Radio World
ENGINEERING EXTRA

June 11, 2008

DESIGNER INTERVIEW

He'd like to thank the Academy: Mike Dorrough (pictured with wife, Kay) won a 2000 Emmy for the Loudness Monitor.

Dorrough Sets Sights on Blind, Deaf

These Days He Is Committed to Helping Handicapped Broadcasters

by Steve Callahan

In any rack in any broadcast facility there is equipment that is best known, and always will be known, by its inventor's name.

When it's time for a remote, you reach for a Marti, and when you want

SEE DORROUGH, PAGE 22

Traversal Server Eases IP Codec Connections

The Internet Can Throw Obstacles in the Way of Your Remote Broadcasts — Here's How to Get Past Them

by Tom Hartnett

Hartnett is the technical director of Comrex Corp.

As you may judge from the number of full-page advertisements in this and other technical trades, IP codecs are among the hottest products in the radio industry today.

Given that ISDN is becoming so much more difficult to get — impossible in some places, in fact — there's an increasing interest in replacing it with something that's cheap, easy to get and reliable. In many environments, IP codecs fit that bill.

Comrex pioneered the application for remotes in 2005 with the introduction of the BRIC (Broadcast Reliable Internet Codec) technology, integrated into the Access line of codecs. I've been the chief architect of the BRIC concept here at Comrex and, having also seen and lived the frustrating learning curve of the early ISDN days, I was eager to find a way to avoid requiring that all users understand the intricacies of IP routing concepts.

While it certainly may be expected of a cluster chief to understand the difference between DHCP and DNS, it's probably not always reasonable to expect it of your promotions staff.

We determined early and quickly that IP codec connections, on top of rivaling ISDN in quality and stability, needed to surpass ISDN in ease-of-use. BRIC Traversal Server (TS) is the final piece in the puzzle to make this technology accessible to the networking neophyte.

In this paper I'll outline the three major idea legs of the BRIC tripod, and focus on the technical and usage details of the last leg, the newly available BRIC Traversal Server. I'll assume the reader has a basic familiarity with basic IP codec concepts.

Simply put, the BRIC Traversal Server is a patent-pending service built and maintained by Comrex on the public Internet that provides users a directory of other users, facilitating connections to devices that would normally have trouble accepting incoming IP connections.

PIECES OF BRIC

Most early attempts at IP codecs (and several currently available) were a migration from ISDN.

By capturing compressed audio frames before they hit the ISDN line, they can be "packetized," have an IP address header added and shot into an IP network instead of (or in parallel to) an ISDN line. The IP decoder, however, must have a "packet catcher" that can receive and align the incoming packets to the correct order.

The lion's share of innovation in the BRIC concept is in how this decoder realignment buffer is designed. Rather than a primitive fixed buffer, BRIC includes a dynamic receive buffer, which grows and shrinks slightly and slowly over time based on the history of packet loss and jitter experienced over the connection.

The routine that manages this buffer needs to be intelligent. This intelligence stems from knowing the capabilities of the various coding algorithms, as well as several years of lab and field "tweaking" the system on different networks.

The goal of the buffer manager is to find the "sweet spot" between delay and stability, and to maintain it even on challenging networks like 3G and WiFi. As shown in Fig. 1, this approach has the benefit of providing a useful visual display of network jitter and packet loss over time.

In the ISDN world, we have a fixed data rate that fits snugly around a compressed audio channel and supports older, fairly low-compression ratio algorithms like MP2 and apt-X. But a reasonable assumption in the variable data-rate Internet world is that the less you are relying on the network, the less it can let you down.

This is why the second BRIC concept is a new suite of audio compression algorithms that can achieve remarkable quality

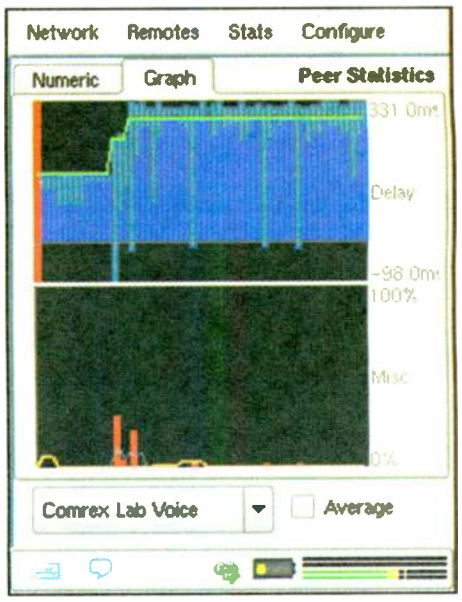
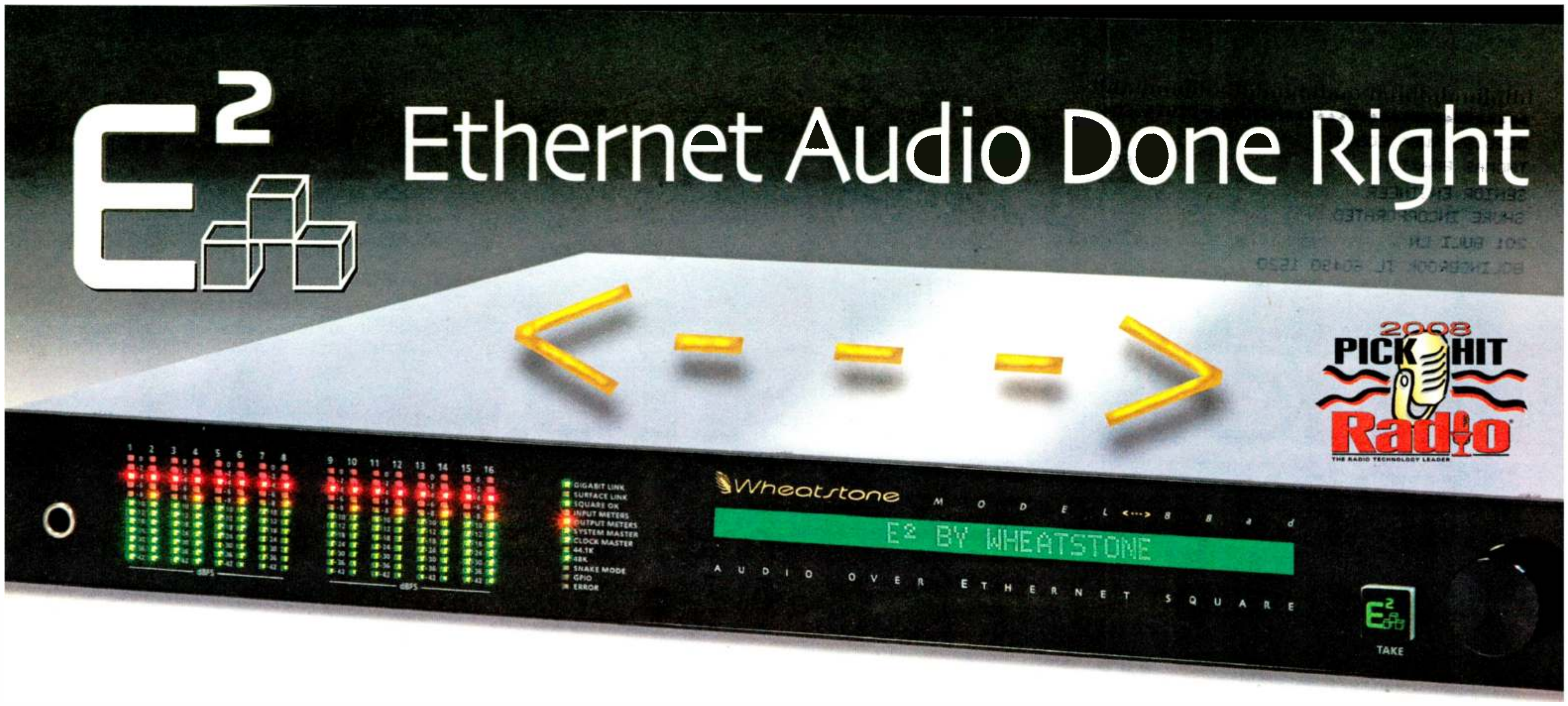


Fig 1: Real-time network quality as displayed on Access portable.

SEE TRAVERSAL, PAGE 16



MEET THE SQUARE

The Wheatstone E² (E SQUARE) gives you the convenience of Ethernet audio without all the IP hassle. It just *knows*. The built-in Setup Wizard lets you configure an entire system with just your browser and a laptop. Unplug it when you're done and there's no PC between you and system reliability.

SQUAREs are totally scalable: use one as a standalone 8x8 studio or transmitter site router, with browser access from anywhere. Plug two together and have a standalone digital snake. Add a fanfree mix engine and build yourself a studio using analog and digital I/O SQUAREs.

All the power is *in* the SQUARE. Distributed intelligence replicates all configuration data to every unit. Profanity delay and silence detection are done *in* the SQUARE. Even virtual mixing (w/automation protocol) —it's *in* there; all with real front panel meters, 32 character status indicators and SNMP capability.

88D I/O: 8 digital inputs and outputs. You can headphone monitor and meter any of the SQUARE's inputs or outputs in real time. The 32 character display gives you all the information you need about your audio and system configuration. And because you can operate in either 8-channel stereo or 16-channel mono mode, 16 channels of metering are provided.

88E DIGITAL ENGINE: Just plug an E-SERIES control surface or GLASS E computer interface into this engine and get all the mixes, mic and signal processing you need. Fanfree, so it can stay in the studio where it belongs.

88A I/O: 8 analog inputs and outputs. You can bring a new SQUARE up in seconds and of course use the front panel encoder for your X-Y control. Front panel status LEDs give you continuous link, status, and bit rate information as well as confirmation of any GPIO activation.

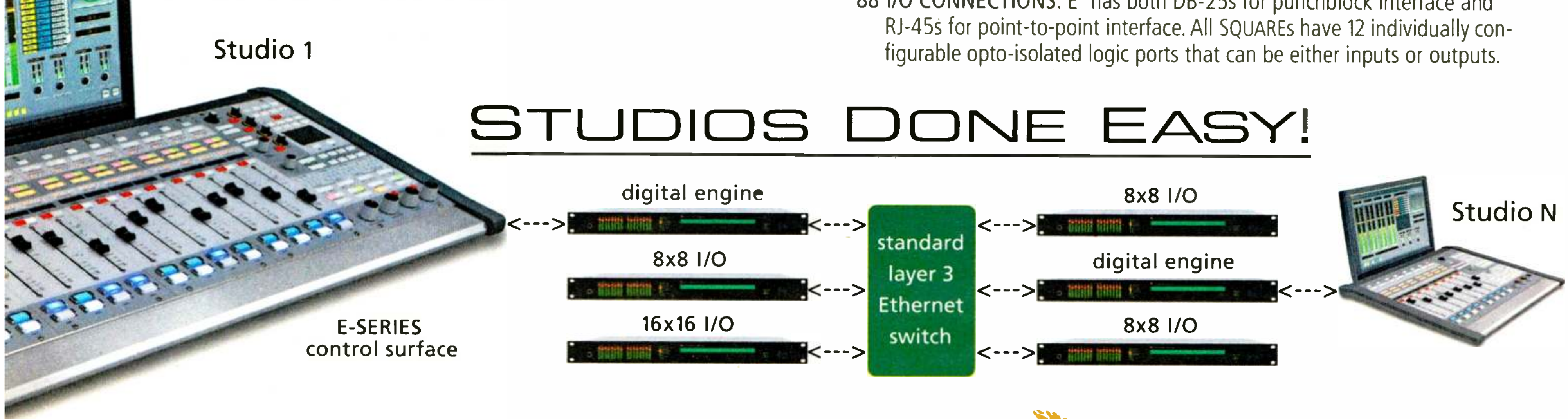
Because the E² system doesn't rely on a third party GUI, tech support is straightforward (and 24/7). Likewise, system operation doesn't require external PCs for continued full functionality. Best of all, 1 Gigabyte protocol eliminates the latency and channel capacity restrictions associated with older technology.

88AD I/O: 4 analog plus 4 digital inputs and outputs—perfect for small studios or standalone routing.

88 I/O CONNECTIONS: E² has both DB-25s for punchblock interface and RJ-45s for point-to-point interface. All SQUAREs have 12 individually configurable opto-isolated logic ports that can be either inputs or outputs.

E-SQUARE is Ethernet audio done RIGHT!

STUDIOS DONE EASY!



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FROM THE TECH EDITOR

by Michael LeClair

Convention Season and The Listserv Effect

Public Radio Isn't Entirely Immune to the Pressures Faced by Commercial Radio

It has been about two months since the 2008 NAB Show but I am just now beginning to reflect on the technological impact of this important convention.

Early this year it became apparent that 2008 was not shaping up to be a strong year for radio.

Layoffs at many of the large radio groups were announced, and soon after those announcements came word that budget cutbacks would prevent many radio engineers from attending this year's show. It looked as if it would be a pretty quiet year in the radio hall with few interested parties able to attend to see our industry's latest technology on display.

The good news is that the 2008 show seemed to be almost as well attended as last year's show, with final attendance numbers coming in just slightly lower than 2007. I know I saw many familiar faces on the show floor, although there were many I missed as well.

Interestingly, public radio seems to be bucking this trend. The Public Radio Engineering Conference, scheduled for the two days preceding the NAB Show, was well attended and featured many of the same speakers and engineering topics. It has become an important event in the public radio universe.

Public radio attendance at the NAB Show, because of the collocation in Las Vegas and sequential scheduling, also has been quite strong. However, this year financial strain in the public radio world was apparent.

THE POWER OF PUBTECH

For the past few years there has been funding for several scholarships to allow engineers from smaller and less well financed public radio stations to attend the PREC. It is an excellent way to teach engineers who may be new to the public radio system or broadcast engineering in general.

Digital radio continues to evolve and improve at least a little bit every year.

This is an important opportunity for these engineers to learn about the latest engineering topics and acquire new skills. Unfortunately, funding for these scholarships was unavailable from the Corporation for Public Broadcasting this year.

Then, in an impressive display, the Pubtech listserv, operated by Chuck Leavens at WDUQ(FM) and a must-subscribe for public radio engineers, came to the rescue. An impromptu post suggesting that it would be easy to fund a scholarship privately caught fire quickly.

The drive for donations was ably assisted by Rich Parker at Vermont Public Radio; perhaps he was inspired by the fact that his own stations were in the midst of a fundraising drive when the idea came up. Both fundraisers came to a successful conclusion.

The appeal to public radio engineers resulted in enough private donations to provide money for one attendee in just a few short days. The recently formed Association for Public Radio Engineers handled the application and award process to determine who would receive the funding.

Kudos also should go to the Society for Broadcast Engineers, which stepped in to assist this effort through its Ennes Foundation, providing a non-profit entity to receive donations and handle the finances. The lucky winner was Steven Gallagher, who was recently recruited at New Hampshire Public Radio.

This was a superb effort all around and a good example of how we can help to support our own industry. It is these kinds of efforts to assist engineers in broadcasting that will help the industry survive in the long run.

As many of us have observed, there is a lot of gray hair in the audience at the engineering conferences. Hopefully next year the scholarship program can be repeated and even grown to a larger size.

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HD EVOLUTION

My main observation from the NAB Show is that digital radio continues to evolve and improve at least a little bit every year.

One of the main complaints from broadcasters has been the relatively high cost to purchase the necessary equipment for HD Radio. That issue was addressed head-on with the release of new versions of the HD exporter that feature an embedded microprocessor.

In a display of industry cooperation and support for HD, four major transmitter manufacturers released new embedded versions, moving this element of the digital radio chain off the personal computer platform. This should bring down the costs of HD Radio considerably, and at the same time improve the reliability.

As part of this process, Ibiquity has released some further improvements to its operating system.

