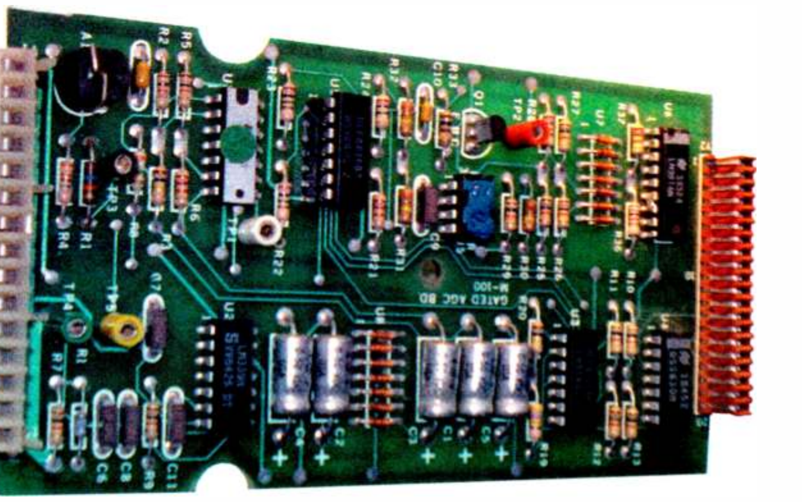

Fig. 1: The heart of the Texar Audio Prism was the M-100 processor card. There was one card for each of the four frequency bands. The M-100 card was the first audio processor to use digital technology in the control chain and reach high-volume production.

What was your first job in radio?

I did the sign-off shift at WGRP(AM) in Greenville, Pa., when I was 16.

When did you get interested in audio processing?

At WLS(AM), Chicago, in 1972. ABC had just moved its Chicago FM O&O — then called WDAI(FM) — from Marina Towers to the newly-completed John Hancock Building. WDAI was getting pounded into the ground by CBS's WBBM(FM) and a few others. Keep in mind that, in 1972, there was no Optimod and the hot box for FM audio processing was the CBS Volumax II — the slim-line unit.

WDAI was where I first started looking at the overshoot in the anti-aliasing filters in the RCA stereo generator and at peak-to-average ratios.

After I left WLS in 1974 to go back to school and finish my degree, I spent a summer working with Eric Small [who was marketing Orban's early on-air processors to broadcasters], carrying around the original, hand-wired, perf-board prototype of the Optimod 8000. I installed it as a demo at WFBQ(FM) in Indianapolis and at several of the ABC FM O&Os for Alan Shaw. The usual reaction was that everyone wanted to keep the demo unit until we could replace it with a production unit. Sometimes it was hard to get the demo unit back.

What is the story behind the development of the Texar Audio Prism?

The whole reason to go back to school was to understand the math of the non-ringing filters that Bob Orban had in the Optimod. But when I graduated I ended up back in a line engineering function as the group director of engineering for the Post-Gazette stations based in Pittsburgh. Dealing with the day-to-day hurly burly of a bunch of rock FM stations and news/talk AM stations was a lot more exciting than watching traces on an oscilloscope for days on end, which is what designing audio processors is all about.

There were three people who were instrumental in the chain of events that led to the Audio Prism. None of them ever knew the part they played.

Diane Sutter had just been appointed general manager of WPEZ(FM), which was the Post-Gazette's flagship FM station in Pittsburgh. Bobby Christian was the program director for WXKX(FM) 96-KIX, Hearst's FM rocker on the other side of town. And the late Ron Jones was the president of CRL, the other renegade processor manufacturer of the day.

Fig. 2: Cray Supercomputer

At the time, about 1980, the Optimod 8100 hadn't yet been released. The hot audio chain at the time was a pair of Dorrough DAP-310s feeding an Optimod 8000 driving a Collins/Rockwell 310-Z exciter. If you really knew your craft, you pulled the input filter out of the exciter to minimize overshoot.

One morning the sky fell in. 96-KIX was just jumping out of the dial. We and the other FMs in town looked small by comparison. At first, we were certain that they were simply over-modulating. But an off-air measurement showed them to be completely legal. Some spy work by a weekend disk jockey revealed that 96-KIX had a secret weapon, a brand-new audio processor from a company in Phoenix that we had never heard of called CRL.

We made a call to Phoenix, placed an order and got on the list of people who would get CRL hardware when our number came to the top of the list. But every time that we thought we were getting near the top of the list, CRL told us we were still several weeks from delivery. When other stations who had ordered CRLs after we did received their product, and we didn't, Diane Sutter, the WPEZ general manager, thundered, "We've been a weak signal compared to 96-KIX for months! If CRL won't send us equipment, go buy this audio processor thing from someone else!"

I explained that audio processing wasn't like buying carpet, where you had a dozen vendors to pick from. Audio processing was a small, niche market with few vendors and unequal technology. So I had the unpleasant task of telling Diane, "There is no 'something else.' We can't buy anything from anyone else that will make us sound as loud on the dial."

What was her response?

Diane was a take-no-prisoners kind of manager. And she wasn't about to be embarrassed by Hearst's 96-KIX, which she had just left to come work for WPEZ.

There are certain moments in all of our lives that will be forever burned into our memories. And this moment will always be burned into my memory. When I told Diane that no one else sells a louder processor, without missing a beat Diane thundered, "Then build one!!" She pivoted on one heel and was gone.

Diane was a sales person through and through. I seriously doubt that if you put an Optimod and a 45 kW Onan generator in front of Diane she could tell which one was the audio processor. And I wondered at the time if she really understood the impact of what she had just said.

But those were in the days before accountants and bankers ran the radio business. You could move a lot of money around from one budget account to another as long as your total budget matched your promises.

Three days later I gave Diane a list of what I needed to "roll our own" processor and Diane, bless her heart, was good on her word. She signed the papers and handed them back to me. All she said was, "I want it done yesterday!"

A month later we had two stone age-looking four-band audio processors ready for their shakedown voyage. Each one took up about 6 inches of rack space. We didn't even test them as a system before we put them on the air. There wasn't time. We jammed in the patch cords and hit the air three hours before the Arbitron started.

A few months later a rumor surfaced that the reason WPEZ couldn't get CRL to ship to us was that Bobby Christian, 96-KIX's PD, had worked with Ron Jones at KUPD(FM) in Tempe, Ariz. Ron was protecting his buddy Bobby by not shipping any more CRL product to Pittsburgh, the rumor went. I don't know if the rumors were true. But what is true is that if CRL had shipped an FM stereo processor to WPEZ in 1980, there would never have been a Texar (see Fig. 1).

Pittsburgh is not a Top 10 market. But it does have a lot of vehicle traffic passing through with the Pennsylvania Turnpike connecting Baltimore, Washington and Philadelphia to the east, with Detroit, Chicago and Denver to the west. We started getting calls at WPEZ from broadcasters driving through on the Turnpike and asking what kind of processing we were running. A few months later I worked out a deal with WPEZ to own the designs in return for other consideration and went into the manufacturing business. That was 1981.

Why did you make a career change after the Prism?

The Texar booth had been close to the Gentner booth at several NAB and SBE conventions. Russ Gentner was looking to make some acquisitions so that he would be big enough to "go public." Russ had let it be known during some casual conversations in the aisle at several of the shows that, if I ever wanted to sell, he might want to buy.

I had just finished the design for the Texar Lazer — the analog version, not the digital version — and was at a logical breakpoint. The Lazer was an integrated FM limiter and stereo generator. For the first time, Texar had an end-to-end product line. You didn't have to co-op with another brand of hardware.

What I didn't count on was that the FCC would make the NRSC-1 guidelines for occupied bandwidth mandatory 30 days after Russ and I signed the deal. Every AM station in the country had an FCC-mandated timeline to get NRSC-1 compliant equipment installed. My guesstimate is that Texar would have dropped $2 million to the bottom line in the next 18 months on the NRSC products alone.

What do you think about the state of audio processing today?

Game over. The great modulation wars of 25 years ago are over.

When I was in Chicago in 1972, the peak flasher on the Belar mod monitor would flicker at 100 percent while the RMS meter would bounce wildly around 70 percent. In 1980, the flasher was still flickering at 100 percent and the meter was waving around 80 percent. By 1990, the Belar meter looked like it was painted on at 90 percent. It never moved except when the announcer stopped to take a breath.

Where is there to go? You already have loudness and clarity. What could a new processor offer the market?

Today, people take the processor out of the box, put it in the rack, spend three days deciding which preset works best for their format and then forget about it.

Did you have a mentor or someone who helped you get started in your career?

The hands-on skills I learned for working with AM arrays came from the late John Mullaney, Jack's father. But there were few mentors available for working on FM prob-

SEE CLARK, PAGE 26

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Clark

CONTINUED FROM PAGE 24

lems. I would characterize solving FM problems more as collaboration than mentoring.

The gray lions knew AM inside out. But, in the very early 1970s, FM was not a force in the ratings and few people had paid much attention to anything more than just keeping the transmitter on the air and putting background music on the channel. The ins and outs of working with FM were fresh snow with no footprints in it.

Most of what we take for granted today was still unknown in 1972. Aligning cart machines with an X-Y scope so that you didn't lose the high end on mono receivers was still a black art. And no one knew then what the impact of synchronous AM noise was on fringe reception at the time.

When I was in Chicago, my two main collaborators, mostly by telephone, were Eric Small and Bob Deitsch. Eric had just left WXLO(FM) in New York to start an audio consulting firm. And Bob had been hired by ABC to be the chief engineer of WPLJ(FM) in New York at the same time I was hired at WLS.