In this issue we have a white paper from Tim Anderson and Ted Staros of Harris about the design process behind the new exporter and the latest capabilities in HD.

Also on display at the NAB Show were new transmitters aimed at both AM and FM digital service. In his *Day in the Life* column, Cris Alexander talks about one of these, a new transmitter from Nautel, and his feeling that it recalls a classic broadcast cart machine design.

In our interview, Steve Callahan talks with Mike Dorrough, who remembers the early days of audio processing and how his experience in the recording industry led him to design and build the Discriminate Audio Processor.

In another white paper, Tom Hartnett of Comrex explains the technology behind the use of a Traversal Server to create networks of audio codecs over the public Internet with the goal of making this even easier than using a telephone.

Rounding out this issue, we have our usual features from Guy Wire and Barry Blesser; a review from James O'Neal on software to document broadcast facilities; and the answer to the questions posed by the SBE Certification column in February.

We are always eager to hear from you. If you have any comments you would like to share with us please drop us a line at *radioworld@nbmedia.com*. ■

IN THIS ISSUE

by Charles S. "Buc" Fitch

So, You Think You Know the Decibel...

SBE certification is the emblem of professionalism in broadcast engineering. To help you get in the certification exam frame of mind, Radio World Engineering Extra poses a typical question in each edition. Although similar in style and content to exam questions, these are not from past exams nor will they be on any future exams in this exact form.

CBRE Sample Question

What is a dB? What is a Neper? For whom is the dB named?

a. A dimensioned, unitless ratio number; something like a dB but with a different log base; Snoopy's sister.
b. A dimensionless, unitless ratio number; something like a dB but with a different log base; Alexander Graham Bell.
c. An audio level; the decade value of the dB; Alexander Graham Bell
d. A power ratio; the cube root of that power level; Alexander Graham Bell
e. Both an audio and a power level; a Greek god and patron to ancient engineers; mathematician Lawrence Titus Bell

The correct answer to the question in the box is B.

The dB, an abbreviation for decibel, is on its own a dimensionless, unitless ratio number named in honor of Alexander Graham Bell.

One of my most learned mentors advised me to think that life is linear but nature is logarithmic; and he is right. Most of the forces in physics exhibit logarithmic phenomena and sound is one of those. Bell recognized this in his work as a speech teacher and progenitor of telephone technology; it was the engineers of Bell Labs who named this logarithmic ratio after their founder.

These engineers wanted a comparative power valuator that would avoid having to deal with too large or too small numbers, and for calculations on slide rules one that would more easily yield workable values to three-place accuracy as well as other mathematical advantages.

The Bel is the common log base 10 of the ratio between any two similar power quantities. There are 10 decibels in a Bel and so the decibel can be stated as:

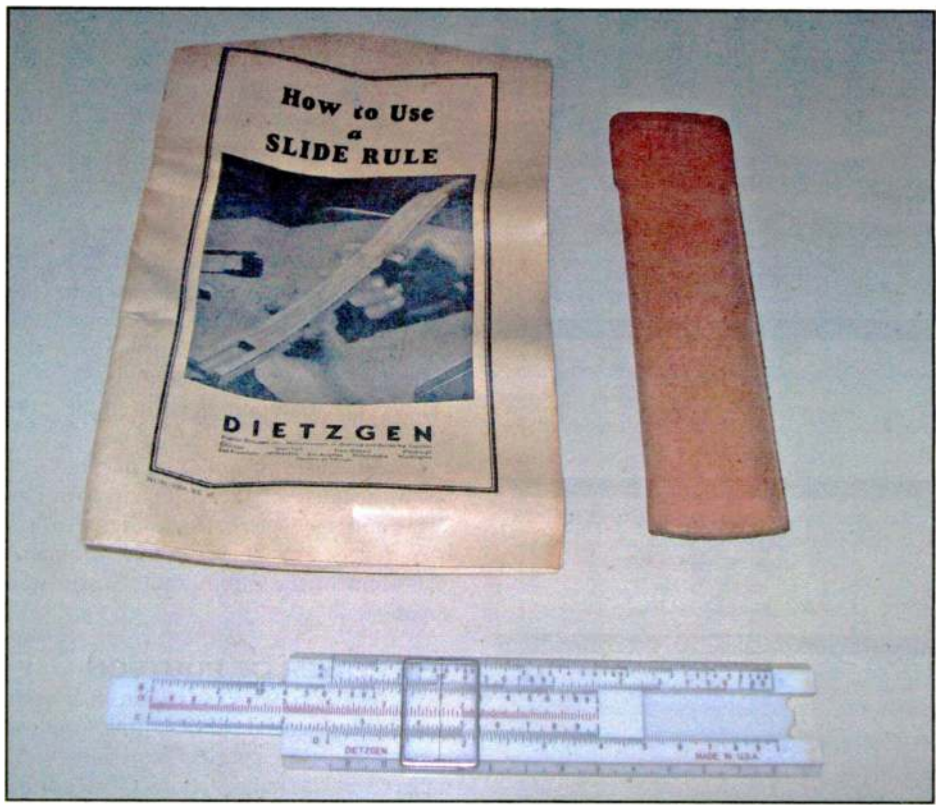
$$\text{decibels} = 10\,(\log_{10} x/y)$$

where this number will be negative for x/y values less then 1 (attenuation) and positive for values above 1 (gain). It turns out that for most people the smallest perceptible change in audio level corresponds to one decibel so this unit is most commonly used to describe audio levels.

SPECIAL CASES OF THE DECIBEL

Here's why the first part of answers C, D and E are wrong.

When the decibel is used for comparison of a power level to some reference power level, a unit is added to the decibel. For example, if the ratio expresses a power increase more than 1 milliwatt, then the value is stated as dBm and we now have a unit-based decibel.



A picture of the author's favorite 'pocket' slide rule. 'The zenith of computational tools of its time, the petite pocket slide rule allowed the taming of mighty rivers, the construction of huge public works and the easy calculation of dB gain factors,' he says.

For instance, your STL has a power output of 10 watts (10,000 milliwatts). The power level referenced to 1 milliwatt (dBm) would be:

$$\text{dBm} = 10\,(\log_{10}\ (10{,}000/1))$$
$$\text{dBm} = 10 * 4$$
$$\text{dBm} = 40$$

A dB alone has no unit and hence cannot be automatically thought of as a power, voltage or current ratio.

The Neper is similar to the dB but uses the natural log (≈ 2.71828) and is interesting to us in this limited discussion, as this unit's name is drawn from John Napier, the baron of Merchiston in Scotland.

The baron was the first to publish the mathematical concept of logarithms in 1614. Nepers are usually used to describe ratios of voltage and current, which are the components of power calculations.

The traditional patrons of engineers are St. Patrick and Lady Godiva. Don't laugh, we need and will take all the help we can get.

Related trivia points to supercharge your next watercooler conversation:

The only telephone company actually started by Alexander Graham Bell was NYNEX (New York and New England Telephone), which is now a component of Verizon.

Elsewhere, noted technical historian Seth Shulman in his latest book "The Telephone Gambit" makes an interesting case that Bell stole the basic concept of the telephone from nearby, comtemporary experimenter Elisha Gray.

A CBRE question for next time: "An RF static drain coil is used where and for what purpose in your radio station?"

a. An important device in any switching supply. Actually an LC circuit, it allows the liberation to ground of the HV back spike when the current stored in the main switching inductor is liberated on turn off.

b. The proprietary curlicue spikes normally on top of a tower to drain static buildup.

c. A high impedance coil usually attached from the antenna input to ground to drain off static charges caused mainly by lightning or wind driven dust etc.

d. The small inductive value (normally built in to the tube socket) between the input and screen grids in a VHF power tube to avoid internal arcing.

e. The near mandatory conductive rug that you should be standing on whenever you work on CMOS circuitry to avoid device destruction.

Charles S. "Buc" Fitch, P.E., is a frequent contributor to Radio World. ■

by Cris Alexander

It's New-School, But Old Principles Still Apply

HD-R Evolves, Yet Basic Principles of Phase Correction, Electromagnetics Remain the Same

We've all heard it said. "The more things change, the more they stay the same."

There's truth in that. We may find a new way of doing something, but we're doing it with the same building blocks as before. We may have a whole new technology, but we find that the principles that applied to the old technology still apply.

The laws of physics have not changed one bit since the apple hit Sir Isaac Newton on the head.

Think back (if you're old enough) to the late 1970s. FM stereo was coming into its own and was being hyped in all the station promotional materials, just like color television more than a decade earlier. Stereo was beyond cool in those days.

Hey, if you really wanted to be cool, you might even try quad on Sunday nights!

But cool or not, FM stereo presented a whole new set of problems for the broadcast engineer.

We had to completely rewire our studio and transmitter plants for the second channel. That meant new boards, new DAs, new source equipment — everything.

For the most part adding a second channel wasn't a big problem (which isn't to say it wasn't a big expense), but it was a challenge.

THE 99 SOLUTION

I recall that perhaps the biggest challenge we faced in those days was monaural compatibility.

We still had a large portion of our audience listening on mono radios and if we didn't pay attention to the details, the L+R matrix would wreck our mono high-frequency response and kill some of our mono loudness. Phasing was critical, and the tried-and-true cart machine was the piece of studio equipment that had the hardest time making the move into the stereo world.

The issue was that the proper record azimuth setting would vary from cart to cart. The thickness, condition and positioning of the pads, the uniformity of the tape guides and even the tightness of the "wind" of the tape in the cart would affect it.

With a reel tape machine, the studio engineer could use an alignment tape to set the playback heads to the proper azimuth and the record heads would simply be calibrated to that. Not so with the cart machine.

The playback head certainly was aligned with an alignment tape, and you could even align the record head to the playback head, but the record alignment went out the window as soon as you pulled one cart out and inserted another.

We had to come up with a fix for this problem, and we did — we were engineers, after all — but even that was a real pain. The compromise fix was to put a fine adjustment motor on the record head azimuth adjustment, install a white noise generator in the studio and permanently connect an X-Y scope to the output of the cart recorder.

The recording engineer would insert a cart, feed the white noise into the L and R inputs of the cart machine and start the recorder. The spring-loaded center-off toggle switch that controlled the fine azimuth adjustment was then operated up and down to "close the loop" on the X-Y scope display, eventually resulting in a straight diagonal line indicating a perfect, broadband, in-phase condition.

The cart was then pulled out and erased and the splice was located and positioned to the right of the pads. The compromise came in as soon as the cart was pulled from the machine. When reinserted, the tape position across the record head was slightly different. Run the white noise test again and you would find the straight diagonal line replaced with a fuzzy one.

But this was the best we could do at the time. Cart recorders did not have erase heads — there was no room for one — so we had no choice but to remove the cart and erase it after aligning the record head to that particular cart.

The bottom line was that this compromise worked. It was less than perfect, true, but it worked, and it's what we did for years.

Sometime around 1980 a leading manufacturer of broadcast cart equipment, International Tapetronics Corp., came up with a better idea. They came out with the ITC "99," a wonder that did everything but make coffee.

You would insert the cart and press a button on the front panel. The cart would be erased, the white noise was applied internally and a servo aligned the record head.

After that the eraser came back on to clean off the tape and the cart was fast-forwarded to find the splice. The cart was now perfectly matched to the machine, erased, splice positioned and ready to go, all without removing it from the machine. All human error was eliminated.

Engineers loved it. Producers loved it. Program directors loved it.

Many stations that weren't doing so already began playing music from carts (gasp!) because the sound was consistent and the highs and loudness were not compromised for the mono listener. It was great!

The ITC 99 became the platform of choice for a number of years, right up until the NAB cartridge fell from favor nearly a decade later.

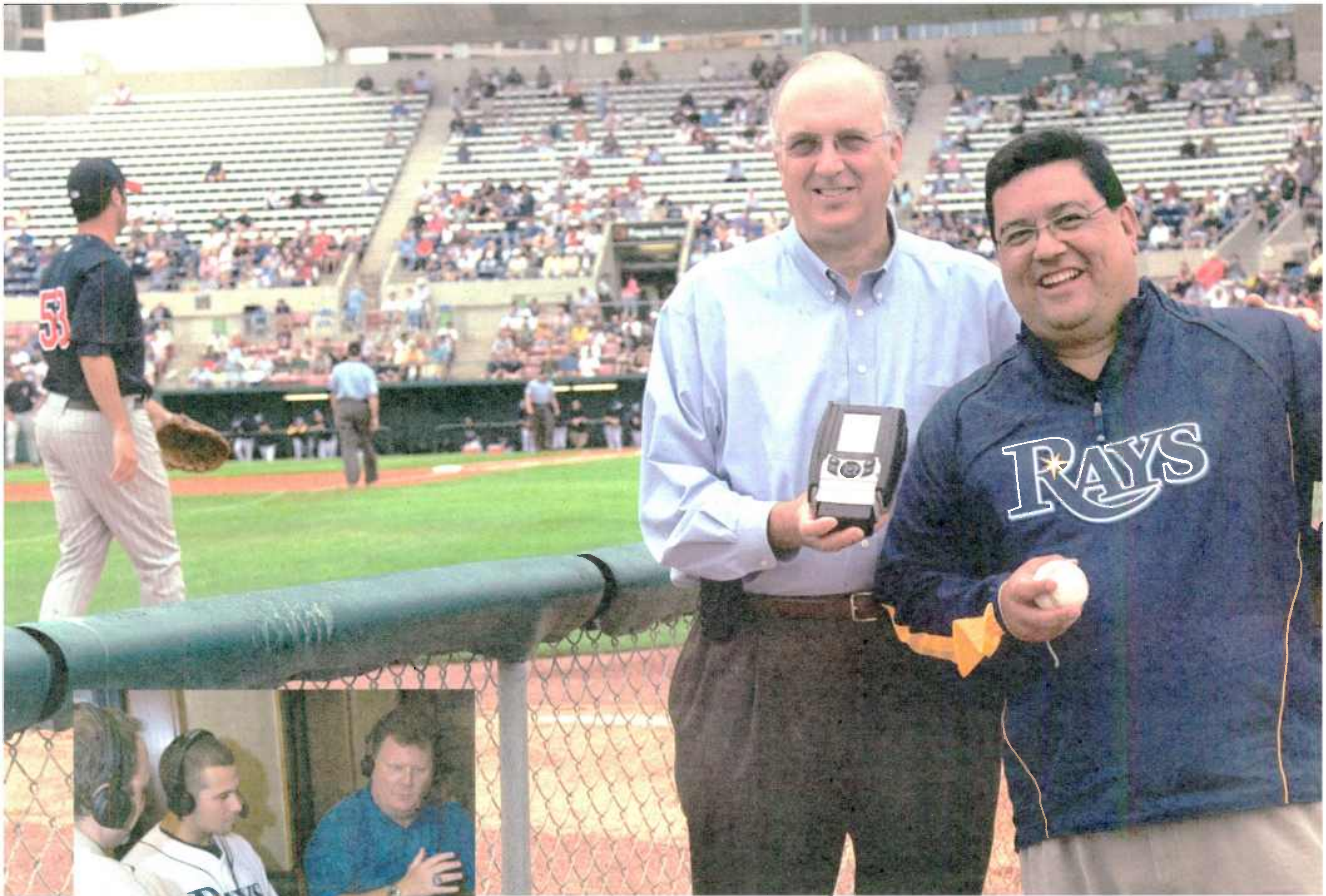
SMART DESIGN

A few years ago, my company began edging its way into AM HD Radio. Our FM stations had long since been converted; it was time to begin the arduous process of converting our many AM signals to the new digital mode.

Fig.1: The new NX50 features a touchscreen that displays spectrum, load and constellation.