A dozen years later, after Texar had opened its doors, Bud Aiello, Jeff Gulick, Jeff Keith and Frank Foti were important sounding boards for new ideas. Bud, Jeff and Jeff were chief engineers for stations here in Pittsburgh. And group owner Malrite had just moved Frank Foti from San Francisco to WHTZ(FM) Z100 in New York.

Bud is now with NPR in Washington. Jeff Keith recently moved from Omnia to Wheatstone. Jeff Gulick, sadly, died last year of a rare form of cancer. And Frank has, of course, gone on to be the chief wizard for the Omnia line of audio processors.

Can you tell us about one of your more challenging projects these days?

My time today is split evenly between playing the stock market and designing directional antennas.

Something I became interested in while at Purdue in 1974 was the supercomputer. Purdue had a pair of CDC 6600 computers, the last computer that Seymour Cray designed before he left CDC to go start his own company. The 6600 was the supercomputer of the time (see Fig. 2).

Several years earlier, a former MIT math professor named Edward O. Thorp wrote a book called "Beat the Dealer."

In preparation for writing the book, Thorp had run tens of thousands of imaginary hands of the card game blackjack on an IBM 704 computer and come up with a set of rules of when to fold and when to hold, based on what cards were left in the deck.

The publication of Thorp's book was the beginning of the science now known as "card counting." If you sit down at a blackjack table at the Bellagio during the NAB convention, they deal multiple decks from a "shoe." You have Professor Thorp to thank for that. The shoe and the multiple deck deal were both in response to Thorp's book.

A few years after writing "Beat the Dealer," Thorp suggested that large computers also could be used to find patterns in the stock market. Thorp left academia, stopped writing books, opened a hedge fund, moved to Newport Beach, Calif., and, by one account, owns the most expensive house in Orange Country; no small accomplishment.

I had always wanted to apply digital signal processing techniques and large computers to Thorp's ideas. But Texar was a never-ending sprint to come up with new designs, so there was no time to explore the stock market during the Texar years.

A few years after selling Texar, I bought a used Cray YMP-EL supercomputer from a defense contractor in Texas that was upgrading to a larger model. I've used the Cray to design about a dozen 50 kW power upgrades for AM stations around the country. One of the designs, a nine-tower we did for CBS in Detroit, has been the subject of an ongoing discussion in a number of blogs. The arrangement of the towers is, shall we say, unconventional. (See Figs. 3 and 4)

SEE CLARK, PAGE 28

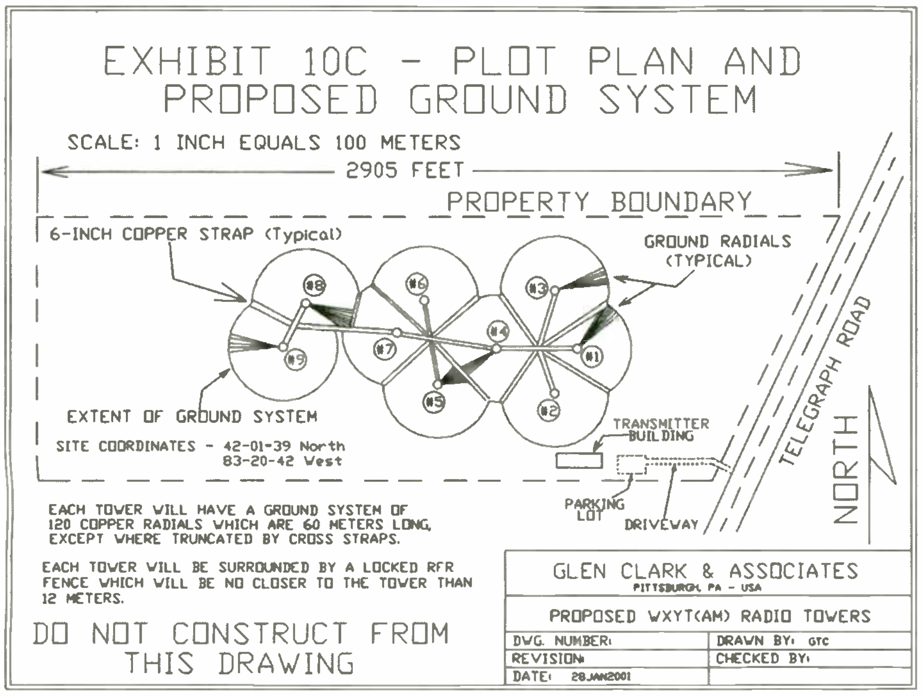

Fig. 3: Diagram of Tower Layout for WXYT(AM), Detroit

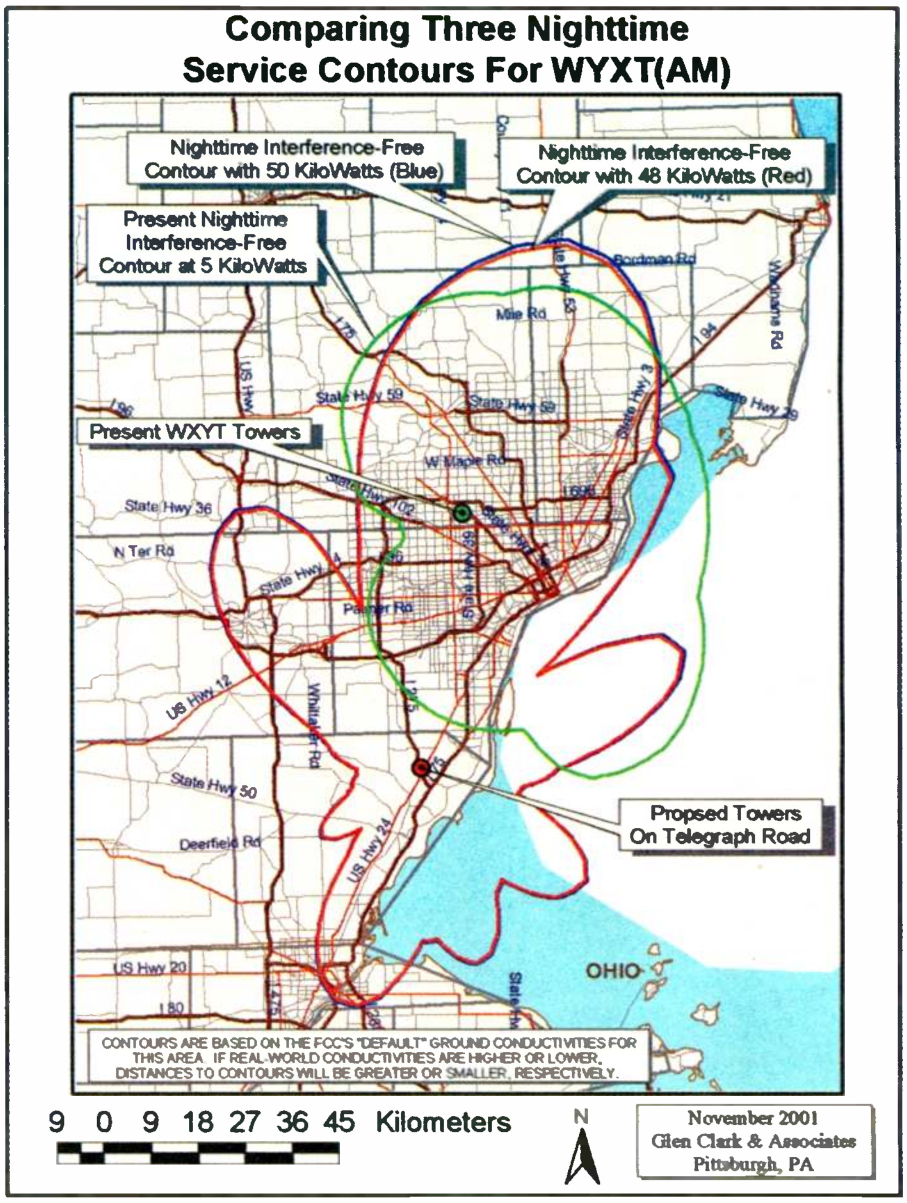

Fig. 4: A Comparison of the WXYT Nighttime Coverage Contours

Antenna

CONTINUED FROM PAGE 4

rig. I am not in favor of high-level combining using injectors due to their energy wastefulness. I cannot see putting an IBOC signal on the air whose payback might be many long years down the road and doing so with greatly increased energy costs.

Dual-port feeds using on-the-tower hybrid isolation technology were becoming available for both side-mount and panel-style antennas. That would permit low-loss combining with good energy savings. So now I had two good reasons to justify the purchase of a new panel antenna.

IDENTIFY ISSUES THAT NEED TO BE FIXED

Whenever I consider a project that is not totally indoors I think about zoning regulations and permits. The local town didn't care as long as antenna changes were not going to vastly alter the appearance of the tower. The cellular arrays with their wide side arms were far more likely to create visual issues than our face-mounted panel antenna, so no problem there.

But what about the tower itself? Could it support a hefty panel antenna? What about wind load, protection against icing and physical space? Getting definitive answers turned out to be the trickiest part of this project.

I hired a structural engineer who was intimately familiar with this tower. I took many digital photos of the tower and even sent a tower rigger up to make physical measurements (see Fig. 2). But in the end, the structural engineering company sent its own man up the tower to re-catalog it. With so many tenants on the tower it was impossible to assume we knew everything up there.

Fortunately, the only appurtenance in our FM aperture was one of our own STL dishes. It would have to be moved up to make room for the wrap-around panel array. But the tower had more surprises for us.

HORSE OR CART?

We needed structural and physical dimensional information to give to antenna manufacturers to get bids, estimates and preliminary design plans. But our structural engineer could not make final determinations about the new load and what, if any, tower modifications would be required to handle it without knowledge of the specific antenna dimensions.

Northeast Towers Project Crew: Lee Miranda, Kevin Znuj and Dan Poole

Panel antennas are custom-built, based upon electrical and physical mounting requirements of each installation. We didn't know how much vertical space the antenna would require, as that depended upon the effect inter-bay spacing would have on the required gain and port isolation.

Furthermore, we had space constraints based upon location of guy wires and side marker lights. Could the antenna manufacturer accommodate the side lights or reduce the inter-bay spacing sufficiently so the antenna could fit below that level? If not, then could we modify the guy wires in a way acceptable electrically and mechanically?

The antenna manufacturer could make design changes based upon structural needs. And our structural engineer could recommend tower modifications to accommodate the antenna. But neither would be able to agree upon the best approach alone.

ERI is Saga Communications' preferred antenna vendor, as it will proof the actual full-size antenna on its test range. Getting the company directly involved was extremely helpful; it determined that, yes, the side marker lights would end up near the middle of the antenna. And the guy wires above were too close and would have to be replaced with non-metallic sections. However, I still felt as though I was the middle term in a differential equation. Both sides needed firm numbers but both sides were part of the problem.

The curves finally started to converge. By substituting some constants and reducing some of the variables, we were able to get some conditional answers upon which to narrow choices.

For example, ERI told us we'd require 20 feet of non-metallic guy wire at the level just above our antenna. Our structural engineer was able to approve the guy wire change. Thus we could now determine how much space we had for the antenna. With this settled, ERI could design the antenna to fit around the side marker lights and provide final mechanical figures for the structural analysis.

At this point I told ERI to take over the job as a turnkey project; to be responsible for acquiring the riggers, getting all of the materials on site, erecting and testing the antenna and connecting the line to my equipment.

However, I still had to wear the hat of Clerk of the Works. No sidewalk superintendent role for me.

PADDING FOR YOUR BUDGET

In our case, a side-mounted antenna would not have provided adequate signal coverage or greatly reduce RF into the tower, so it was more a matter of what panel vendor to choose.

As indicated earlier, our best IBOC solution was a dual-port antenna, as there was no room on the tower for separate antennas. And two sets of space-diversity panels, one each for IBOC and analog, would have

> **Could the tower support a hefty panel antenna? What about wind load and protection against icing? Getting definitive answers was the trickiest part of this project.**

been economically infeasible. There was really only one solution that met all of our goals: a dual-port panel antenna.

It is valuable to know in advance what the total cost of a major project will be. In this case I provided a wide estimate with plenty of padding for the unknown. It has been my experience that 10 percent is often inadequate, especially for projects with many unknowns or with potentially expensive side issues. Modifying a 500-foot tower falls into this category. Thus, I'm more comfortable using a contingency factor of 20–25 percent.

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Clark

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But the real goal with the supercomputer has always been to explore Professor Thorp's premise that, with a big enough computer, you can consistently beat the stock market. Three years ago, I retired the Cray and replaced it with a 100-node cluster computer (Fig. 5).

A lot of the cluster's time is still spent redesigning AM arrays to broadband them in preparation for HD Radio. But when it is not busy on an antenna project, it is sifting through reams of stock market data, looking for patterns that predict, a day in advance, when a stock will go up or when it will go down. That day of advance warning gives us time to buy stock options.

Some people have asked how someone could go from audio processors to antenna design to stock market trading. But it's all just math. It would amaze people if they knew how similar the equations are for an antenna and for a non-ringing audio filter. The science you need to beat the stock market is inside an Omnia audio processor.

What do you think the future of AM and FM IBOC is?

Fig. 5: 100-node Computer Cluster for Complex Calculations

Harder question than the last one. Everyone thought that the "must have" application for HD was going to be digital clarity. But it is turning out to be HD2. Two high-quality distribution channels for almost the same price as you used to pay for one channel? Not bad. And a bunch of new receivers have found their way into mainstream distribution channels in the last few months. But the flip side of the equation is that Apple announced on April 10 that it had just sold its 100 millionth iPod.

A man is climbing up a ladder on the side of a boat that is sinking. Is he getting further from the water or closer to the water? Hard to tell. That may not be so much a statement about HD as it is a statement about the plurality of alternative distribution channels, which have come online recently.

There were several years when the prevailing wisdom was that XM and Sirius would spell the end of AM and FM radio. But I am far more worried today about Verizon's FiOS fiber-to-the-home service.

No, FiOS won't give you traffic advisories of whether to take the upper or lower level of the George Washington Bridge into Manhattan. But it sure will let you load a lot of music on your iPod before you leave home. And an iPod port is a far easier option to find in an auto dealership showroom today than an HD Radio option.

What do you do when you're not working?

I love to water ski. There is nothing like making a J-turn around a slalom buoy at 50 mph with your right hip and your right elbow skimming the water's surface and throwing a 50-foot-high "rooster-tail" wake that people can see from the other end of the lake. Some friends say that skydiving is a bigger adrenaline rush. But I'm afraid of heights.

What do you want to be doing ten years from now?

Dating Reese Witherspoon. But, even though she and Ryan split up, I still can't get her to call me back.

I think that stock market trading is endgame for me. Texar was fun when it was about solving puzzles. How do you handle the bass punch of Queen's "Fat Bottom Girls" without punching a hole in the midrange? Directional antennas are still an interesting puzzle. How do you put a westward nighttime null from Detroit to protect the 950 kHz in Chicago without putting a null across Interstate-75, Detroit's lifeline to the world? But I don't know how many years AM has left.

Stock trading and options trading are pure math puzzles. The puzzle is always changing and the profit potential is gigantic. Once I get Reese Witherspoon to marry me, I can't imagine anything I would rather be doing than trading options.

Steve Callahan is a frequent contributor to Radio World Engineering Extra. ■

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A good way to test your contingency estimation is to look at the worst-case scenarios. I look at the most costly side issues even if they are under control and add those costs to my worst-case estimate. If that brings me close to 10 percent, I'll opt for the safety of 20 percent.

For this project, my cap-ex figures included funds for tower modifications, the non-metallic guy replacements, additional labor, additional transmission line and additional professional engineering fees. I also was able to roll some of my IBOC conversion expenses into it. While some of the expenses were exceeded due to unforeseen issues, the total figure was not.

The only safe way to bring a project in at or under budget is to not be frugal with your estimates. List all your potential expenses including all known side issues. Then add a contingency factor. Consider increasing it to a full 25 percent, especially on big projects where side expenses tend to be big-ticket items all by themselves.

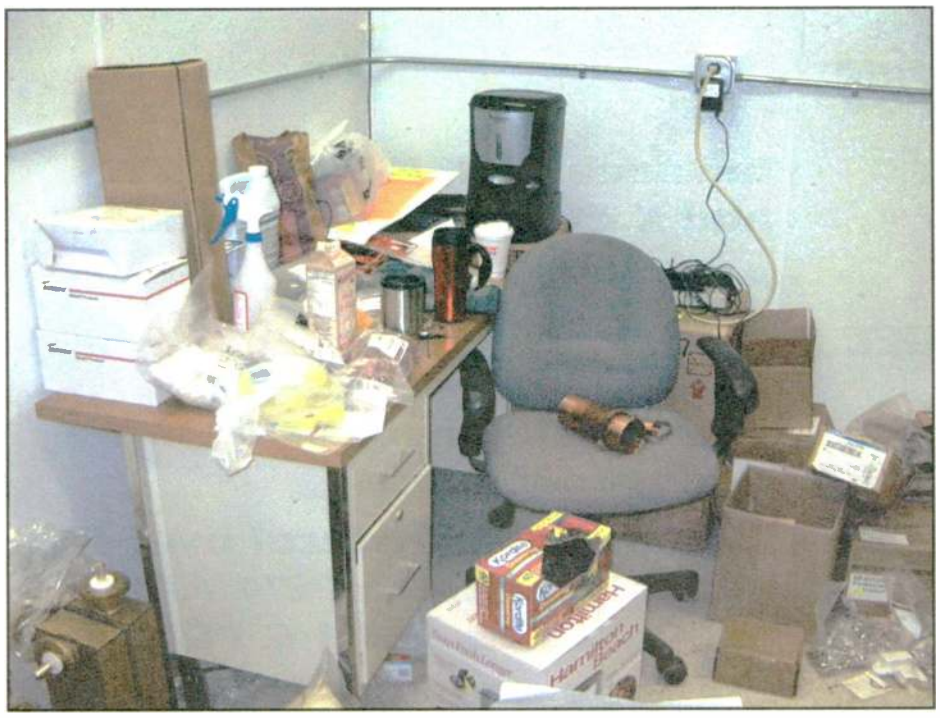

Fig. 4: Transmitter Room With Tower Rigger's Coffee Pot

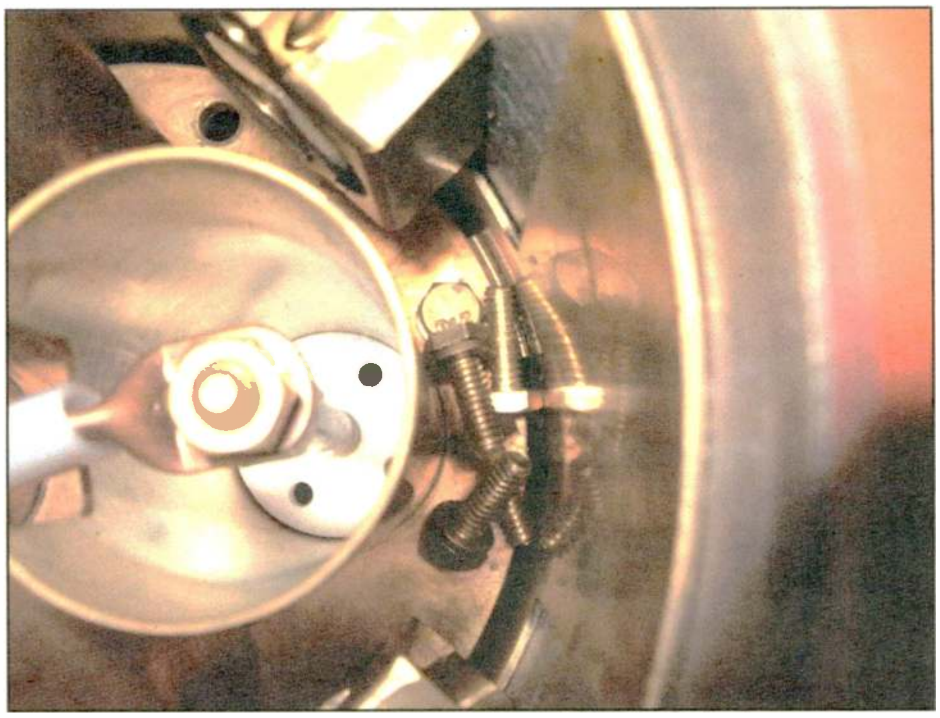

Fig. 5: Two of the bays had lots of loose hardware.