I had some idea of what was required but no experience to go with it. In fact, my limited knowledge about AM HD-R told me that we had several antenna systems that very likely would not work with HD Radio and could not be made to work. But we

SEE DAY IN THE LIFE, PAGE 8



Above: Rays broadcasters ***Andy Freed*** *(left) and* ***Dave Wills*** *(right) interview Rays' star third base prospect* ***Evan Langoria*** *on the "The Hot Stove Radio Show."*

Top: ***Larry McCabe****, Tampa Bay Rays Senior Director of Broadcasting and* ***Rich Herrera****, broadcaster and Director of Radio Operations are shown on the field during spring training.*

Impossible Remote?
Nah...You've Got ACCESS!

Tampa Bay Rays' Real-World Super Hero Saves the Day!

Fans of the Tampa Bay Rays baseball team are intimately familiar with Dave Wills and Andy Freed, play-by-play announcers and hosts of "The Hot Stove Radio Show." Offering the inside track on all things Rays, the show kicked off its 2008 season with the "Countdown to Opening Day" series. While at a remote from a well-known sports bar, ACCESS showed its true worth. Two minutes before the broadcast, the ISDN line that was supposed to be used for the broadcast failed to connect. Luckily, they had the ACCESS running on Wi-Fi provided by the restaurant. The broadcast got on the air and was flawless for the entire one hour show.

ACCESS delivers mono or stereo over DSL, Cable, Wi-Fi, 3G cellular, satellite, POTS (yep, ACCESS is a full featured POTS codec and works seamlessly with Matrix, Vector and Bluebox)—plus some services you may not have even heard of. Given the challenges of the public Internet, it's no small boast to say that ACCESS will perform in real time over most available IP connections.

NEW from COMREX:

BRIC TS TRAVERSAL SERVER & AAC–ELD *Software from Fraunhofer IIS*

Two new options to enhance your ACCESS:

BRIC Traversal Server makes IP connections a snap by automatically syncing with your buddy list.

The **AAC–ELD** option offers exceptionally high quality, low latency audio. Contact Comrex for more info!

Contact Comrex today and find out how ACCESS can help you become a Real-World Super Hero — wherever you are!

Put Comrex On The Line.

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Day in the Life

CONTINUED FROM PAGE 6

would try anyway.

With a view toward using the HD Radio equipment (exciters, processors, etc.) from those stations elsewhere in the company if we couldn't make those antenna-challenged stations work with HD Radio, we converted them first. And I was surprised that we were able to make them work — and work well.

One station has +/–15 kHz sideband VSWR values well over 2:1, even with an HD-optimized phasing and coupling system, and the digital performance of that station is very good.

While we found that we could make those antenna-challenged stations work with the new digital medium, we also found that the load orientation was hyper-critical. A few degrees of rotation either way would make or break the digital performance.

What we didn't know was what effect normal pattern tweaking would have on the load orientation and digital performance.

The scenario plays out like this: environmental conditions change, either from dry to wet or from thawed to frozen or vice versa, and an engineer makes slight changes with the phasor controls to reset the operating parameters to their licensed values.

All appears normal until the trip back to the studio. That's when the engineer notices a problem: digital "squeaks," "chirps" and dropouts.

He then has to return to the site, take the station off the air, connect the network analyzer, sweep the common point and make network adjustments to restore the load to its optimum orientation. Quite often, as I mentioned above, the change was very small — just a few degrees. But that's all it took to wreck the digital performance.

This situation wasn't unlike that of the old cart days of FM stereo. A small change really messed up the sound and performance of the station. And the fix was likewise cumbersome.

So we began bugging transmitter manufacturers for an integrated solution. We needed a means of real-time load analysis, either something built right into the transmitter or an outboard device that would give us the same information.

At least one manufacturer, Nautel, listened to us. It just released a new line of solid-state AM transmitters, the "NX" series, which features just what we need. The transmitter now performs and displays real-time load analysis from a sample point right at the power amplifier output (which is where the load orientation really counts, by the way).

It also provides an on-transmitter spectrum analyzer display along with an HD Radio constellation display (see Fig. 1). We can now see all these important pieces of the puzzle without leaving the air or connecting up the network analyzer.

One other feature we had asked for was adaptive pre-correction in the exciter, something similar to what they have been doing for some time in their FM rigs, which would maximize linearity and minimize spectral regrowth.

We got it in the NX series. That will greatly simplify the process of alternately tweaking the DC offset and magnitude delay, staring at the spectrum analyzer display and trying to figure out if the resulting spectrum was better or worse.

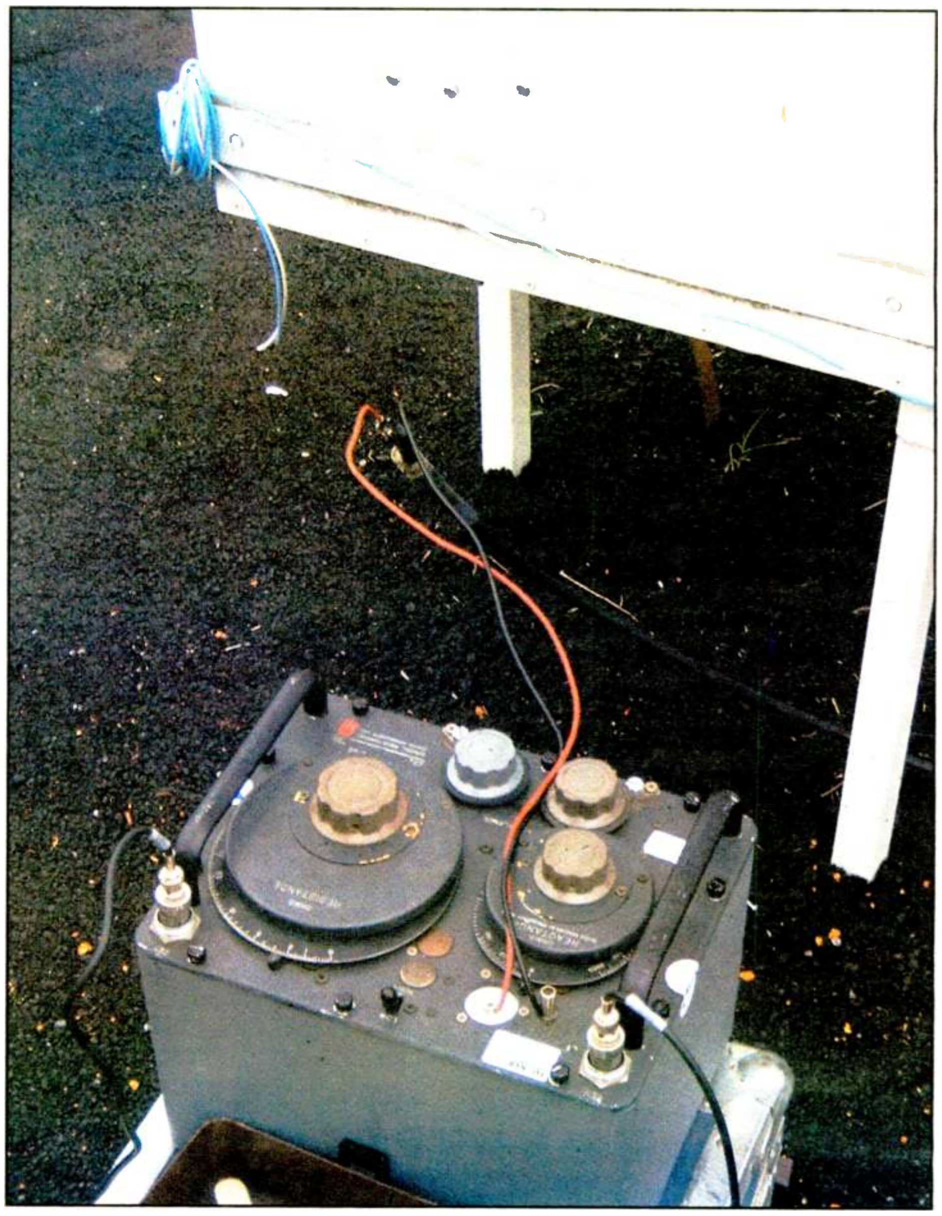


Fig. 2: In situ shot of GR bridge being used for measurement. An impedance bridge can be used to 'resonate' a transmission line to determine the exact electrical length.

As I talked to one of the design engineers about the product, he showed me the little 5-inch square DSP board that does the heavy lifting. He told me that he envisions putting that board into a transportable package that one can take out into the field. The engineer can then drive into the main lobe somewhere, connect an antenna and take a "shot" of the signal. The device stores the information and the engineer takes it back to the transmitter. The unit in the transmitter looks at the far-field main-lobe spectrum and configures its pre-correction to make it right.

When I saw all these new features in the NX-series transmitters, I immediately thought of the ITC 99. What we have here is a transmitter that addresses the real-world issues users face with an elegant, integral solution.

I suspect that it won't be all that long before transmitters themselves are relics of the past. We seem to be headed toward a different type of broadcast media distribution.

I recently heard a local TV engineer say that only 14 percent of the station's viewers in his market get their signal over the air. Something like that may well be headed our way in radio as well, with the Internet and various WiFi and wireless connectivity schemes taking over the role of the broadcast transmitter.

But until that happens, we have something we can really use, a piece of equipment that addresses our needs and makes it possible to transmit the best possible signal, both digital and analog.

Last time, we took a look at some innovative ways that broadcast engineers have made measurements over the years.

I was a little surprised that so few people had heard of the three-meter method of dynamically measuring an unknown impedance. This time, we'll dust off another old-time technique that is still used today.

IMPEDANCE MADE EASY

What is the impedance of your transmission line? 50 ohms, you say. How do you know that? Because Andrew or Cablewave says so, right?

Would it surprise you to find that the actual characteristic impedance of a piece of transmission line can vary by as much as 7 or 8 percent?

And suppose for a moment that your nominal 50-ohm impedance line has an actual impedance of 47 ohms. Assuming that your matching networks were all designed to work into 50 ohms that means your starting point is a VSWR of 1.06:1.

That doesn't sound too bad, but if that's where you're starting how much higher will the VSWR be out on the sidebands?

When tuning up AM antenna systems, I have made it a habit to design and adjust the networks to the measured impedance of the transmission line whenever possible. That can sometimes make a significant difference, particularly in a larger array where the errors tend to be compounded.

So how does one measure the actual impedance of a transmission line?

Actually it's very easy. Start by disconnecting the transmission line on both ends and then measure and note the far-end-open impedance, Z_{OC}, with the bridge on the operating frequency. Now short the far end and repeat the measurement, noting the short circuit impedance Z_{SC}.

SEE DAY IN THE LIFE, PAGE 10

Day in the Life

CONTINUED FROM PAGE 8

Now for some math:

$$Z_O = \sqrt{Z_{OC} Z_{SC}}$$

where: $Z_{OC} = R_{OC} + jX_{OC}$
in complex polar (vector) form
$Z_{SC} = R_{SC} + jX_{SC}$
in complex polar (vector) form

Easy enough, right? Yes, except for the calculations involving complex polar numbers. But it's easy enough to write a few lines of computer or calculator code to do the heavy lifting.

The result of this little equation will, with only two quick measurements, give us the characteristic impedance of our transmission line.

WHAT ELSE CAN WE KNOW?

Had enough, or are you thirsty for more? Here's some more math:

$$K = \sqrt{\frac{|Z_{SC}|}{|Z_{OC}|}} \qquad D = \frac{2A}{1+K^2}$$

$$A = K\cos\left(\frac{\phi_{SC} - \phi_{OC}}{2}\right)$$

Now with that out of the way we can calculate:

$$Loss_{dB} \quad 5\log_{10}\left[\frac{1 \quad D}{1-D}\right]$$

As long as we still have the bridge connected, we can determine the exact electrical length of the line by simply opening the far end of the line and finding the frequency on which the line is resonant, i.e. where X = 0.

That will give us the exact frequency on which the line is an odd multiple of quarter-wavelengths long. If we know the ballpark (or exact) physical length of the line, it's easy to translate the resonant frequency into the exact electrical length of the line.

This figure is important in the phase budget of a directional array, where in the design process an electrical length for each line is assumed. With a known value, we can then fine-tune the phase budget, making adjustments to the phase shifters and ATUs as necessary.

The electrical length also is important in a sample system, where it is critical that each sample line be exactly the same. I like to use the open/short circuit measurement technique on sample lines as well so I can get a look at the overall "health" of the lines. They should show the same loss and characteristic impedance, within 1 percent or so. If there are differences between the lines, you'd better look at them carefully to see what's causing it.

Needless to say, differences in the characteristic impedance and loss of the individual lines will produce errors on the antenna monitor.

THE STANDARD FIELD

Finally, let me leave you with one other bit of relatively useless but otherwise interesting information.

Did you ever wonder about where we got the value of the unattenuated field strength of a quarter-wave antenna at 1 km?

Try this on for size.

The area of a sphere is equal to $4\pi R^2$, where R is the radius, right? So it stands to reason that the area of a hemisphere is half that, or $2\pi R^2$.

A ground-mounted vertical antenna will exhibit hemispherical radiation (it cannot radiate below ground, only above), so that's the figure we're interested in.

The area, then, of a hemisphere 1 km in radius is then calculated as:

$A = 2\pi R^2 = (6.2832) \times (1000)^2 = 6.2832 \times 10^6\ m^2$.

One kilowatt power radiated uniformly over the surface of the hemisphere (an "isotropic hemispherical radiator") produces a power density of:

$Pd = 1000\ W/6.2832 \times 10^6\ m^2 = 159.155 \times 10^{-6}\ W/m^2$, or $159.155\ \mu W/m^2$.

Now let's convert that to voltage. Ohm's law says that:

$$E = \sqrt{PR}$$

Let's use a value for R of 376.73035 ohms, the intrinsic resistance of free space.

$$E = \sqrt{(159.155x10^{-6} x376.73035)}$$

$$= 244.86x10^{-3}$$

... or 244.86 mV/m.

Now we know that the power gain of a quarter-wavelength vertical antenna over a perfectly conducting earth is 1.64 times that of an isotropic hemispherical radiator, so the inverse distance field of a quarter-wavelength vertical radiator is:

$Pd = 1.64 \times 159.155 \times 10^{-6} = 261.01\ \mu W/m^2$

Now convert to voltage:

$$E = \sqrt{(261.01x10^{-6} x376.73035)}$$

$$= 313.57x10^{-3}$$

... or 313.57 mV/m.

Check that against the theoretical curve of §73.190 Figure 8 in the FCC rules.

Now we have transmitters that measure and adaptively pre-correct their own spectrums, and dynamically analyze and display their own loads, everything but make coffee (and that feature may be coming in v. 1.1!).

But no matter how sophisticated and technologically advanced our equipment gets, some things never change. We still use the same techniques to make many of our measurements, tried and true methods that are as valid today as they were 70 years ago. And the theoretical inverse distance field of a quarter-wave radiator is still 313 mV/m.

Like I said, the more things change, the more they stay the same.