Fig. 6: The author stands with an assembled antenna panel.

Fig. 7: Assembled Panel About to be Lifted to Tower

DEVELOP A TIMELINE

Steps in a project will have a logical order, which can be used to create a preliminary timeline. For example, planning will include formulating a plan of attack, surveying available products and vendors, acquiring quotes, etc. You need to reserve time to hear back from vendors and allow them to fix errors in their quotes and resubmit them. That alone might require more than a month depending upon the complexity of the project.

When you finally secure a specific vendor or product manufacturer, you need to determine the lead time required to provide the product if it is not an off-the-shelf item. Lead time will include not only the tangible such as average time-to-manufacture and waiting in the queue for the manufacturing process, but also the intangible; how long it will take to finalize the product design in the case of a custom product such as a panel antenna.

The one item in the timeline that may defy estimation is the weather. This is the one variable that can be quite unpredictable. Tower riggers can give you a good estimate for completion of a job based upon their experience in your neck of the woods. If they say two to three weeks, assume three weeks.

I had some unrealistic timing goals for this project. Little did I know that the antenna manufacturer actually required a six-month lead time to design, manufacture, test and deliver our antenna, or that my corporate business office would somehow forget to submit a deposit in a timely manner. So time posts slipped.

Coordinating the approval process of the structural engineer with the design phase of the antenna from ERI provided more slippage. When I thought both entities were creating solutions they were actually both waiting to hear from each other or from me. Both required more data from each other as well as more precise data about the tower.

Unfortunately, the tower owner did not have up-to-date information about his own tower and his tenants. I had to arrange to collect that data from other sources, such as hiring my own rigger to re-map the tower. So a project I had projected would take three to four months to complete took six months.

At one point, ERI's riggers didn't have cleared schedules for us and winter was closing in. To solve the rigger-scheduling problem I put ERI in touch with a local tower company (Fig. 3) with a well-deserved reputation in the northeast, Northeast Towers. It has done good work for me in the past. Having a home base not too many hours away meant more flexibility in keeping the company on or near the job even if we suffered some delays due to weather. The antenna had yet to be built and it was turning cold up here in New Hampshire.

PROVIDE SUPERVISION

I had to hold up delivery of the Broadcast Electronics FMi-77, as I wasn't sure if it would be sufficiently powerful without confirmation of the entire antenna system gain/loss. Final numbers for RMS antenna gain for both analog and digital finally came from the ERI test range along with the polar pattern for my perusal.

TPO was calculated for both our new analog transmitter, a BE FM-20T, and for our on-order IBOC transmitter. This included antenna-mounted hybrid losses, power divider losses, line loss and magnetic circulator loss on the IBOC side. Now I could release delivery. The BE IBOC rig arrived many weeks before the ERI antenna. So much for coordinated timelines.

I kept on communicating with ERI and my riggers to ensure things were moving along. Riggers are moving targets. They have to stay busy. So, if your project isn't ready due to materials not arriving, you can be sure they won't be waiting around unless you want to pay for their idle time. Truckers can lose their way up rural mountain roads even though it is quite hard to miss the sight of a 500-foot tower.

The big day finally came when the antenna was set to be delivered and installed. Unfortunately it was now the

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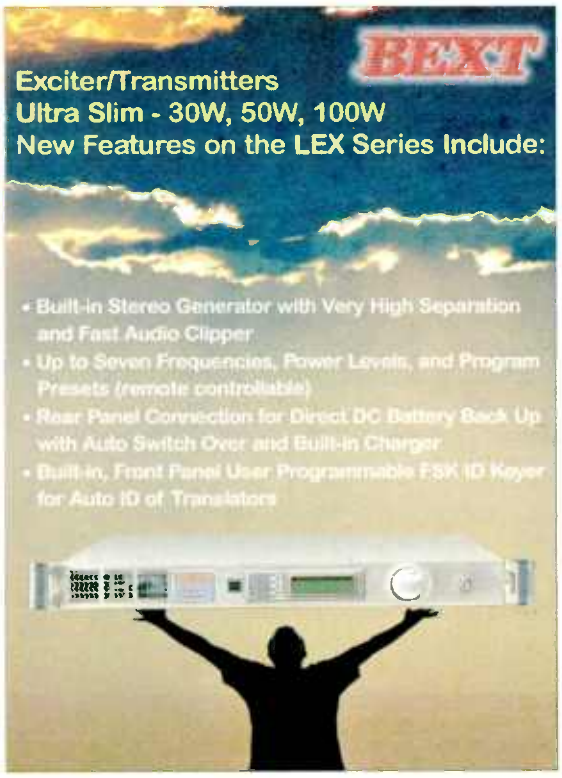
THE ENGINEERING BLOCK

Products & Services

SHOWCASE



NAB2007: North Hall Revamped, HD Radio Hits Mainstream

The annual NAB rite of passage on the desert has come and gone for broadcasters. If you were lucky enough to attend, you got to see firsthand how the tide is turning toward all things streaming.

Almost everywhere you looked, especially in the vast Central and South exhibit halls, there was something on display confirming the reality that Web streaming is the shooting star carrying consumer multimedia into the future. There is no doubt that this includes traditional broadcasters.

Perhaps you could not attend, though, so let me provide the scoop on new products and hot topics you missed. What is overheard in conversations amongst attendees regarding their experiences at NAB, not the expected pabulum you read in the trade press, tells the real story of what went on there.

RADIO GIVES WAY

The first thing I noticed when entering the North Hall where radio exhibits had always been for many years was that instead of the "Radio-Audio Exhibit Hall," I was met with "Acquisition & Production" and "Management & Systems."

Radio and audio were mere footnotes in the Program and Exhibit Guide. Half of the North Hall was filled with TV folks including Grass Valley and the vast Harris layout. Our old radio exhibitor friends were either at the other end of the hall or scattered throughout the remaining floor space along with a relocated attendee registration area.

This change speaks volumes about how our industry is being transformed and also why many traditional radio/audio vendors see the need to expand their universe of potential customers. Orban, for example, was only going to support one main booth in the South Hall to lure in new multimedia prospects, but then decided at the last moment to erect a small booth in the corner of the old radio hall. Unfortunately it didn't appear to me they were all that happy with the action in either location.

The South Hall seemed absolutely mobbed on most days. You could probably find every device known to man that could capture and stream video (and audio).

There were very few major products or "breakthrough" technology introductions for radio this year. Most of the hardware and software shown were improvements, enhancements or feature additions to existing products. I'll get to the notable ones, including some of the "Cool Stuff" winners, in just a moment. First let's shed some light on the big picture topics of NAB2007.

Radio and audio were mere footnotes in the Program and Exhibit Guide. Half the North Hall was filled with TV folks.

HD RADIO BECOMES MAINSTREAM

Aside from all the streaming hoopla, the issue of HD Radio was much on the minds of radio attendees and exhibitors.

Every transmission equipment booth there was pushing its IBOC-ready hardware. Harris, BE, Nautel and Continental all showed improved or upgraded versions of their exciters and transmitters. After not having an exhibit booth last year, Ibiquity chose to hold court this year at the new "Radio and Audio Stage, an HD Destination."

In the middle of the North Hall, a large roped-off presentation area featured most of the new HD Radios now being marketed, including several that sport price tags near $100. There are now literally dozens of models to choose from, including tabletop, component tuner and aftermarket car radios.

I had predicted last year after NAB, when Radio Shack announced the HD Accurian, that Circuit City and Best Buy wouldn't be far behind. Almost on cue, both are now on board. Best Buy is carrying HD Radios in all of its mega-stores across the country.

Unfortunately, none of the HD floor

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middle of December. No snow yet, thankfully. I escorted the trucker with the antenna bays and assorted crates of parts up to the tower site but there was no sign of the riggers. They finally arrived after the driver and I had unloaded most of the cargo ourselves. I'm glad he was built for lifting.

The rigging crew set up their fly lines on the tower and positioned the cable drum truck in the mud where it would remain for the next three weeks. They unpacked a brand-new coffee pot and set it on my desk in the new transmitter hall. It would be there for at least the next three weeks (Fig. 4).

Next day, while the crew was assembling the antenna element feeds to the base frames they asked me what I thought about a noise coming from several of the bays. Noise? Yep. Turn a bay over and it sounded just like a South American rain stick! I had to dismiss the riggers, let them go home and wait out this unexpected delay.

ERI had rushed to get this antenna to me before harsh winter weather set in. But did it rush too hard? I immediately notified the company of the problem. To its credit, it stopped everything at its factory, pulled its teams together and tried to figure out how this antenna could have left its facility after being successfully tested on its range with hardware loose enough to come apart in shipping. Tom Silliman, president of ERI, was involved directly and personally apologized to us for the mishap. Hey, stuff happens.