Cris Alexander is the director of engineering for Crawford Broadcasting Co., Denver. Comment on this or any article to radioworld@nbmedia.com.

by James E. O'Neal

VidCAD SQL Eases Documentation for Engineers

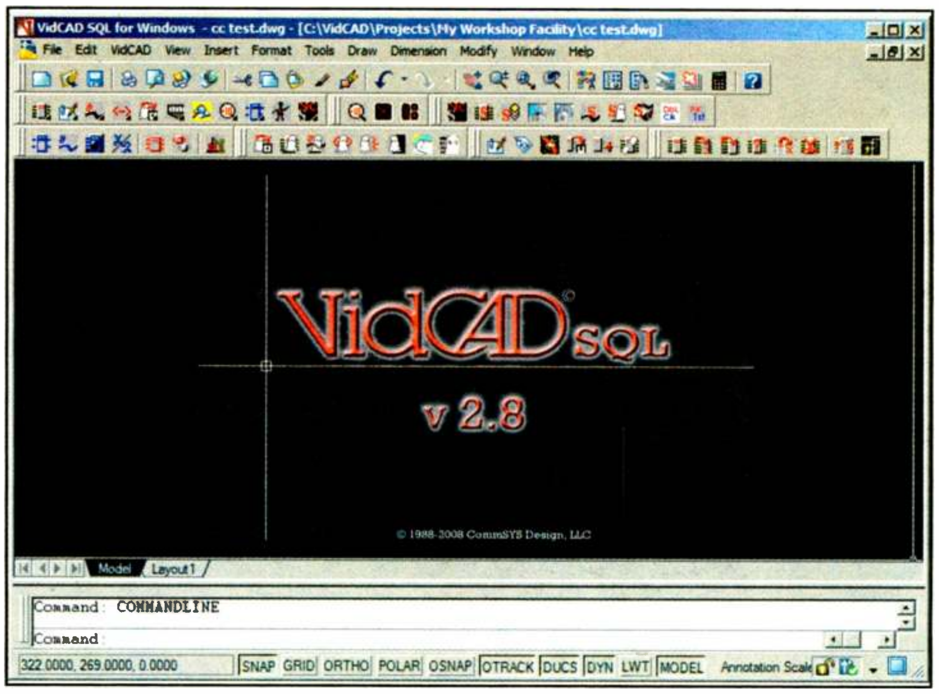
James E. O'Neal is technology editor at TV Technology, RW's sister publication, and a retired broadcast engineer.

Documentation — the final frontier! How many times have you heard the old catchphrase, "The job's not finished until the paperwork's done"?

Unfortunately for a lot of us with staggering workloads, the engineering documentation part of the paperwork gets pushed aside until we can "get around to it."

In some broadcasts facilities, a few scratches on the backs of envelopes or flypages of equipment manuals pass for engineering drawings. At others, it's all in the chief's head. (Job security, perhaps; but what happens when the chief's on vacation?)

I go way back to the time when the only computers were mainframes and the only way to prepare drawings was with a T-square, triangle and lettering guide. It was not fun. And it was slow.



VidCAD commands are substantially sped up, especially when access to the database is happening. Creation of large signal routers also is much simpler and faster, even the very large routers being used at some facilities.

The advent of smaller and more affordable computers (and CAD software) in the 1980s helped in this never-ending struggle to provide something tangible as to where equipment was located and how signals flowed around a facility. At least you didn't have to do hand lettering anymore!

Software was available that allowed you to create a library of equipment icons and then draw lines (and assign cable numbers) to interconnect them.

However, there was still a time-consuming job after this: creating the cable run list. This involved combing the drawing pages, searching out cables and typing up all cable numbers, along with their sources and destinations.

WORKING TOGETHER

Way out in New Mexico, Dr. Walter Black recognized the fact that while CAD was custom-made for engineering documentation work, it had its limitations.

He brought together some pretty sharp software people, and after a lot of hard work, created VidCAD. Black's software was a composite of sorts — Autodesk's AutoCAD did the heavy lifting, but was paired with data extraction and databasing tools.

VidCAD made it possible to bring in equipment icons, give them unique names or identifiers and interconnect them.

The real beauty of the system was that when the drawing was finished, the program automatically spat out your cable run sheet. And as equipment became obsolete and was replaced, or configurations changed, it was possible merely to enter these changes and create a new set of drawings, while the equipment and cable database automatically got updated.

I became a VidCAD convert in the mid-1990s and used the program almost daily until my retirement from broadcast engineering in 2005.

As VidCAD alum, I've made it a point to visit with Dr. Black at trade shows and keep up with new product developments. A couple of years ago, he informed me that a really big change was coming, as the FoxPro databasing that had been with VidCAD since its inception was being replaced with Microsoft's SQL.

This change became a reality recently and I decided to test drive VidCAD SQL.

FEATURES

VidCAD SQL is now in its second release, v2.8.

This version runs with AutoCAD 2008, superseding release 2.5, which was geared to AutoCAD 2005. As AutoCAD is essential for the operation of VidCAD, users have always had the option of purchasing the full AutoCAD package with VidCAD, or purchasing the VidCAD software bundled with an "OEM" version of AutoCAD.

While this OEM version may be missing a few features, it is in no way hobbled, should you want to use it outside of the VidCAD environment. Purchasing it this way makes the system more affordable.

Of course, the really big change is the SQL database. It's all about speed.

While FoxPro worked, it had its downsides. It was slow, and a new commandment was instilled in the heads of all VidCAD trainees: "Thou shalt repack the database at frequent intervals; this is not an option!" I'm glad to report that this is no longer necessary (or even possible).

In its present configuration, VidCAD commands are substantially sped up, especially when access to the database is happening (creation of new equipment or cables).

Creation of large signal routers is also much simpler and faster, even the very large routers being used at some facilities.

Creating rack and room layouts has always been a part of VidCAD, but this latest rev is very happy when working in metric units, without scaling equipment blocks, which can save time for some users.

In line with this metric improvement, VidCAD now takes into account various currencies of the world when computing project costs.

If you are a stranger to VidCAD, you will be pleasantly surprised with its utility for tracking project costs and/or arriving at a project budget. It also can compute installation costs.

Given standard equipment (recorder, monitor amp, utility switcher, DA tray, etc.) installed in a standard rack in a 3D layout drawing, the program will compute how much cable is needed for interconnects. It also can come up with the number of connectors needed to do the job. If you enter the cable cost per foot and the connector unit price, it will supply you with the complete costs for these materials.

The program can even prepare printed labels for applying to your cables.

The new VidCAD features are too numerous to mention here, but I would like to flag one more: the ability now to link and manage configurations at multiple facilities (or even one extremely large single facility).

IN USE

After setting up the review with VidCAD, I received the software ROM and the all-important USB hardware key. (VidCAD doesn't run without it.)

VidCAD recommends a Pentium IV 2.6 GHz processor and at least 2 GB of hard drive space as a minimum desktop configuration. A 2.8 GHz Core 2 processor, PCI bus and a 120 GB drive is favored for optimum results. Also, at least one gig of RAM is absolutely essential for proper operation, with two to four times this amount recommended.

In order to facilitate evaluating VidCAD "in my spare time," I elected to load it on my fairly new Compaq laptop. The processor speed is 2 GHz and I had previously increased RAM to the gig level. While this is not the optimum platform, I encountered no real problems. Admittedly, a laptop is not really the best way to go, given its display size and usual pointing device. I added a high-precision mouse, as a fingerpad is just not intended for CAD work.

I did run into a slight glitch when loading the program. Somehow, a part of it wound up in the wrong location; a call to VidCAD's software ace, Jeanette Aguilera, put things right in just a few minutes.

Bringing up the latest edition is slightly different that when I last used VidCAD (FoxPro version). However, once I started experimenting, things became easier and more familiar.

True, library icons looked a bit different and some controls were in slightly different places and worked slightly differently (there also were some new buttons to push), but it was not long before I was pulling in "phantom" gear to create what's referred to, interestingly enough, as a "phantom drawing."

This is not a required step in creating a construction drawing, but is generally the first step that many users take. In the "phantom" version, equipment block borders and interconnecting cables are dashed lines. Also, no equipment names (such as "MON AMP-1") are assigned and cables are not numbered.

The "phantom" version basically allows the placement of gear, and for users to see how signals should flow. It's rather like a high-tech sketchpad representation of how a facility should be built.

Once everything is where it should be and connected with "phantom" cables, the user "transmutes" the phantoms to "real" existence. (There's a cute little ghost icon on one of the pull downs signifying "phantom" status. There's an equally cute icon of a sleeping ghost to indicate that "phantoms" have been turned off.)

With the phantom ghost put to bed, the user then clicks on gear and cables one by one to convert them to a "real" state. While this is happening, project equipment names and cable numbers are assigned.

ICONOGRAPHY

My first test drawing involved interconnecting some fairly simple gear: a couple of recorders, a switcher, monitors, DAs and a patch panel.

I pulled up supplied library equipment icons and did the necessary configuration. VidCAD icons show all possible inputs for the gear — inputs and outputs, reference inputs, control ports ... anything that allows a signal in or out is there.

To avoid clutter on a drawing, the user can turn on only the ports that are actually needed. If you're just dealing with audio, there's no need to show reference or control ports.

Early on, I elected to make a change in one of VidCAD's cable representation

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VidCAD

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color selections. The default screen and plot color for one of the cable types was brown. I admit to being slightly color blind, and this hue doesn't really stand out for me.

I went to the palette and selected a light blue that is much easier to distinguish. This same functionality can be used, within limits, to match drawing cable colors with real cable jacket colors used within your facility. If you use red-jacketed cable for Channel 2 audio, you can adjust VidCAD to create red interconnecting cables on your drawing. If you use purple cable for reference lines, they can appear in purple.

Once you get used to VidCAD, it's relatively easy to create icons for equipment that may not be in the supplied library. This not only applies to the two-dimensional blocks used to represent equipment in an interconnect drawing, but also 3D versions used for modeling racks and consoles to give a three-dimensional view of what your facility will look like.

To further test the new program (and to see if I remembered how to do it), I decided to create some icons which weren't likely to be in the program's library.

These involved a 60-year-old audio console I just happened to have, some older DAs, monitor amps and other broadcast gear; some from companies that don't exist anymore.

I quickly constructed the icons by copying more modern gear and customizing. If anything, this was easier than I recall with earlier VidCAD versions. Soon I'd interconnected everything and transmuted it to a working drawing with equipment names and cable numbers.

During my testing, I raised the question of what happens when the SQL version is used to replace a previous FoxPro-database version of VidCAD.

VidCAD can make the difference between a hodgepodge of out-of-date or half-finished facility drawings, or having high-quality documentation for everything in the place.

The company said this had been well addressed and that transparent linkage of FoxPro-generated data with SQL was a non-issue. I couldn't test this, as I left my older VidCAD system, and its database, behind when I retired from engineering work, but have no reason to believe that this base hasn't been covered as thoroughly as the other program elements.

SUMMARY

Having been a VidCAD user in an earlier life, I found it indispensable in my work. I really can't imagine ever going back to combing drawings for cable numbers and typing up a cable run list.

What impressed me most was the speed of the program, even though my laptop wasn't the recommended platform. I was also pleased not to be stopping periodically to repack the database.

When I was getting ready for my test drive, VidCAD's VP of technical services, John Weadock, informed me that the software I would be testing had not been out of beta that long. I was a little fearful of this, but need not have been. VidCAD SQL v2.8 was beautifully stable. Other than the slight difficulty in getting modules correctly loaded, I experienced no glitches with the program.

I do have to add a couple of provisos for anyone contemplating the purchase of VidCAD.

As with most any complex software, it just may not be possible to start using it productively as soon as it's loaded. In order to do everything that it has to do, VidCAD is a complex program. Some commands are intuitive; many others are not.

Having used earlier versions allowed me to navigate through the SQL version without too much difficulty. However, I cannot recommend too highly the purchase of training with the program (even if you're already trained on its AutoCAD component). VidCAD schedules periodic training workshops and these are well worth the time and expense.

Also, the program's price tag could scare away some potential users. However, when you look at the cost of acquiring a CAD-only program, manually creating equipment icons and then separately creating cable run and equipment lists, the price becomes a lot more understandable.

What is your time really worth, anyway? VidCAD can make the difference between a hodgepodge of out-of-date or half-finished facility drawings, or having high-quality documentation for everything in the place. It's up to you to decide the value of good documentation, especially if there's a failure somewhere that puts you off the air. It takes a lot of costly air time to cut cable ties and do hand-over-hand cable tracing.

My impression of the program is favorable indeed. Dr. Black and his program developers are to be commended for their considerable efforts in bringing this software to the marketplace. ■

MARKETPLACE

RFS Debuts Online Business Extranet

Radio Frequency Systems says its new interactive system allows the company and its business partners to exchange generic and customer-specific documents in both directions with a few clicks.

The "myRFS" extranet is available to participants in the "RFS World": customers, partners, vendors and system integrators. By way of a secure link, registered users of myRFS can upload and/or access information such as project specifications, design documents, quotation material and product designs.

myRFS also can be used in the field. "myRFS allows system integrators to access essential software online, instead of providing each of their team-members with multiple CDs," said Eric Mariette, RFS vice president of global marketing and strategy. "As well as simplifying operations, this ensures that correct and up-to-date software versions are always on-hand"

RFS says the system has been trialed over a number of months, and is now operational.

For more information, visit www.rfsworld.com.

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Letters should be 100 to 300 words long; the shorter the letter, the better chance it will be published in full. We reserve the right to edit material for space. Longer commentaries are welcome but may not reach print as quickly.

Include your name, address, contact information and permission to print, as well as your job title and company if appropriate.

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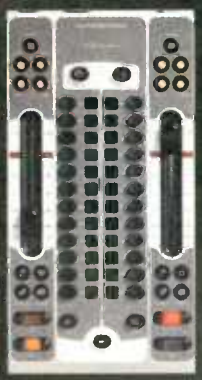

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Traversal

CONTINUED FROM PAGE 1

at compression ratios an order of magnitude lower than the algorithms of the 1980s.

As an example, BRIC-ULB, the most aggressive coder offered, can produce G.722 voice quality in about 1/6th the bandwidth. In general, the BRIC codec suite allows you to optimize your connections for highest stability, lowest delay or a mix of both.

A more recent addition to the choice of coders is the newly standardized AAC-ELD algorithm. This algorithm is the work of the highly regarded Fraunhofer IIS in Germany, and blends the best features of the low

While it may be expected of a cluster chief to understand the difference between DHCP and DNS, it's probably not reasonable to expect it of your promotions staff.

delay and Spectral Band Replication aspects of previous AAC derivatives, creating a coder that is uniquely suited for remote broadcasts on IP. I believe AAC-ELD will quickly become the industry standard for low-delay IP codecs.

Using the first two BRIC concepts, reliable connections can be maintained over most IP networks; we've sold many Access codecs containing this technology for STL, studio-to-studio, remote broadcasting and newsgathering applications worldwide. But it's not always the simplest thing to connect two devices which are essentially "peers" on the Internet, and there are two major reasons why.

WHEREFORE ART THOU, CODEC?

First of all, to initiate a stream to a device on the Internet requires that you know its IP address.

This is the number that gets applied to the "destination" field of the IP packet, so the Internet routers can figure out how best to send it along its way. Every device that connects directly to the public Internet must have one, but when Web browsing or sending e-mail, this information is usually hidden from the user.

In the traditional client/server scenario (like Web surfing) a Uniform Resource Locator (URL) is used to represent the IP address of the Web page, which is decoded by a DNS server. Once a computer requests a Web page from a Web server, the Web server can automatically derive the reply address from the request and respond to it. So the traditional four-segment decimal address (e.g. 70.22.155.130) is completely obscured to the user.

Even if you know your IP address, it's quite possible that address will change over time. This is because the vast majority of Internet users establish their addresses via DHCP, a protocol whereby a server (maintained by the ISP) will deliver one of their available addresses to the client on initial connection. That address is "leased" from the server for a particular time period, and after the lease expires the server is free to change it.

The commonly encountered NAT (Network Address Translation) router adds to the confusion, making codecs even harder to find. Most LAN-based Internet connections (as opposed to computers connected directly to ISPs) actually negotiate with a local router containing its own DHCP server. This router assigns the LAN computer or device a "private" IP address.

We'll cover more about the challenges of connecting codecs behind NAT routers shortly, but one of the hassles they add is that the private IP address delivered to the codec (and the only address of which the codec is aware) has no bearing on the public address seen from the Internet.

As shown in Fig. 2, several layers of address locality can be stacked in extreme scenarios, assuring that the IP address assigned to you is several degrees removed from the public IP address used for connections. And of course, each address in the stack is temporary and able to change at any time.