In the meantime, ERI had a field technician depart for New Hampshire the next morning.

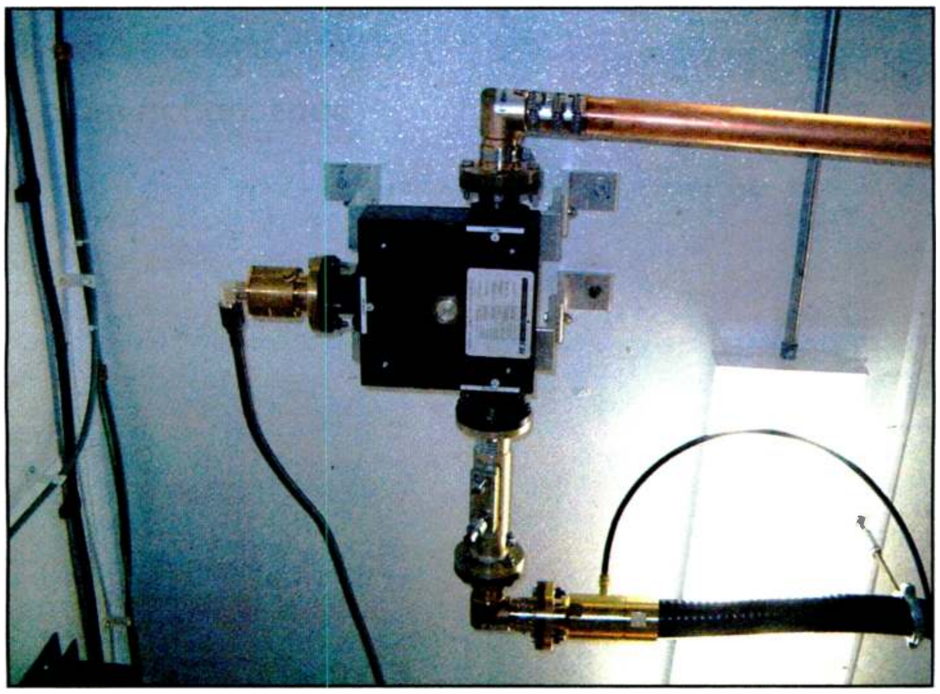

Fig. 8: View of circulator installed on digital transmitter for improved isolation.

When he arrived we opened the end plates on all of the bays. Two of them had lots of loose hardware (see Fig. 5). The nuts and lockwashers that affix the ground plane on the radiating element side of the RF balun transformers were floating around loose.

After careful inspection and repair we were back in business (see Fig.6). Well almost.

Along with some wrong-size hardware, one damaged insulated guy wire rod and other material requiring replacement, the delays began to mount up. Even when we had all the right parts, the weather started to play havoc. Not just rain, snow and cold, of which we had plenty, but wind.

On a windy day you can't fly a bay or safely work that far above the ground. At one point the crew enshrouded their workspace at the 370-foot level with a blue plastic tarpaulin to cut the wind chill. So after a Christmas break to wait out the high winds, the crew returned to complete assembly of the antenna system (see Fig. 7).

Due to poor weather it took two nonconsecutive days to get the antenna field-trimmed. Although we were well equipped to operate from our auxiliary tower site for as long as it would take to swap antennas and transmitter halls at our main site, we were in for one more surprise.

On the first day of measurements the network analyzer's noise floor was a bit high. The field technician hadn't realized we were on the air from our auxiliary site and the mutual coupling, even at a mile distance, was great enough to make his measurements inaccurate. So on the second attempt a day later, we did have to leave the air for a few minutes at a time to permit final antenna tuning measurements.

GREAT SUCCESS

The numbers looked very good from the network analyzer. Better than 43 dB isolation from analog to IBOC ports (see Fig. 8). Signal reception in our sister community is much improved and we have a relatively low operating cost IBOC solution too. The project was completed within budget although it did eat well into my contingency reserve. All goals were met.

Overall, the management process went well despite a few hiccups. The project was a moving target requiring frequent intervention and shifting of gears. One must always be prepared for the unexpected.

Even though I was prepared for surprises on the tower and weather-related issues during rigging, I did not anticipate the spate of hardware problems we encountered. Nor did I anticipate the delays resulting from the need for interdependent data, tug of war between the antenna manufacturer and my structural engineer. I was preoccupied with normal day-to-day broadcast engineering work and didn't give this issue the undivided attention it required to get it unstuck in a timely manner. The moral of the story is: clone thyself.

Ira Wilner is the director of engineering for Monadnock Radio Group, Saga Communications, Keene, N.H. ■

Guy Wire

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models on display were powered up for demonstration there, but a few were demonstrated in the Ibiquity hospitality suite at the Hilton. Every few hours various Ibiquity and HD station engineers would give a presentation about HD Radio implementation on the Radio Stage to a well-attended sit-down crowd.

HD Radio has almost become a fait accompli. Aside from a dwindling number of never-say-die HD-R opponents, including list-server noisemakers and quite a few small-market owners, every clear-thinking broadcaster I talked with realizes that HD-R is our digital platform for the future and is probably here to stay. By the time you read this, hopefully the approved FCC rulemaking for HD-R transmission standards will be in effect.

No it's not perfect and yes many compromises were made to make it work in our existing limited-bandwidth channels. There will be some AM interference to adjacent channels when full-time AM HD-R fires up. But the smartest guys out there who have studied this issue carefully do not see any AM "meltdown" resulting.

Other than the unhappy DXers and rimshooters, the instances of real and actionable interference mitigation should be rather limited. On FM, the major markets are saturated with HD and HD2 signals. HD Radio prices are sure to drop below $100 on some models for the upcoming Christmas season.

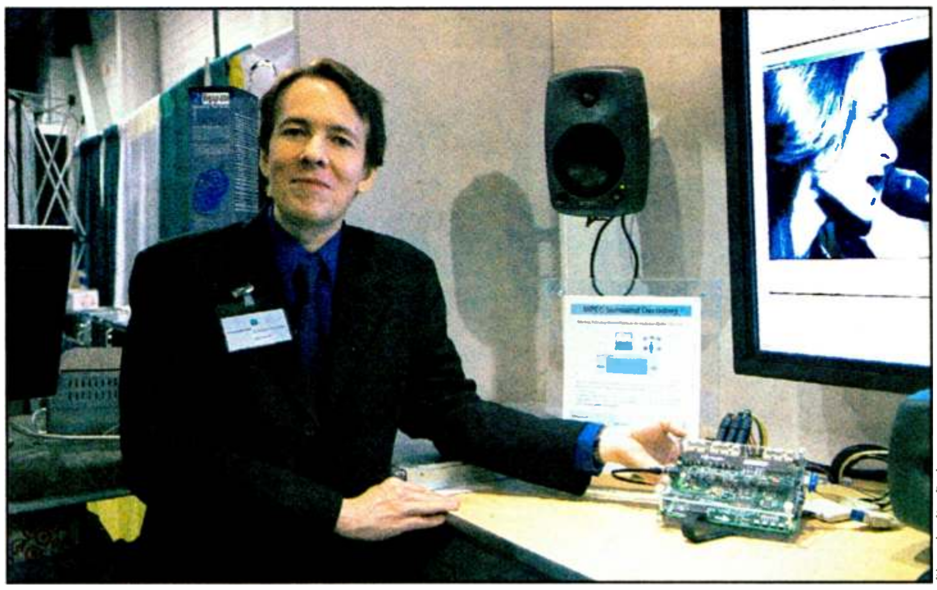


Photo by Jim Peck

Robert Bleidt of Fraunhofer USA holds an MPEG Surround fixed-point DSP decoder for HD Radio.

NEW FEATURES FOR HD

We did see an HD-R innovation at the BE booth in the form of EPG, an electronic program guide integrated in the HD text display. Using a data engine from The Radio Experience for control via touchscreen, users will be able to select programs for store and replay in future generations of HD Radios.

This feature will be necessary to enable the long-promised and big interactive killer-app for HD-R: Radio TiVo. With so many folks addicted to the real TiVo, and also now their favorite podcast downloads, the necessity of real-time radio is easily trumped by store and play later.

Both BE and Harris showed another new HD feature called conditional access. It's being touted as a potential new moneymaker for HD stations who want to sell subscription radio to captive audiences. NDS developed the technology for set-top TV boxes that encrypts the HD Radio data stream to be able to turn on and off the channel in a user's radio. The technology has been field-tested at WUSF(FM) in Tampa on an HD3 channel and appears to work well.

With so many potential customers now using the Internet for targeted and protected content distribution, we have to wonder how much demand will emerge for this service, especially when WiMax and IP radios become significant. Nonetheless, it was honored as an RW "Cool Concept."

of getting the data through becomes bulletproof-reliable and fault-tolerant. Nautel hopes to establish its invention into a standard protocol.