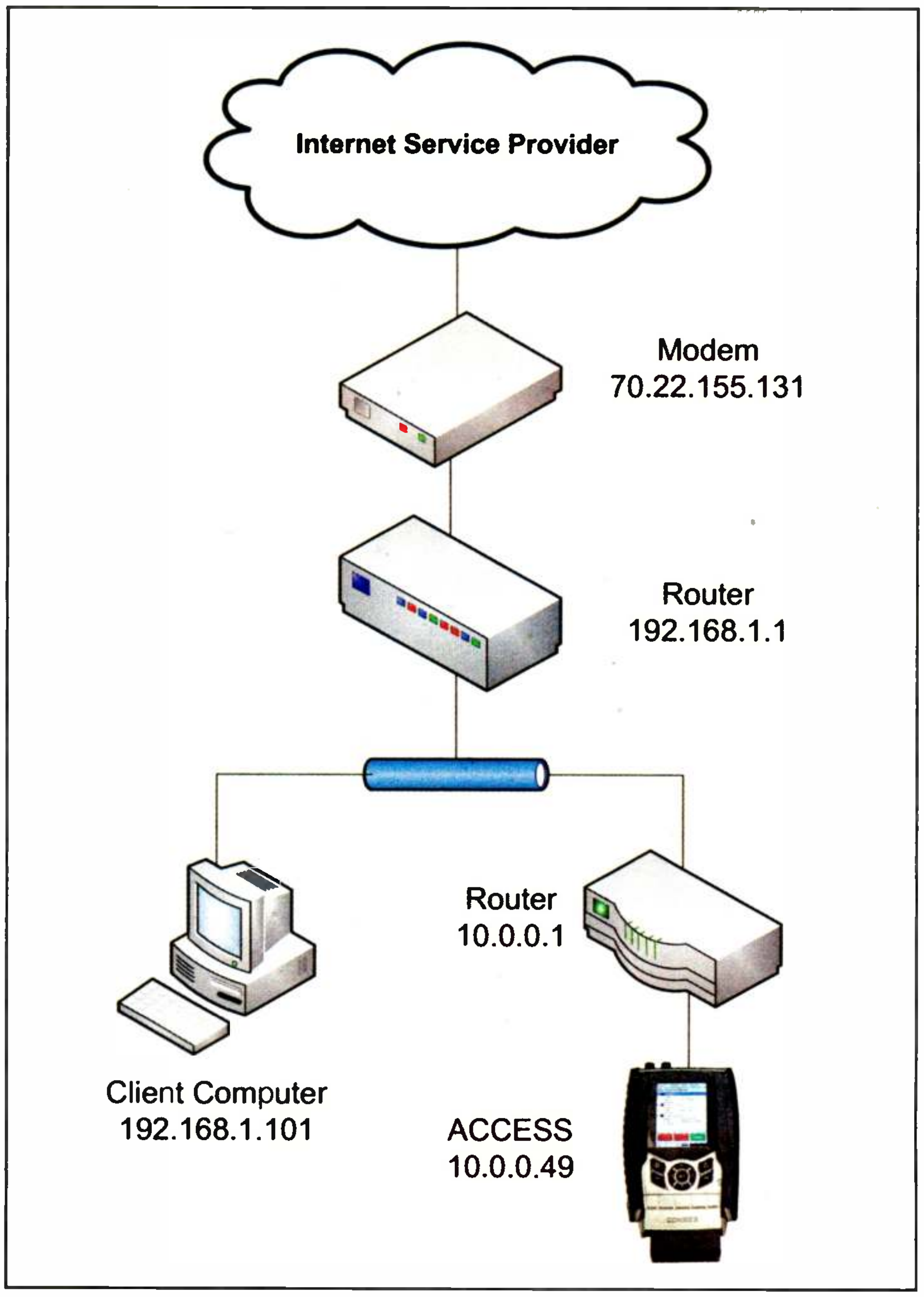

Fig. 2: The IP address you receive from the network may be many layers removed from your Internet IP.

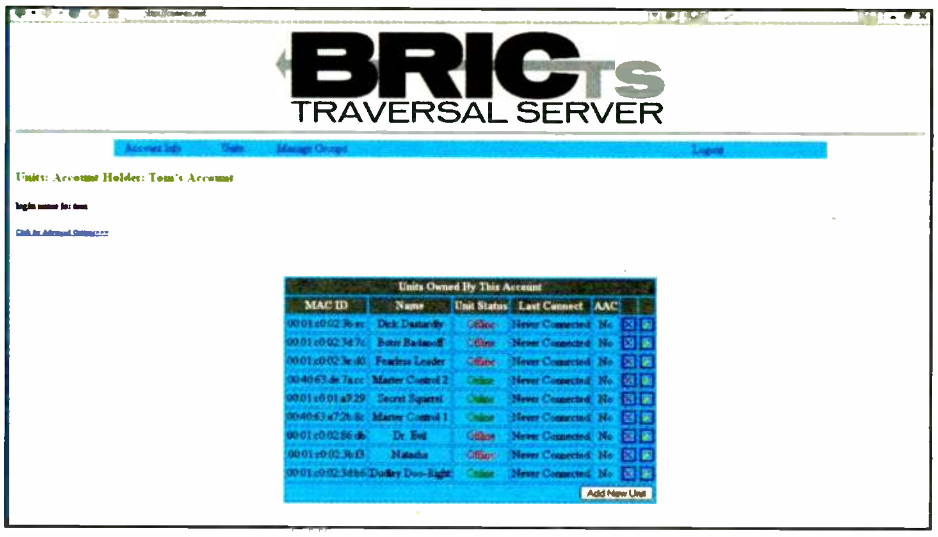

Fig 3: User logged in to the BRIC TS server.

Fig. 4: The 'Buddy List' as displayed on Access Portable.

Before deployment of the Traversal Server, the answer to this dilemma has been to assure that the codec located in the studio has a fixed, public IP address. By fixed, we mean that the address is allocated exclusively by the ISP, and that address is entered manually into the configuration of the codec and not subject to change.

This scenario works because IP "calls" are usually initiated from the field. As long as the field unit can find the fixed address of the studio unit and send a stream to it, a reverse channel can be created easily and automatically by the studio unit using the "source" information contained in the incoming packets.

Of course, even in this scenario the studio IP address must be memorized or input into each codec individually.

ALL CODECS PHONE HOME

The first function of the Traversal Server works around the dynamic IP address problem by acting as a directory server.

Codec users simply log in to the free server, and are given an account name and password. Once logged in, it's a simple process to input the details of each codec owned.

On the codec itself, the user will input a familiar name by which the codec will be known within that group. Fig. 3 shows a user logged into the server, with the server reflecting each codec owned and their current status.

Once enabled, whenever a codec in the group gets physically connected to the Internet (by any means — 3G card, satellite, Ethernet, etc.), the unit will sync with the server. The current public IP address of the codec will be obtained by the server and the user directory will be updated with the new IP. In addition, the availability status of the codec also is updated.

The codec will "ping" the server if anything changes (address, status, etc.). As we'll see, this "ping" function will prove useful in other ways.

Once the codec has updated its status with the server, it's time to download the directory. This process happens instantly.

The update includes current addresses and status info for all codecs within the group. As shown in Fig. 4, this information forms a sort of "Buddy List" that gets integrated into the codec's connection "Address Book." The list may still consist of entries made manually by IP address into the codec, but those are signified by a different icon. Current status of each codec is reflected by "graying out" entries that are not currently connected or haven't been

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synchronized to the server for any reason.

As shown in the diagram, IP addresses are not displayed at the first level, as they are no longer important to the user. If the address should change, the codec will re-sync with the server from the new address, and all will be updated. Connections can be made by simply clicking on the correct name, regardless of current IP address.

BREAK ON THROUGH TO THE OTHER SIDE

The other roadblock provided by the use of NAT routers is the inability to accept unsolicited incoming connections from the Internet.

In a general sense, this function acts as a rudimentary firewall and is a net positive for security, but it does cause headaches for codec users.

As shown in Fig. 5, a router that receives a connection request doesn't have a clue where to forward that stream unless it has specific instructions programmed into it. Known as "port forwarding," this can work well for fixed installations but it's not always an easy task to obtain that kind of security access on corporate routers, and forwarding functions are implemented differently on different hardware.

Imagine the complications of obtaining or managing port forwarding on the LAN at each remote venue; you would certainly encounter a high volume of grumpy IT staff if you tried.

IT'S 'NAT' THAT SIMPLE

In describing NAT routing, it's important to understand the concept of ports. These are numbers, like the source and destination IP addresses, that are attached to each packet to further qualify which application on a computer (or codec) is meant to send or receive a packet.

Network Address Translation (NAT) refers to the ability of a router to translate requests from computers (or codecs) within its LAN on to the public Internet.

A codec that has multiple applications running, like streaming audio while simultaneously serving a configuration Web page, would deliver these applications from and to different port numbers, but perhaps to the same IP address. Port numbers also are used by NAT routers in segmenting applications flowing through them, and they may change source port numbers at will.

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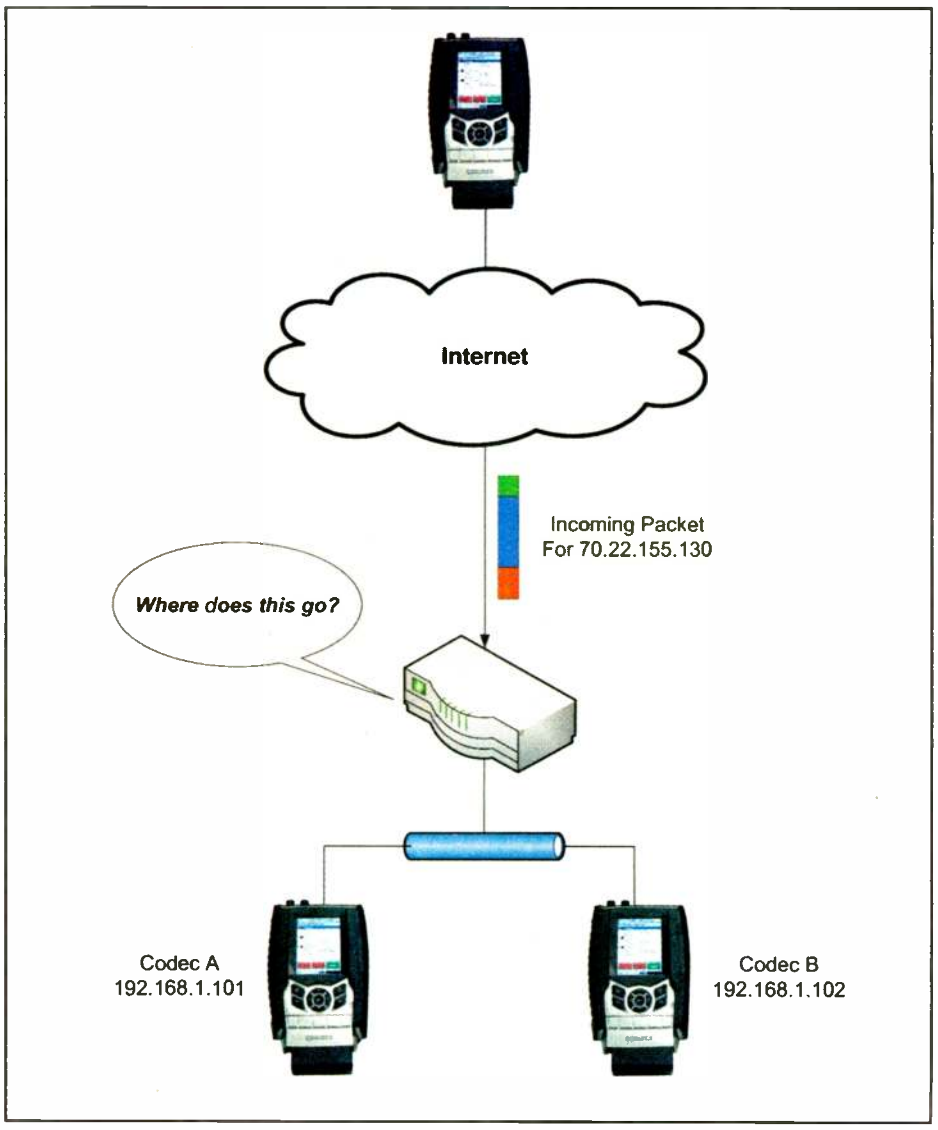

Fig. 5: NAT routers need directions to correctly forward unsolicited data.

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CONTINUED FROM PAGE 18

Network Address Translation (NAT) refers to the ability of a router to translate requests from computers or codecs within its LAN on to the public Internet. On its most basic level, this involves replacing the

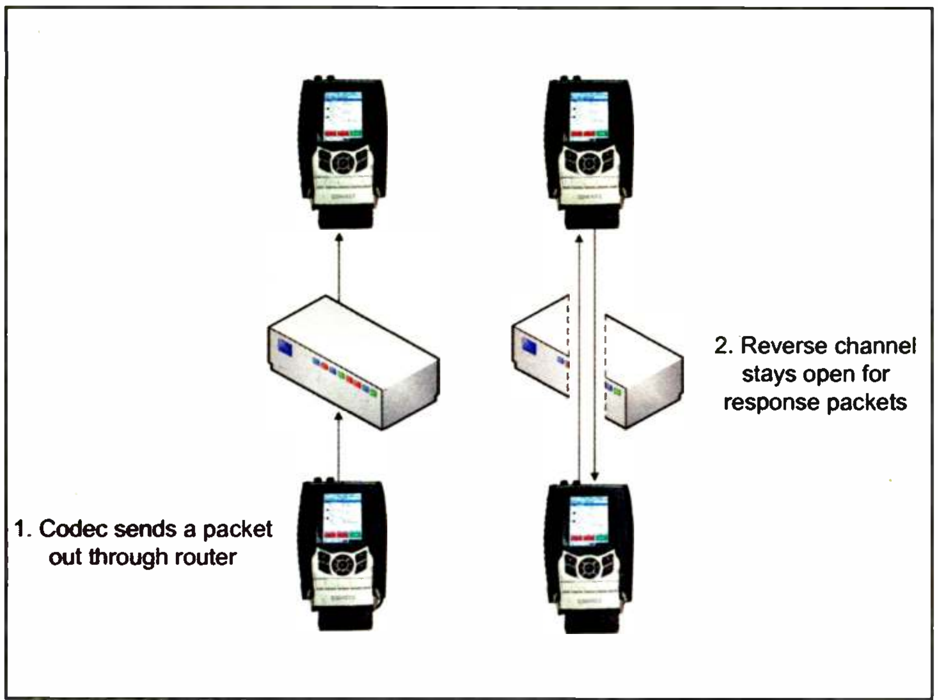


Fig. 6: 'Punching a hole' in a NAT router.

private "source" or return IP address in each packet with the true public IP, and remembering where that packet was sent so that any response can be forwarded back to the proper device.

A good metaphor for this would be that an outgoing packet "punches a hole" in the router, through which authorized reply packets may be returned to the codec for a limited time, as shown in Fig. 6.

But the actual Network Address Translation function is implemented in several different ways by routers. A few of the options routers may be configured for are:

Send all packets received from the internal codec (regardless of destination) out to the public Internet from the same public IP address using the original source port number.

Send all packets received from the internal codec (regardless of destination) out to the public internet from the same public IP address using a different source port number that remains consistent on all connections.

Send all packets received from the internal codec out to the public Internet on a specific public IP and/or source port number that changes based on destination (known as a Symmetric NAT, the toughest kind).

The Traversal Server aids in breaking through these different types of routers for incoming calls. Because it is in constant contact with all subscribed codecs, it can send and receive "test patterns" to determine whether one or more NAT routers exist on a link and what type they are. It can then choose a connection method to be used to circumvent the problem.

Options available to it include: instructing the calling codec to make a normal connection (no NAT detected); using the hole punched by connection to the directory server for incoming connections from other codecs; and instructing the called codec to make the connection in the reverse direction.

The second option, which utilizes the outgoing directory server "ping" described earlier, is very useful. The interval of this ping is adjustable, but defaults to about one minute, which is short enough to keep a "hole" punched through the majority of NAT routers.

These techniques are based loosely, with enhancements, on a generic Internet protocol called STUN (Simple Traversal of UDP through NAT). The system works well in all environments except one: when both users are sitting behind a symmetric NAT. In this situation, calls will fail even with Traversal Server. The only option in that environment is to resort to port forwarding on one side of the link.

BACKUP AND SUBSCRIPTION MODEL

The Comrex BRIC Traversal Server is designed to be fully redundant and keeps duplicate databases of user groups. It is located at a reliability-proven data center with sufficient and scalable bandwidth for codec users.

Another common question about use of the Traversal Server is whether there will be a charge to use it. The model we've set up is that the codec-side software features, which enable its use, are a purchased upgrade. Access codec users can purchase a license key that enables the BRIC TS function on their codec, and that comes with an account for group setup and free use of the Comrex-maintained BRIC TS server.

But larger networks, international users and those who simply want to avoid relying on a third-party server can arrange to get the code to build their own Traversal Server, as it's freely available from Comrex. This assures that if for any reason the Comrex server becomes unavailable, BRIC TS service can continue from any point connected to the net.

SUMMING IT UP

While I've presented the technical details of what BRIC Traversal Server does, the most important point is why it does it.

The goal of the entire BRIC concept, and BRIC TS in particular, is to make IP codec connections that rival the quality, stability and delay broadcasters have come to expect from ISDN, while providing the ease-of-use they've come to expect from cell phones and other consumer devices.

By eliminating the NAT router issue, and presenting users with an easy-to-manage directory, BRIC Traversal Server makes a technically complex topic simple to use for both engineers and non-technical users. ■

MARKETPLACE

LP Technologies Has Spectrum Analyzer for HD Tests

LP Technologies released its 9 kHz to 3 GHz RF spectrum analyzer for broadcasters. The company says it is suitable for test and troubleshooting in broadcast applications such as HD transmitter testing and compliance mask verification.

The LPT-3000 features a FM/AM compliance mask including Federal Communications Commission, NRSC and Ibiquity test measurements. The unit also has DTV (8 VSB), occupied bandwidth, channel power and adjacent-channel power ratio measurements.

The LPT-3000 has great sensitivity with an average noise level of –105 dBm with preamplifier off and –127 dBm with preamp on (1 kHz RBW, 10 Hz VBW), according to the company. Resolution bandwidth selections include 300 Hz, 1 kHz, 10 kHz, 30 kHz, 100 kHz, 300 kHz, 1 MHz and 3 MHz. The sweep rate ranges from 100 ms to 1,000 sec, and 40 ms to 1,000 sec in zero span; phase noise is –90 dBc/Hz at 10 kHz offset.

Additional highlights include digitally synthesized RF, wide range frequency, wide dynamic range, large internal memory, 6.4 inch TFT LCD screen and Ethernet card for remote control with an IP address.

For more information, contact LP Technologies at (316) 831-9696 or visit www.lptech.com.

BC-2000D Manages Linear, Compressed Audio

AEQ's BC-2000D Multiplexer inserts and extracts digital or analog, mono or stereo audio channels in E1/T1/J1 or Ethernet data transmission flows.

Audio channels can be linear, or compressed for better use of the link. Link capacities not used for audio can be employed for data transport.

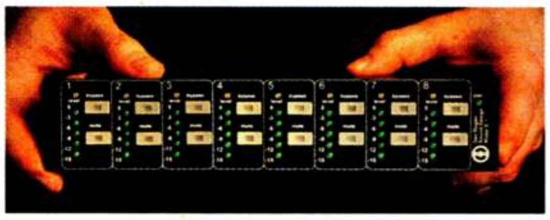
The BC-2000D Multiplexer is part of the BC-2000D router digital audio platform that routes, mixes, processes and distributes audio. The system transports audio between stations and also routes it within each station to the required destination. Audio channels are accepted and extracted with flexibility, including analog channels at the mic or line level; AES-3 and S/PDIF digital channels; and AES-10 MADI digital multi-channels.

The unit can be configured, controlled and monitored with computers, which allows setup circuits for monitoring or intercom use through the loudspeakers and microphone installed in each computer, using audio over IP.

Other applications for the BC-2000D Multiplexer are studio-to-transmitter links and transmission networks for radio with different centers for production and emission.

For more information, contact AEQ in Florida at (954) 581-7999 or visit www.aeqbroadcast.com.

Model E-1 Adds ADAT Connectors, Input Switch



Dan Dugan Sound Design expanded its line of automatic mixing controllers with the Model E-1, which implements features Model E users asked for, such as two pairs of ADAT connectors — one pair for digital I/O and one pair for linking. The E-1 can be linked with the Models D-2, D-3, and E.

Additionally, a back-panel switch changes the input from analog (TRS insert connectors) to digital (Lightpipe). Both analog and digital outputs are always active simultaneously, according to Dan Dugan.

The Model E-1 retails for $3,199.

For more information, contact Dan Dugan Sound Design at (415) 821-9776 or visit www.dandugan.com.

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Dorrough

CONTINUED FROM PAGE 1

to measure loudness, you turn to your Dorrough Loudness Monitor.

Mike Dorrough, recipient of the 2000 NAB Radio Engineering Achievement Award, has a long and interesting history in broadcasting. Born in Southern California, he had the opportunity to be part of the broadcasting scene in the 1960s in Los Angeles at some venerable call letters with some very memorable people.

Dorrough shared with Radio World how he developed the Discriminate Audio Processor, or DAP, and by doing so set the stage for multi-band audio processors we use today.

He and his wife Kay live in Wisconsin. One of his passions these days is preserving broadcasting heritage by restoring and preserving classic broadcast equipment and programming. Another project close to his heart is the establishment of a shortwave broadcast station that could help the blind and print handicapped. His wish is that blind and print handicapped people would operate the station and provide programming of interest to the blind community. However, that project has run into obstacles.

Mike Dorrough, right, and jazz great Les Paul.

Where were you born and where did you go to school?

I was born in Southern California and due to a rheumatic heart went to a special school in Northern California called the "Sunshine School" for children with disabilities. It was there that I had my first interactions with blind children and came to appreciate their remarkable coping skills in a world of touch and sound.

What was your first radio experience?

We lived two blocks from radio station KYA(AM). One day at the age of six or seven, I ambled into the station. They were wide open to the public before the age of lawyers, vandals and copper thieves. By and by I saw the transmitter and was instantly hooked on big iron.

As a very young kid at the end of World War II, I discovered that the local dumps were full of radio hardware discarded by the military. Disc cutters and audio gear also were discovered in those treasure piles. Thousands of pounds of the stuff got dragged home and formed a strange kind of playground. Putting those radio bits and pieces back together gave physical form to my interest in radio and audio.

To this day it's painful to see so many wonderful pieces of historical, lovingly designed and built pieces of hardware rusting away or crushed and melted into refrigerators.

As a less-than-stellar student, it was possible to compensate and even buy some favor with teachers by fixing their house and car radios, a kind of '50s version of the recent "schools to work" programs. It was hard to resist the temptation to do a little bootleg radio broadcasting, tapping into the junkyard stash and an assortment of hardware discards from local radio stations.

My first official job while still in high school was doing remotes for KITO(AM) in San Bernardino. It was amazing to see the mixer's meter go off the scale while the off-air signal being fed back to me through the headphones didn't get loud on those spikes but actually backward modulated before rebounding. This seemed a little like magic at the time.

Was this "shock absorbing" characteristic inherent in the transmitter or was there some other device in the audio chain? That's when I discovered limiters.

The station engineer pointed out the RCA 86A. I learned through doing those remotes that conventional limiters were disproportionately affected by low audio frequencies. That simple observation planted the seed eventually leading to the Discriminate Audio Processor.

An assortment of radio station jobs in maintenance and audio engineering eventually led to a move to Los Angeles and a transition to the recording industry.

When and where was it that you discovered that radio was what you wanted to do?

There was never any doubt that audio and broadcasting would be my career.

Growing up before television became so pervasive, kids could exercise their imaginations to enjoy drama, music and comedy, all while doing their chores, hobbies or homework. A medium that informs, entertains and enhances productivity at the same time is worthy of devotion.

Was there a memorable person who mentored you early?

In a general context, my technical heroes are Edwin Armstrong, Nicola Tesla and, on a first-name basis, Leonard Kahn.

Before some interesting "button-down" time as a recording engineer at RCA, I worked in the early 1960s as a sound mixer for "Emperor Productions," owned by Casey Kasem and Bob Hudson. I was very proud to have earned their trust. It was a great environment for a young audio engineer, affording almost unlimited creative latitude.

It was there that I first met my wife and partner Kay.

She was a producer with an ad agency then using the services of Emperor Productions. With Kay acting as the agency's liaison, we recorded Dodge car commercials and Rockwell Tools spots.

Because Kasem and Hudson were also top DJs at KRLA(AM) at the time, they knew lots of important people and brought them into the Emperor studio to do their commercials, program bumpers and other radio bits. We also recorded artists such as The Seeds, The Impressions and Jim Messina. Through this flow of talent I got to know Dick Bogart of RCA. That connection would have significance down the line.

As all good things must pass, so it was with Emperor Productions. Casey Kasem was hired by Hanna-Barbera for cartoon voices, the next step toward becoming a living legend, and Bob Hudson went on to write for television.

The studio was up for sale so I was at liberty to do a brief stint in Detroit for Motown. I loved working with the talent at Motown but missed Kay and California. After returning to L.A., Dick Bogart got me the gig at RCA.

Can you tell us about your experiences as a recording engineer for RCA in the 1960s?

The time at RCA was the highlight of my career in recording. As a kid from a working class background, the wonderful talent and atmosphere of pure class set a benchmark in my life. It might seem terribly dated but there is something to be said for jackets, ties and good manners in setting a tone of professionalism.

I had the honor of working with great producers like Joe Reisman, Neely Plum, and my most favorite, Al Schmidt. The artists who passed through that Hollywood studio were a who's who of the arts.

I had the honor of working with Odetta, Carol Burnett, Harry Nilsson, Peggy March, Lorne Greene, Glenn Yarbrough and other notables. The legends I got to see in action included Elvis, Eddy Arnold, Chet Atkins, Artie Shaw and many more.

The musicality, creativity and perfectionism were inspirational. In those days it wasn't "cut and paste"; orchestras were

SEE DORROUGH, PAGE 24

MINSTRUMENT MATRIX

Sophisticated Minstruments from NTI give you comprehensive test capability... and these flexible audio instruments fit in the palm of your hand

DL1 Digilyzer
Digital Audio Analyzer

A handheld digital audio analyzer with the measurement power & functions of more expensive instruments, the DL1 Digilyzer analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as embedded digital audio. In addition, the DL1 functions as a smart monitor and digital level 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 connect to an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a comprehensive event logging capability.

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- Status/User bits
- Event logging
- Bit statistics
- VU + PPM level meter for the embedded audio
- Monitor DA converter and headphone/speaker amp
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DR2 Digirator
Digital Audio Generator

The DR2 Digirator not only generates digital audio in stereo & surround, it is a channel transparency and delay tester as well, all condensed into a handheld package. Delivering performance & functionality challenging any digital audio generator made today, it produces all common audio test signals with sampling frequencies up to 192 kHz and resolution up to 24 bit. The Digirator features a multi-format sync-input allowing the instrument to be synchronized to video and audio signals. In addition to standard two-channel digital audio, the DR2 can source a comprehensive set of surround signals.

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- Dolby D, D+, E, Pro-Logic II, DTS and DTS-HR surround signals
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- I/O Delay Measurement
- Sync to AES3, DARS, word clock & video black burst
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AL1 Acoustilyzer
Acoustics, Audio & Intelligibility Analyzer

The AL1 Acoustilyzer features extensive acoustical measurement capabilities as well as 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.

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MR-PRO Minirator
High performance
Analog Audio Generator + Impedance/Phantom/Cable measurements

The MR-PRO Minirator is the senior partner to the MR2 below, with added features and higher performance. Both generators feature an ergonomic instrument package & operation, balanced and unbalanced outputs, and a full range of signals.

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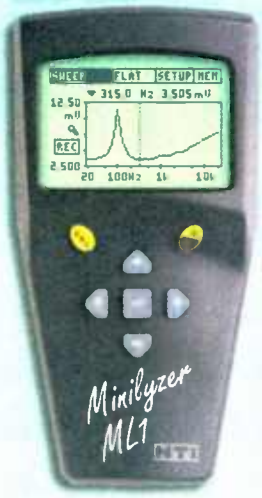
- Cable tester and signal balance measurement
- Protective shock jacket

ML1 Minilyzer
Analog Audio Analyzer



The ML1 Minilyzer 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, plus VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external response sweeps generated by a Minirator or other external generator.

Add the optional MiniLINK USB computer interface and Windows-based software and you may store all tests on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.


MiniLINK

- Measure Level, Frequency, Polarity
- Automatic THD+N and individual harmonic distortion measurements k2 – k5
- VU + PPM meter/monitor
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- Scope mode
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Dorrough

CONTINUED FROM PAGE 22

there in back of the artists, live! I experimented with three RCA BA6A limiters in a patchwork, composite multi-band processor system. People loved the quality but the rig was cumbersome.

RCA was wonderful but large corporations are not as receptive to technical innovation and experimentation from the trenches. I became obsessed with shrinking a multi-band processor into a single box so I could apply the technique to multiple channels. The pursuit of a compact multi-band audio processor eventually led me away from RCA.

Can you tell us about the genesis and development of your Discriminate Audio Processor?

Even as a youngster I began toying with ideas for making recordings sound better on

Dorrough's archiving complex on his property in Wisconsin. 'This kind of space provides a means for us to preserve some of the history of broadcasting,' he said.

The transmitter room at the archival house.

Discriminate Audio Processor

radio, and in the 1960s experimented with crude composite multi-band processor rigs to punch-up studio recordings. Simple broadcast audio limiters, first used in the 1930s to protect transmitter components from harm due to occasional spikes in audio levels, had the side effect of creating more "talk power." The "compression effect" allowed the broadcast engineer to safely turn up the gain. Signals sounded louder, but there was a downside-reduced fidelity.

As stated before, undesirable side effects such as "pumping" were just accepted as the price of protecting the transmitter. A sustained high note, such as a horn, would actually be modulated by prominent, repetitive bass notes.

The solution for broadcast might also be separate limiters for each portion of the sound spectrum. A bandpass system was devised to first separate "highs," "mids" and "lows." Through a long process of experimentation the ideal breakpoints were determined. Once segregated, the three bands were fed into discrete limiters. The limiters were painstakingly configured to provide the sweetest balance.

Early on it was determined that to maintain "transparency," in order for the processor not to draw attention to itself, some deliberate overlap, or tapering of frequencies, would be necessary. The active filters exhibited a gentle slope.

The next step was to feed the output of each bandpass filter to an individual processor, each with an ideal ratio of compression over the entire audio spectrum. These processors were not summed through the conventional method of applying tone, but rather by injecting pink noise to achieve power flatness as opposed to simple electrical flatness.

This is the first design where the time factor was properly considered along with amplitude. Power, or loudness, as a function of time and amplitude. As a result, the audio material's original waveform balance, complexity and delicacy were not compromised.

After a number of prototypes, my wife Kay and I began manufacturing the Discriminate Audio Processor 310 right on our kitchen table.

The only way to spread the word was to barnstorm throughout the country, literally putting a half million miles on my car installing the units in each market, virtually on speculation. It didn't take long for the engineers and sales departments to see that DAP-equipped stations had improved their coverage.

These days very little is manufactured in the United States. What was it like to manufacture your own electronic products in the 1970s?