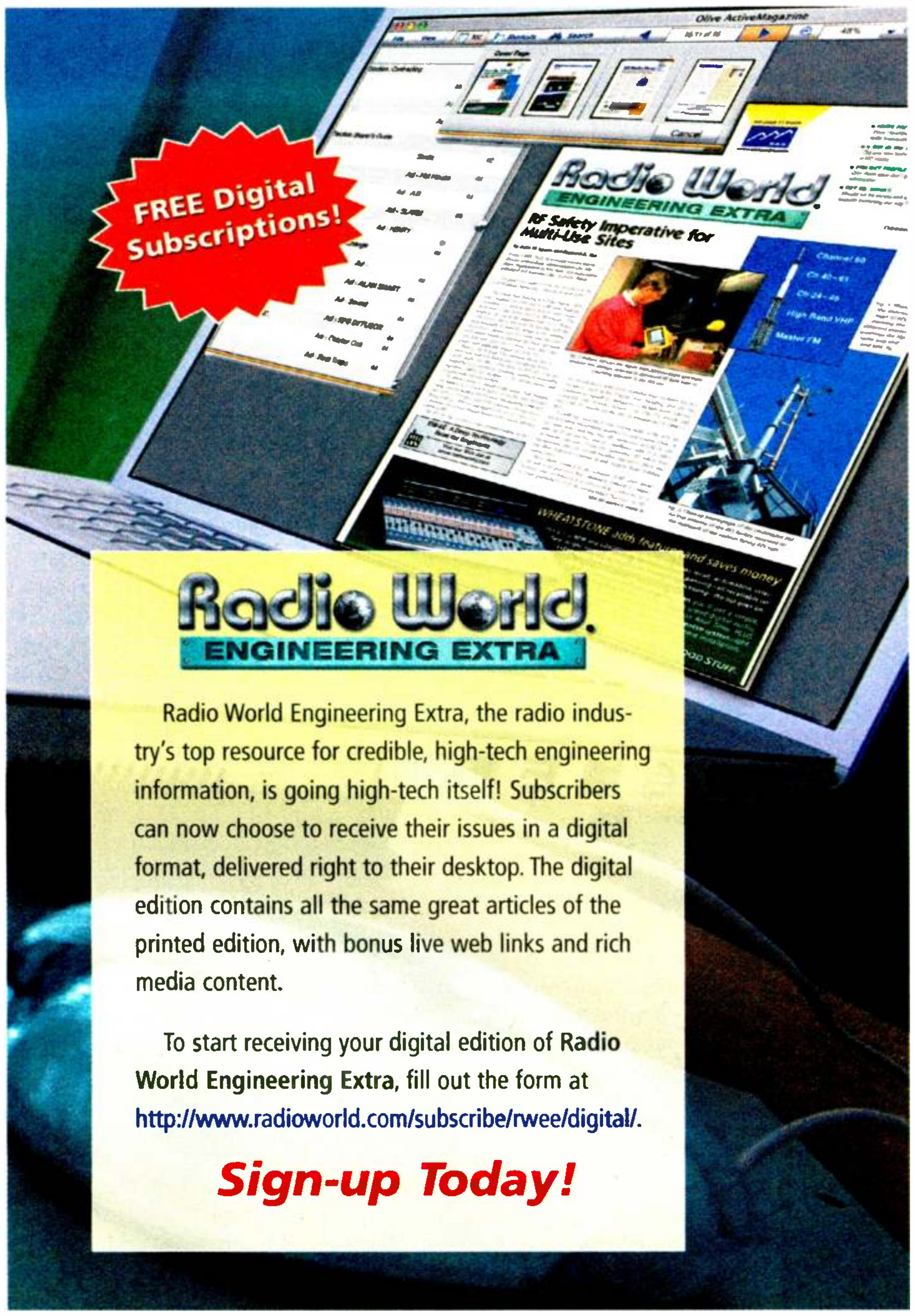
SURROUND MAKES NEW NOISE

The promise of transporting the 5.1 surround sound home theatre experience to radio has been treading water since five separate encoding systems appeared to vie for attention about four years ago.

Behind the scenes, Franhaufer quietly has been pushing forward its new MPEG surround solution. Its marketing partner in the United States is Telos, which announced over-the-air tests for it last year on WZLX(FM), Boston. They finally got it up and running just days before NAB2007 opened with a demo in the Telos booth.

The Telos team along with WZLX staff searched far and wide for original master recordings of classic rock tunes that could be encoded with MPEG surround, including a true stereo mix-down with full mono compatibility. After completing multi-channel upgrades to the WZLX audio chain, about 200 songs were encoded and are on the air right now. That's about 20 percent of their format. I can say unequivocally it is doggone impressive.

Microsoft's Skip Pizzi (our RW colleague) and Cox DOE Steve Fluker headed up the NRSC subcommittee on surround sound technologies. Skip reported in a Thursday session pretty much what the industry has been expecting: there will be no attempts to evaluate the various systems for the purposes of setting a "standard" surround sound technology for FM broadcasting. All



Conditional access is being touted as a potential new moneymaker for HD stations who want to sell subscription radio to captivate audiences.

The last remaining hurdles HD-R has to clear for more rapid acceptance by the public are the successful introduction of small portable and pocket HD radios, along with OEM HD car radios. The new SiPort ultra-low-power consumption HD chipset promises to solve the first issue. By 2012, the "Big 3" American automakers should be rolling out stock HD Radios in many models to solve the second. After that, we can forever ignore the HD-R naysayers once and for all.

MAKING HD MORE RELIABLE

One of the few truly breakthrough award-winning ideas emerging at the show was Nautel's proposal to improve HD transmission performance and reliability over STLs using data networks.

The company calls it the E2X secure HD transport protocol. It's designed to dramatically smooth out the instantaneous bandwidth requirements and prevent data-packet loss and audio dropouts.

Any engineer who has installed HD-R using the Importer and Exporter/Exgine topology has discovered how fragile the process becomes when fighting through data traffic jams. The first lesson learned is to separate the HD transmission data path apart from the usual station business LAN using a VLAN, managed router or separate subnet. Adding E2X, the process

of them, including the matrix systems, play reasonably well for consumer entertainment consumption.

It will be up to broadcasters to decide which one fits their goals best before building multi-channel capabilities and finding adequate and appropriate library resources to feature over the air surround sound. Let's hope record companies embrace this opportunity to sell new versions of old and new favorites alike and start ramping up production of surround sound music in all genres.

Steve Church at Telos is convinced that is already happening. But I still have a hard time finding much surround sound product at most popular music stores.

VISITING FMEXTRA VIA ARUBA

Derek Kumar's all-digital subcarrier solution has attracted some support as a possible alternative to HD-R.

Introduced two years ago, Digital Radio Express has been working hard installing its FMeXtra system on various stations to test and prove its viability. DRE staged a large booth to show off its capabilities along with the unveiling of the new Aruba FMeXtra tabletop receiver. They gave away an Aruba every hour via business card drawings every day of the show.

As a dramatically more efficient FM subcarrier delivery platform, FMeXtra is a win-

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ner. At 48 kbps, audio quality in stereo can match HD-R using both HD and HD2 at those rates.

But without time and frequency diversity for multi-path mitigation, plus lack of multi-channel and significant data capability, this technology is no match for HD-R, especially in the mobile environment. At best, FMeXtra is an upgrade for existing SCA services. Nonetheless, it did garner a "Cool Stuff" award.

VERY COOL STUFF

Speaking of things cool, the annual Radio World "Cool Stuff" awards and the Pick Hit awards given out by our fine competitor Radio Magazine revealed how targeted and diverse the usual new product offerings have become.

While I have no idea who does the picking and what the criteria are for these proceedings, only five products were honored with both awards out of 24 total "Cool Stuff" and 15 Pick Hit awards. In past years, there were many more "double winners." What now appeals to one group as a surefire big deal sometimes is ignored by the other.

Most of the winners were niche products filling a particular application, but several of them, along with a a few deserving non-winners and a popular MIA product, are worthy of further discussion here:

Harris has always covered the gamut of almost every significant piece of broadcast technology in its grand-scale booth. Its Intraplex digital T1 STL product line has always been shown in recent years and has been a bestseller. This year, Intraplex was nowhere to be found. Down the hall, the APT Technologies booth of competing products was larger than ever, displaying an expanded line of T1 and Ethernet STLs and digital codecs.

Barix AG, a Swiss company showing very effective yet inexpensive audio over Internet codecs, was passed over for a "Cool Stuff" award. The improved Instreamer and Exstreamer units are being used everywhere as STLs where microwave and telco are not affordable or available. What could be more cool? (RW editors tell me Barix won an earlier award as a contributor amongst several to the Harris Masterlink-IP product. But it appears to me the company has advanced this technology and it's notable that these are now offered as its own two flagship products.)

Wheatstone was probably one of the more significant non-winners with a large presence. Almost without being noticed, the well-established console company has added a full line of audio processing products for all applications. Its flagship full-featured product, the Vorsis, was introduced and won a "Cool Stuff" last year, but this year it seems even more impressive. Bob, Frank and Marvin need to make room at the processing table for one more.

If you've been looking for a 12-channel console/mixer that looks and feels like a real console, and comes with full broadcast functions in a small package, Don Winget of Broadcast Tools has stepped up to offer the budget-priced ProMix12. It looks very similar to a Harris mini-console from 2001 that never made it, but Don's version is $500 cheaper. No longer are the Mackie and Behringer mixers your only small-footprint choices.

Hank Landsberg and Henry Engineering won again this year with yet another little blue box, the USB-AES Matchbox. It's a natural successor to the ubiquitous analog Matchbox.

Burk impressed many with its new AFD-1 arc and flame detector module for remote monitoring apps. It also won with the cleverly named WatchBand off-air monitor. With WatchBand, engineers and groups can remotely monitor their stations via a Web page, including audio metrics, out- of-tolerance and off-air audio alarms and logging. It can even generate playlists for market stations.

DaySequerra joined in the remote air monitoring parade with its snazzy M3 Monitor. The M3 contains three separate AM, FM and HD Radio tuners in a 2 RU box to monitor and alarm virtually everything. Each tuner's vacuum florescent display shows station frequency, HD channels, analog RBDS data, signal strength and multipath, plus status indicators. We finally have a number of good HD mod monitors to choose from. Early HD adopters had none for several years.

Comrex added the highly crafted portable Access cellphone remote broadcast kit to the companion base unit showed last year. Doing near-broadcast quality remotes with a handheld device via a cellphone call really revolutionizes that activity. Tieline also showed its enhanced product in this category, the G3 Commander, which deserved to win as much as Access. The Tieline product won the award last year but has undergone substantial improvements as standards changed. The Commander seems deserving for most of the same technical reasons Comrex was given a second award for the Access when its portable started shipping.

The JK Audio Daptor Three attracted lots of attention. Anything Bluetooth is always cool. This unit allows balanced or unbalanced connections to your cell phone like any other Bluetooth wireless technology-enabled headset. It also will connect to any other product that allows a wireless headset connection such as a laptop.

Kowa introduced the PX-10 compact Hotkey audio player using multiple USB thumb drives or flash cards for storage. It even looks a bit like an Instant Replay, but with this one, no more headaches replacing noisy or dead hard drives.

Frank Foti has been busy developing a digital audio clean-up process called Sensus. He showed it as an enhancement to his Omnia audio processors, including the new Omnia ONE. Sensus is a new algorithm designed to dynamically optimize and precondition digital audio so coding artifacts are greatly minimized when subjected to heavy bit-rate compression, typically used on Web streams. The A/B demo was unbelievably impressive. Frank has always been good at that.

Doug Vernier of V-Soft unveiled AM-Pro-2, an AM RF engineer's dream come true. Analyzing protection limits and designing optimized directional arrays for new or existing stations with full-color dynamic graphics is finally a snap. Or should I say, just a few mouse clicks.

Perhaps the most surprising "Cool Stuff" radio award went to a TV product. As one judge wrote in the wrapup issue of RW, it's a sign of the times that increasing numbers of radio stations see the need to be able to shoot video of special events in and out of their air studios to throw up on their Web sites and live streams. The NewTek Tricaster Studio is an affordable video capture unit with effects, editing, storage and streaming capabilities. "Just the ticket for those who think radio must become TV to survive the video Web streaming revolution."

Guy Wire is the pseudonym of a veteran broadcast engineer. ■

Aside from a dwindling number of never-say-die HD-R opponents, every broadcaster I talked with realizes HD-R is our digital platform for the future and is probably here to stay.

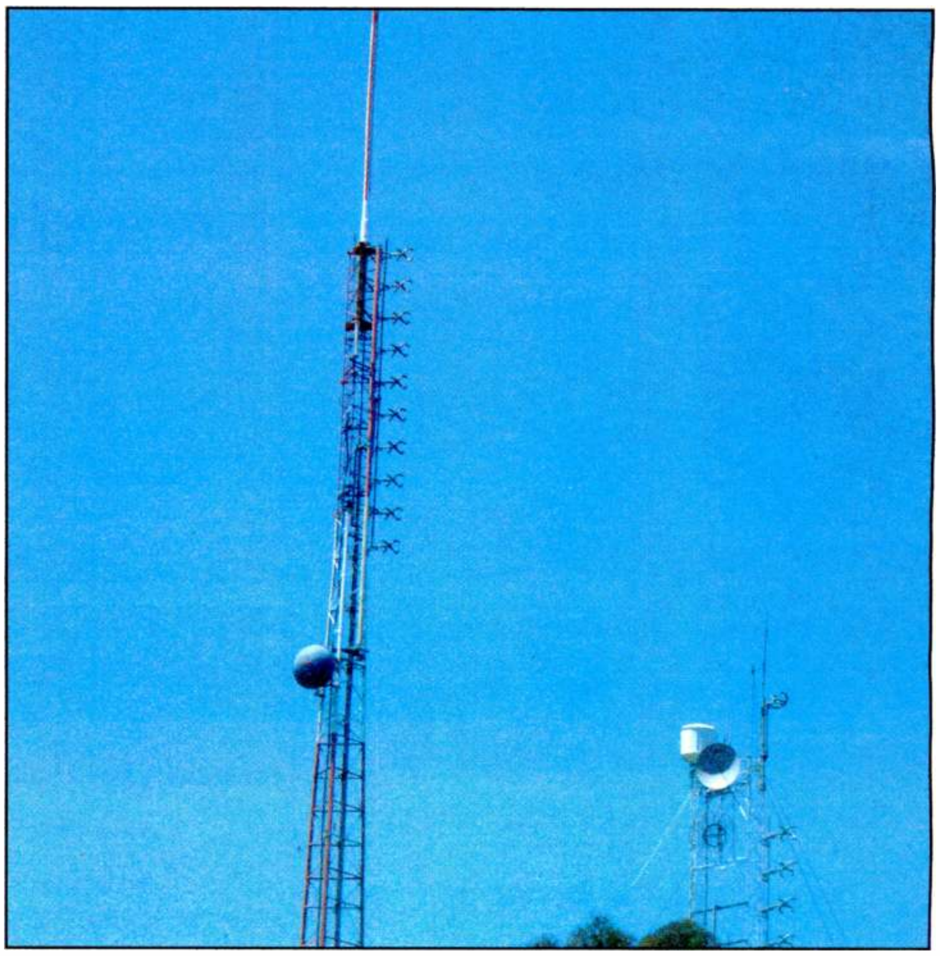
San Diego

CONTINUED FROM PAGE 22

Two other Soledad FM broadcasters using the nearby University of California at San Diego (UCSD) tower, KUSS 95.7 MHz, and KLQV 102.9, have had to temporarily decrease power to meet the public RFR guidelines.

HIGHER AND CLEANER

In February of 2006, the FM broadcasters on the KGTV and UCSD towers agreed to decrease power temporarily by 25 percent each. The one exception was Super Class B grandfathered, normally 100 kW, KMYI 94.1 ("Star 94"), which due to a null at the site in question did not have to decrease power at all. KMYI was added to the combiner system to allow the new antenna to be installed on the KGTV main tower removing its weight and wind load contribution to the overall tower loading.



The new 10-bay antenna.

Each of the Clear Channel and CBS stations obtained construction permits in mid-2006. ERI delivered the antenna system in late March this year, and crews were waiting to erect it immediately.

John Rigg reports that their expectations regarding both the increased performance of the antennas and their decreased downward radiation have been exceeded. They've now got KMYI at 77 kW ERP and he's happy with the coverage. He says the new antenna is higher and the pattern is cleaner than before, so they need less power now to reach their licensed contours.

For his part, Mike Prasser, San Diego market director of engineering for CBS Radio, appreciates John taking the role as project leader.

"He should be commended for how smooth the project went. As for the results of the project, I am extremely pleased." He's satisfied that they've mitigated the RFR issues and says that he is now working hard to get KSCF broadcasting in HD Radio, which should be up in June.

The author is director of engineering for XETV FOX6 San Diego/Tijuana; he has been a broadcast engineer since 1977. He is Webmaster and has held various offices with SBE Chapter 36 San Diego.

This article appeared in the newsletter of Chapter 36 and is reprinted with permission. ■

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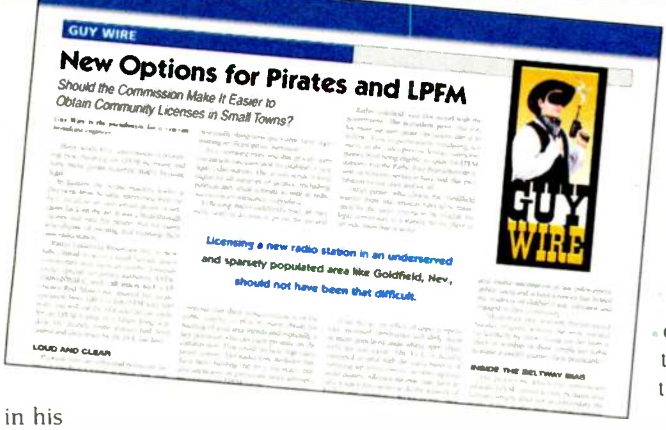
GUY WIRE

New Options for Pirates and LPFM

Should the Commission Make It Easier to Obtain Community Licenses in Small Towns?

Licensing a new radio station in an underserved and sparsely populated area like Goldfield, Nev., should not have been that difficult.

LOUD AND CLEAR

INSIDE THE BELTWAY BIAS

Rod Moses and Radio Goldfield

RWEE's Guy Wire wrote about me and Radio Goldfield in the April 4 issue ("New Options for Pirates and LPFM," April 4). I'd like to provide a different perspective on this case, which has generated so much attention.

Sen. Harry Reid is a statesman, not a politician. Big difference. A senator works for his constituents. So I placed a call to one of his aides in his Las Vegas office. She was unable to return my call. However, a Washington aide to the senator called me at midnight Eastern time, which is 9 p.m. our time. I was very impressed.

I guess it's about time people look over the candidates running for office before they elect them. You see, Sen. Reid is from a small town (Searchlight, Nev.) and he knows what it's like to be unable to broadcast local events like ball games, etc. Sen. Reid is just doing what the voters wanted. Is there something wrong with that?

We have one station 30 miles away in Tonopah, KHWK(FM), which broadcasts intermittently. When I went on the air there was not a station in Tonopah; for months it was silent. Then it came on with hard rock music, in an older population area. No IDs whatsoever, with 30 seconds of dead air between songs. I called it "knit-a-sweater-radio" between songs. And yes, parts of Tonopah can hear us and listen because we also ran, and now run, community announcements for that area.

As I stated in Radio Goldfield Broadcasting Inc.'s reply to the law firm of LS&L's attempt to shut us down, it wasn't my ego thinking I could do better then the local commercial FCC licensed stations. It's just that there aren't any!

Would I have done the same thing in San Francisco or Las Vegas? Of course not. For the most part they have stations serving the public. We had no local stations.

So for the most part I agree with Guy Wire's opinions.