From the Kasem/Hudson days on, I had been using variations on multi-band processing for recording.

These early composite versions took up an entire rack, but in 1967 I became aware of new technology that might make it possible to manufacture a compact, fully integrated system. The IC (integrated circuit) made it practical to produce our processor in the context of a "cottage industry." With a major assist from Academy Award-winning electronics pioneer Bill Lasmondes, we put a compact, fully-integrated unit into limited production.

The Dorrough/OpAmp Labs version was an important learning experience. I think that the historical record will support that we were the first to apply integrated circuits to a broadcast/audio product. We never wanted to be a manufacturer but the OpAmp Labs iteration showed us that the necessary components could be integrated onto one chassis.

In 1968 KRLD was outfitted with the "second-generation" multi-band processor. The results were so gratifying that we redoubled our efforts to join forces with a large corporation with the power to fully exploit the worldwide market. As with all unproven technologies it became clear by the early 1970s that we were on our own.

The brilliant Mike Callaghan built us a prototype of a fourth-generation unit, the DAP 310, which was a clever industrial design, more practical for a gradual ramping-up of production. I'm proud that their desirability on eBay 30 years later is a tribute to the 310's performance and visual appeal.

At first we assembled and calibrated the units in our kitchen, a half-dozen or so at a time, and I would go out with hat in hand, station by station, trying to convince engineers to try them out.

The DAP 310 took off and quickly exceeded the capacity of our kitchen table assembly line. Younger readers may not realize that in the 1970s, southern California was the center of advanced electronics manufacturing before we all but surrendered that capability to Asia.

Military and aircraft industries demanded high quality and innovation. Many subcontractors with mil-spec construction standards were available to us at the time. During the first few years of wild growth we tapped into these resources.

As sales increased into the late '70s, it was possible for us to set up our own factory to centralize operations and start development of the first digital-controlled DAP 610, and its companion product the Loudness Monitor.

The monitor is extensively used today. How did that come about?

The Loudness Monitor actually grew directly out of the DAP 310 and development of the second-generation DAP 610 in the late 1970s. The Loudness Monitor was invented as a way to visualize the effects of processing, displaying the true, real-time relationship between average and peak power.

LEDs were a fairly new technology at the time and seemed ideally suited to studio and broadcast environments. Forty inertia-free, color-coded LEDs in specially designed isolation cells provided superior resolution and readability.

The Loudness Monitor would be the first audio metering device to show a "third dimension," beyond peak and average audio level readings. The peak and average parameters are based on complementary algorithms.

With more aggressive processing and compression, the gap between the average and peak ballistics closes because the monitor is responding to the dynamics of the audio waveform itself. With pure tone or extreme flat topping, the two ballistics merge. The peak ballistic can display instantaneous transients that would be utterly missed by conventional peak-reading meters.

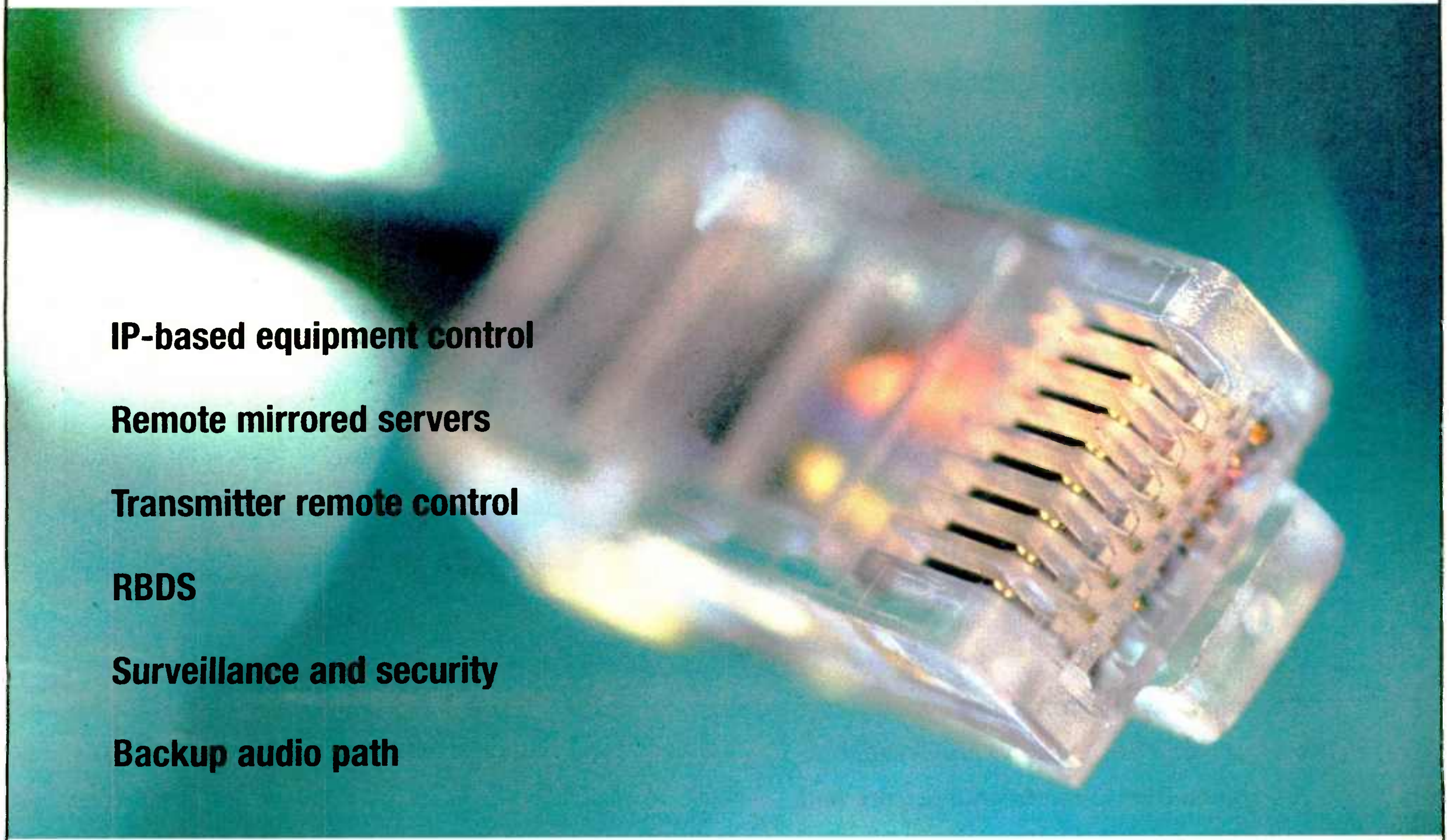
The Loudness Monitor warns users visually of clipping and distortion that might have occurred at some earlier link of the audio chain. Built-in, fully buffered left/right inputs give the audio engineer the ability to select and monitor discreet left and right channels, or sum and difference.

This capability provides an instant check on channel phase relationships and "center-channel buildup," becoming more and more problematic as engineers struggle with the complexities of mixing surround sound for a wide variety of output devices.

We have recently been awarded additional patents for carrying these unique capabilities into the analysis of digital audio streams as well as analog. It was apparent

SEE DORROUGH, PAGE 26

Ethernet path...



to the transmitter site.

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by Tim Anderson and Ted Staros

Bringing the Embedded Exporter to Market

Project Is an Exercise in 'Distributed Development'

Anderson is FM/digital radio product line manager for Harris Corp.; Staros is the director of its Pacific Design Center.

In 2006, NAB representatives approached Harris to discuss how best to encourage a broader adoption and reduce the cost of HD Radio implementation across its membership. Harris was eager to have these discussions and help the NAB study the architecture chain to identify the most costly elements and those with the most potential for failure.

It was felt that the high cost of the exporter, built on a computer, has been a substantial roadblock to wider HD Radio implementation. Service lifetime and system size also have been concerns. The large PC-based exporter has inherent service lifetime and reliability limits due to fans, disk drives and thermal characteristics that leave it subject to eventual failure.

These investigations resulted in a plan for an improved HD Radio program exporter that could reduce the cost of HD Radio implementation between 10 and 20 percent (around $10,000) per station.

The embedded exporter demonstrates how industry cooperation and investment can advance the HD Radio architecture and hasten HD Radio rollout.

With financial assistance from the NAB, Ibiquity Digital developed the necessary software libraries for the next-generation exporter. Several broadcast equipment manufacturers also were subsidized by the NAB to encourage development of their own exporter solution incorporating the new Ibiquity code.

Harris' Pacific Design Center in Vista, Calif., which has significant expertise in embedded design through its studio products, led Harris' development efforts. These efforts resulted in the next-generation Harris HDE-200 Program Exporter.

The HDE-200 is an "embedded" exporter, which means that a microcontroller CPU has been embedded within the exporter, thus eliminating the cost of an external Linux x86 PC and the inherent PC hardware liabilities. The Ibiquity HD Radio codec and data encoding algorithms, and the required diversity delay, are processed within the unit.

This third-generation HD Radio Program Exporter provides a powerful hardware/software platform that offers improved reliability and ease of use at a significantly lower cost over first and second-generation products.

The HDE-200 product development has been an exercise in "distributed development," the practice by which multiple individuals, at multiple locations, working for different firms, must act as a unified development team. Participants on this project included Harris and Ibiquity staff, and a short list of dedicated supply chain partners and consultants.

Distributed development only works when all participants feel responsible for the achievement of the overall project goal. Nobody can succeed without everybody else being successful. This setup makes people consider what the "other side" thinks and encourages collaboration.

HD RADIO SYSTEM AND EXPORTER

The HDE-200 is a program exporter for HD Radio broadcasts. It allows a broadcaster to add the necessary information to broadcast one or more HD Radio digital audio or data channels within an existing analog FM channel allocation.

The exporter adds the signal encoding required by the HD Radio Exgine/Exciter. The exporter accepts the main program audio and Program Service Data (PSD). In addition, it encodes the Advanced Application Services (AAS) data and supplemental audio channels (supplied from an HD Radio Importer like the Harris HDI-100 Program Importer).

The exporter compresses the MPS audio stream, and combines services into a single IP data stream for transport to the Exgine/Exciter via the Exciter Link interface. The exporter also provides a delayed audio output of the main program audio for the legacy analog broadcast to facilitate smooth blending between the analog and digital signals at the receiver. Fig. 1 shows the physical architecture of the Generation 3 HD Radio system.

The HDE-200 exporter can be located in a studio or terminal room, as opposed to being collocated at the transmitter as in earlier generations of exporters. The data stream between the exporter and Exgine is the "Exporter to Exgine" or E2X transport protocol and may be either TCP over a bidirectional link or UDP over a unidirectional link, making it fully compatible with digital STLs, local- or wide-area networks, satellite, virtual private networks or even the public Internet.

HARDWARE DESIGN

Structural and functional modularity was a central theme in the design of the HDE-200. The design team wanted an architecture that could be built of modular elements providing segregated functionality, testability, serviceability and development disciplines.

Creating this modularity ultimately reduces manufacturing cost and lead times, and consequently reduces total cost of ownership to the customer. Some of these modular elements benefit from reuse in other Harris Studio System products.

Determining the modular structure of a product requires a careful balance. Too much modularity can result in higher system cost. Too little modularity often results in longer, more costly development cycles. Fig. 1 shows a simplified block diagram of the HDE-200.

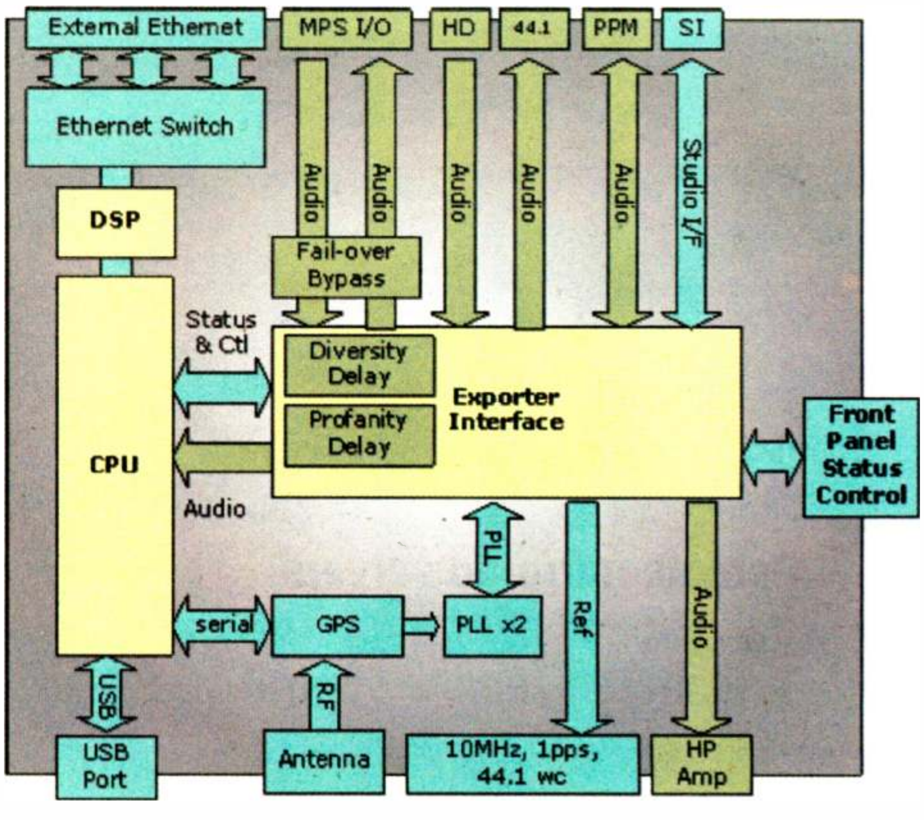

Fig. 1: Simplified HDE-200 Block Diagram

Modularity

The design team also wanted the product to reflect the modular nature of Ibiquity's reference design. By using a modular approach, at each step of the development process we can check to make sure the software will work properly on the Ibiquity reference development platform.

Being able to swap the digital signal processing employed in the Ibiquity reference platform with our version, or being able to swap in a software emulation of the same DSP codec, allows controlled comparisons of interchangeable elements. In addition, too little modularity can complicate manufacturing yield and severely limits service

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Dorrough

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from the beginning that the Loudness Monitor might have even wider applications than the Discriminate Audio Processor itself.

You are now trying to establish a shortwave facility operated for and by handicapped folks. What started you on this project?

I've had a long and fulfilling relationship with gifted blind and visually impaired people in the audio and broadcasting fields.

Our family acquired a 16.2 acre plot of land in the town of Oregon, Wis., as the setting for a home and unique broadcast/archiving complex. This kind of space provides a means for us to preserve some of the history of broadcasting.

We have been collecting and protecting rare and fragile transcriptions, tape recordings, films and documents for decades, including much of the UCLA record and transcription library. This new property is the perfect place to properly archive and preserve these irreplaceable treasures of broadcasting's Golden Age.

The establishment of the first-of-its-kind shortwave radio service for and by visually impaired persons would dovetail perfectly with the massive audio archive. The planned non-profit, low-profile, low-power residential operation would be no more noticeable to the widely spaced neighbors than a typical ham radio station. Due to the unique characteristics of shortwave radio, even at the planned modest power levels, the signals would still be heard across the nation.

The benefits to the sightless broadcaster would be apprenticeship and a sense of achievement, and to visually impaired listeners it would offer an endless array of diverse programs created for radio — a medium that once told vivid stories and entertained without visual cues. The program mix would not only include vintage radio plays but new productions from a largely untapped reservoir of creative talent.