Now for some geographical data: Nevada has more mountain ranges than any other state, including Alaska. High-power FM is senseless here, even AM, as the soil is very alkaline, providing poor grounding for AM. Our elevation is 5,860 feet. Summit to the south is 6,280; summit to the north is about the same.

Our antenna authorized by the FCC is 26 meters (85.3 feet), 1,700 meters below the average terrain. We are in a bowl at the top of a mountain. The signal is not getting out far, but farther then if you are in a city because there is not a first, second, third, fourth adjacency.

I did not start Radio Goldfield to set a precedent. My motive was to provide information for the health, safety and welfare of this small community.

— Rod Moses

I did not start Radio Goldfield to set a precedent. My motive was to provide information for the health, safety and welfare of this small community, and motorists traveling on State Route 95, the only highway connecting Las Vegas to Carson City, Reno, etc.

In conclusion, let's examine some other factors facing our area. Nevada test site Area 51 misfired a missile a few years ago and came within 10 miles of hitting the town of Goldfield. I ask you: Do we need communications for the people here?

And now comes the Yucca Mountain Project to store depleted nuclear waste from all over the country. Yucca Mountain is about 68 miles from Goldfield. Trucks hauling all the nation's nuclear waste will be traveling through our neighborhood via State Route 95. Sen. Reid says it won't happen; however, billions of dollars have been spent on this project already. Should Goldfield have communications for the people here?

Come on, let's wake up and quit painting this country with a broad brush. The country wants to store its nuclear waste in our mountains but doesn't want us to have any communications. The Hon. Harry Reid thought differently, and the FCC obviously felt the same. The FCC is just doing the job Congress intended it to do.

However, on the other side we have a monstrous huge law firm, LS&L representing the corporate borgs trying to run the government to satisfy their big-money commercial clients, with absolutely no concern for the life, safety and welfare of this community, or motorist traveling SR 95.

Rod Moses
Owner
Radio Goldfield, KGFM(LP)
Goldfield, Nev.

Radio Down the Hopper

Good afternoon Mr. Wire. I'm sure I know you.

I read with interest your article and the subsequent comments. Yep, I spent almost 35 years in radio and TV, everything from a quarter of a megawatt FMs to 50 kW AMs and 5 megawatt TVs. But I clearly saw the handwriting on the wall about five years ago.

Once Wall Street found out there is a profit to own a broadcast license, they did what they do to everything: immediately think they are smarter than the people that actually make broadcast happen. So they bought into it, replaced the veteran broadcasters with their own financial people and down the toilet it went.

As they were after the quick buck, and almost anyone with the simplest of thought processing would know that when the concentration is only on instant success, the tendency is to kill the long-term viability. It is a pattern that is repeated over and over, yet expecting different results.

How well I remember when working in radio was considered elitist. Howard Stern fixed that.

So nowadays I am mostly involved in the world of wireless and it has been good to me and our group. Radio and TV will sputter and have a few upside activities over the next few years, but the spectrum is going to be more valuable for other services in the not-too-distant future.

Rick Edwards
President
TowerAmerica Corp.
Coral Springs, Fla.

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by Barry Blesser

A Tall Tale of the Long Tail

Technology Advances Have Produced a Shift in Storage and Distribution, Making Customization Viable

My parents often reminded me that I was always asking "why," even at the age of 2. And I immediately followed their answer with another question that expanded the scope of the initial question.

Readers of my *Last Word* columns may have noticed that nothing has really changed in six decades. As an adult, I appreciate the value of a deep understanding, which frequently contains a simpler explanation with more predictive value than a collection of isolated insights.

This article is yet another view of how changes in terrestrial radio actually are part of a universal transformation as pervasive as the industrial revolution. But unlike previous discussions, I now offer a very compact explanation for what broadcasters have been observing for the last decade.

APPLYING IDEAS

Before actually delving into this new view, readers may wonder how I have been creating new ways of looking at old questions.

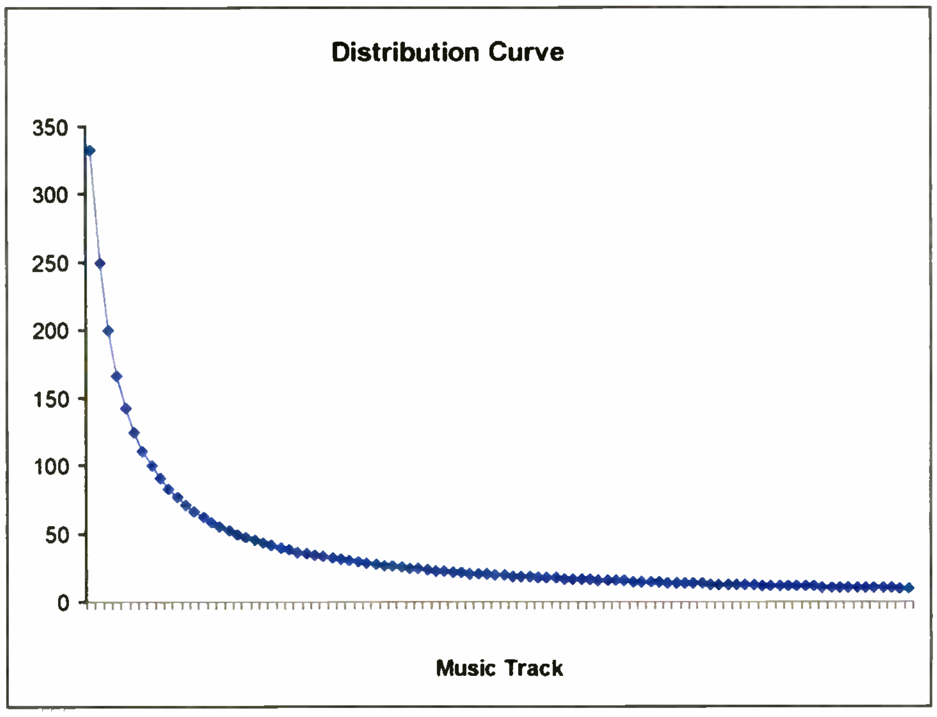
The answer is actually simple: Rather than pretending I am brilliant, which I am not, I constantly look for books and people who have already discovered ideas that can be applied to broadcasting. I shamelessly steal and adapt, a skill I have acquired over the years.

In this article, I am applying the ideas from Chris Anderson's book "The Long Tail: Why the Future of Business Is Selling Less of More." Changes in terrestrial broadcasting are just more examples of the ascendancy of the long tail, the relevance of which will shortly become clear.

To begin, assume that there existed an infinite supply of styles of clothing, music, food and furniture. Each of us would select individual items that best suited our personality and personal preferences. Each of us is a unique individual, and we would select goods and services that best matched that uniqueness: customized everything.

Let's consider an example of music tracks or songs. Perhaps there are 10 million such tracks in existence. If we plot the number of people who are interested in a given track we would form a distribution curve as illustrated in the figure below.

In this made up example of 100 tracks, there might be 350 people interested in the most popular track, and there might only be 10 people interested in the least popular track. This kind of analysis produces a popularity distribution curve. The bulge at the front is called the head, or in marketing language the blockbusters. And the long flat region to the right is called the tail, the niche oddball tracks that only a few individuals have an interest in.



Popularity Distribution of Music Tracks

THE POWER OF THE TAIL

To illustrate the power of the tail, Anderson provides statistics from 2005 or earlier. The Rhapsody download music company, which has an inventory of some 1.5 million tracks, receives 40 percent of its revenue from songs that are simply not available in retail stores.

In contrast, the top 200 albums account for 90 percent of Wal-Mart's sales because they do not have the space to inventory songs that might sell once a month. For those organizations that use technology to cut their cost of inventory, the amount of total business for objects in the tail increases.

For example, if available, I would delight in listening to some songs I remember from my childhood in the 1950s. But I would never find them in my local store; they are rarely played on the radio. I might wait for years before I could hear them again. They are scarce. The range of music choices is limited to those that appear in the head of the distribution.

Who would play a song on a radio program that was only of interest to 10 people? And a bookstore could never find the shelf space to stock 3 million books of which most only had a few readers.

In other words, scarcity, whether in shelf space or broadcast channels, forces the tail to be cut off. With scarcity, everyone looks for the blockbuster, the head of the distribution that contains the most popular objects. It has always been so — until now.

If one looks carefully at the curve, one would observe that the tail actually continues forever and that the number of objects in the tail is actually very large. Using a different language, the tail represents custom-made objects suited uniquely for you and you only.

If you could buy ready-made clothes that were tailored exactly for your body shape, and if the price was very low, you would buy custom clothing. If you could listen to a music track that exactly matched your mood, you would. The kings and queens of the 17th century could request

Scarcity forces the tail to be cut off.

that court musicians perform a particular piece of music in a specific style at a specified time at a specific location. They could customize their musical experience. We would all like to enjoy such customization but it has not been economical to do so, or so we thought.

Recent technology advances have produced a dramatic shift in economics of storage and distribution, which now makes customization viable. Each of us can be like the royalty of the 17th century. The cost for storing on a hard drive every piece of music ever performed is small.

In the 1970s, Gordon Moore observed that the density of transistors on integrated circuits had been doubling each year. Applying Moore's law to music, the capacity of hard drives to store song tracks continues to double each year, which is a thousand-fold in one decade or a million-fold in two decades. Scarcity of distribution is no longer the controlling factor in choice.

Comment on this or any article at rwee@imaspub.com.

Barry Blesser is director of engineering for 25-Seven Systems. ■

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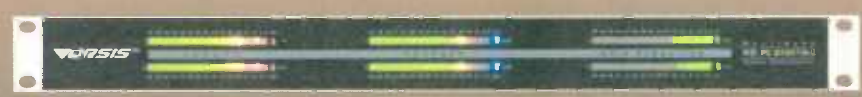

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