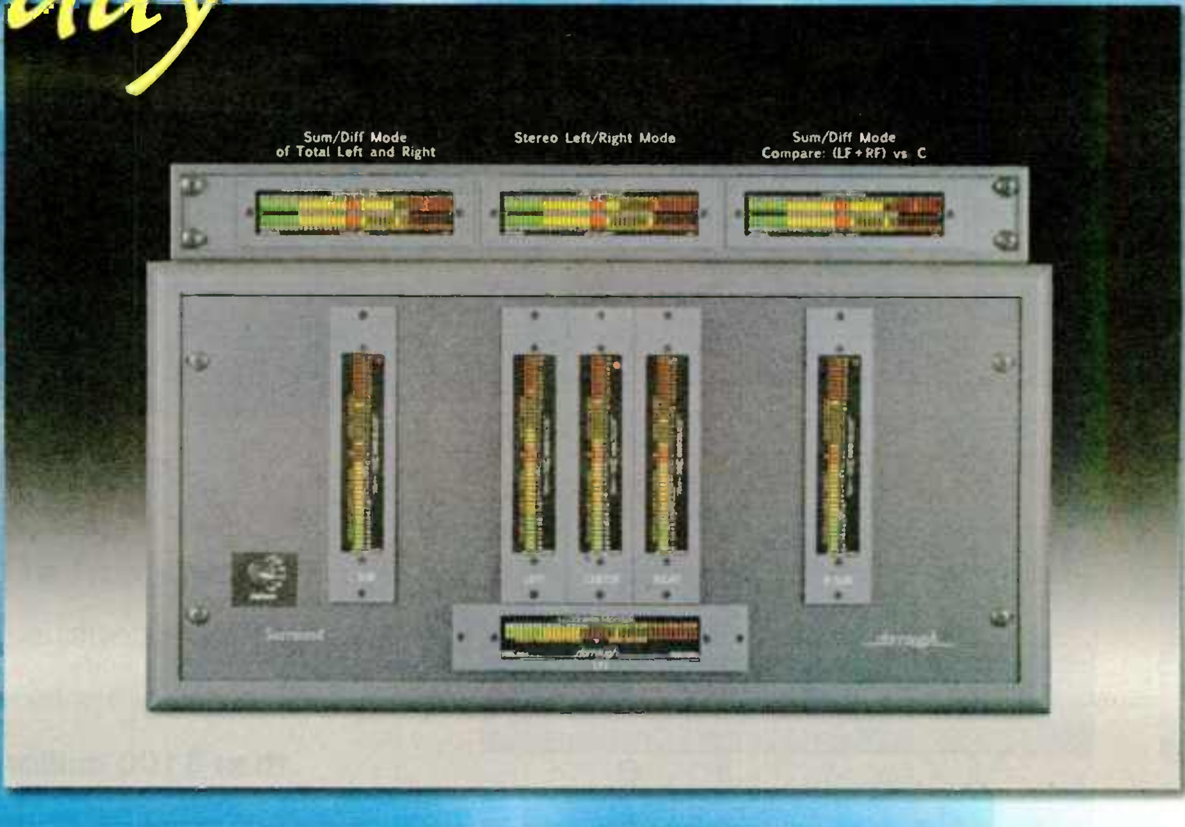
With buildings and antennas already in place, just as we were about to apply for our license, we were shocked to see ground stakes outlining what looked like a house foundation in close proximity to our antenna array. The land was a small, triangular parcel left over from the farm subdivision process, only about 1/6 of the minimum required for residential construction.

We're still seeking the advice, legal or otherwise, to help salvage this project and at least a part of our recorded heritage before time and the elements erase the archives forever.

Steve Callahan is the director of engineering for Rhode Island Public Radio. ■

It all began with

And today



Thanks to each of my many friends in the Radio and TV industry. It's been a great career with more to come!

Exporter

CONTINUED FROM PAGE 26

by substitution, unless the substitution is of the entire device.

The HDE-200 broke down into four component modules: Exporter Interface; CPU, a.k.a. microcontroller; digital signal processor; and user interface.

The Exporter Interface is the physically largest element of design. It contains the input and output structures, diversity delay management and Global Positioning System. Central to this design is that the Exporter Interface may be fabricated and tested in a manner that provides isolation of the other components.

The Exporter Interface is the element that provides the application-specific functions this product demands. Every other modular element — the DSP, the CPU and the user interface — are general-purpose devices. This assembly is purpose-specific.

The CPU in our design required careful study. Cost, system and Direct Memory Access performance, power consumption, the development tool chain, vendor support, component availability, Ethernet and USB host support were prime considerations. Again, modularity and our ability to segregate the CPU function from other development threads were critical to the design requirements.

It was decided to use an ARM9-based Atmel processor on a 144 pin SODIMM module. The module looks like a slightly oversized laptop memory device. Measuring 2.6 × 2.3 inches, the compact form factor is deceptively powerful (see Fig. 2).

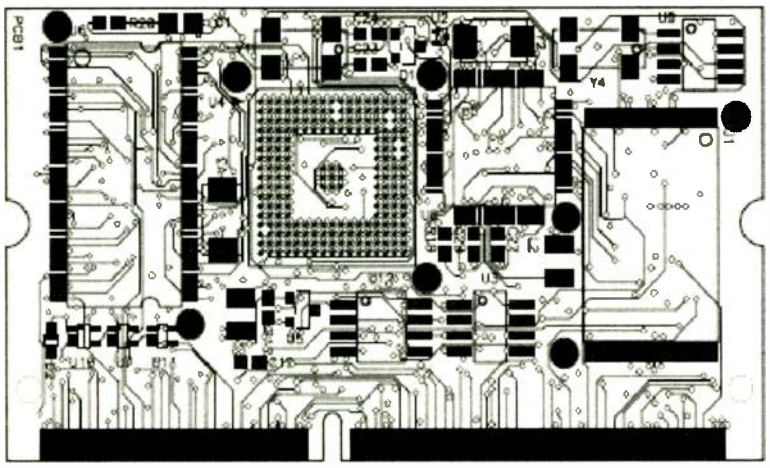


Fig. 2: ARM9-based SODIMM CPU Module

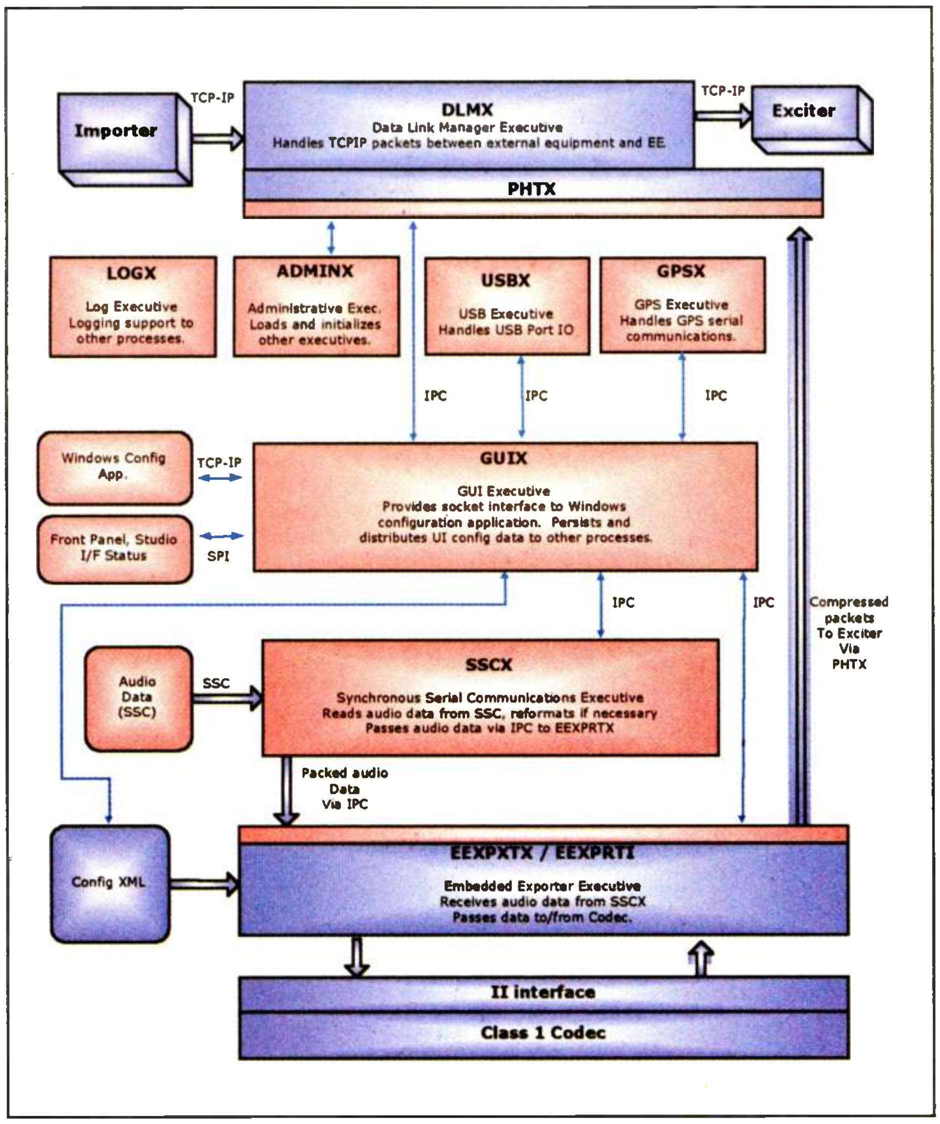


Fig. 3: Modules illustrated in red were developed specifically for the HDE-200.

Our DSP structure was the easiest choice, as Ibiquity made this one for us. The primary software component of the DSP, Ibiquity's codec thread, was to be provided with its intellectual property safely protected in an inscrutable, machine-readable, binary format. This covert code was compiled to run exclusively on a TI 6713 DSP chip.

Our user interface also was an easy choice. User interface elements that could be readily adapted had already been developed by the Harris Pacific Design Center for our studio products. We chose to reuse a control panel element from our VistaMax audio management system family of products.

Reliability

Reliability of a product can be easily reduced to a single driving factor: power dissipation. This one factor influences all aspects of hardware failure.

By designing to a restricted power budget, we eliminated our reliance on forced-air cooling. Fans fail and their filters become choked with dust. Moving parts like fans and disk drives create their own power burdens, which drive up total power consumption. A failure of one of these components often results in a total system failure. Consequently, designing a product capable of performing to specification using only convective and radiant dissipation was a primary design goal of this project.

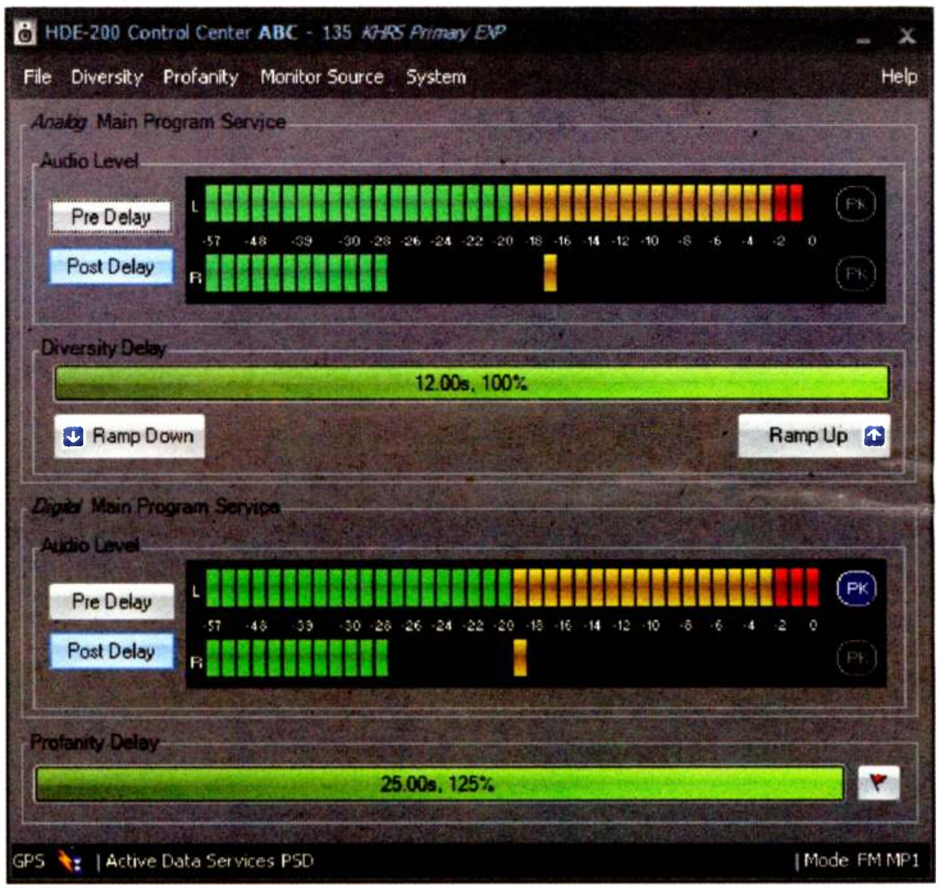


Fig. 4: HDE-200 Control Center

The lower cost of the platform could save broadcasters more than $100 million.

The total power dissipation of the HDE-200 measures at less than 15 W. As a bonus, with no fans, this device can be placed in even the most acoustically sensitive locations.

Incorporating the control architecture within our platform allows our audio diversity delay to remain intact even if a microcontroller reboot is required, something previous designs could not do.

SOFTWARE DESIGN

Software library transformation from a PC environment to an embedded model would appear somewhat straightforward. It's anything but.

To achieve the cost advantages of an embedded system, one must break free of the hardware foundation of the PC platform. Gone are specialty PCI bus audio cards and expensively packaged GPS subsystems, as well as the user interface with mouse and keyboard.

Replacing these are new, efficient software structures to interface with application-specific real-time signal input and output. Our need to maintain functional modularity across the PC to embedded transformation required significant up-front planning

Expecting that we would encounter various software library compatibility issues as well as inter-process communication problems, the software team was cautious. To offset these challenges, we focused on our modularity mindset. Given our distributed development program, the key to a modular approach was to focus on the first rule: The more moving parts one needs to accommodate, the more complexity and risk one introduces into the system development.

Our modular implementation of the software design allowed a substantial re-use of stable and time-proven software modules. A new code structure, specific to the hardware efficiencies of the HDE-200, was crafted to integrate with these pre-established modules.

One of the best lessons learned from this distributed development effort is the importance of inviting remote contributors to the each other's development centers periodically. Digital collaboration and information sharing is helpful, but nothing can replace the interaction and camaraderie of occasional face-to-face meetings.

IMPROVEMENTS TO THE EXPORTER PLATFORM

As part of the development of a new exporter, we were able to incorporate the latest improvements included in the new Ibiquity core software.

Transmission Control Protocol (TCP) has been incorporated by Ibiquity into the E2X transport layer providing "guaranteed delivery" of data between the exporter and Exgine/Exciter over a bidirectional link. This provision relaxes the significantly more stringent network performance

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Exporter

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requirements of UDP, which remains an available option for transport over unidirectional links.

To unify communications between the various HD Radio components, HD Protocol was developed by Ibiquity. HDP supports protocol content creation and distribution as well as command and control across the entire HD Radio system from local, centralized and/or remote locations.

Fig. 5: HDE-200 Front View

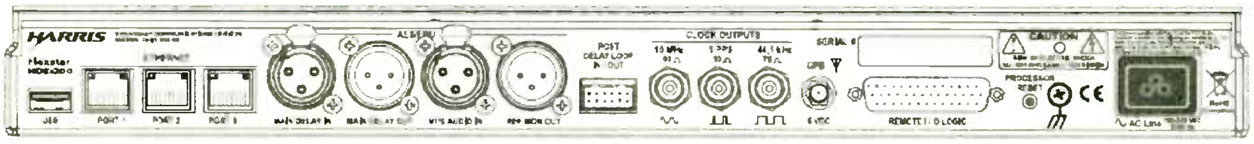

Fig. 6: HDE-200 Rear View

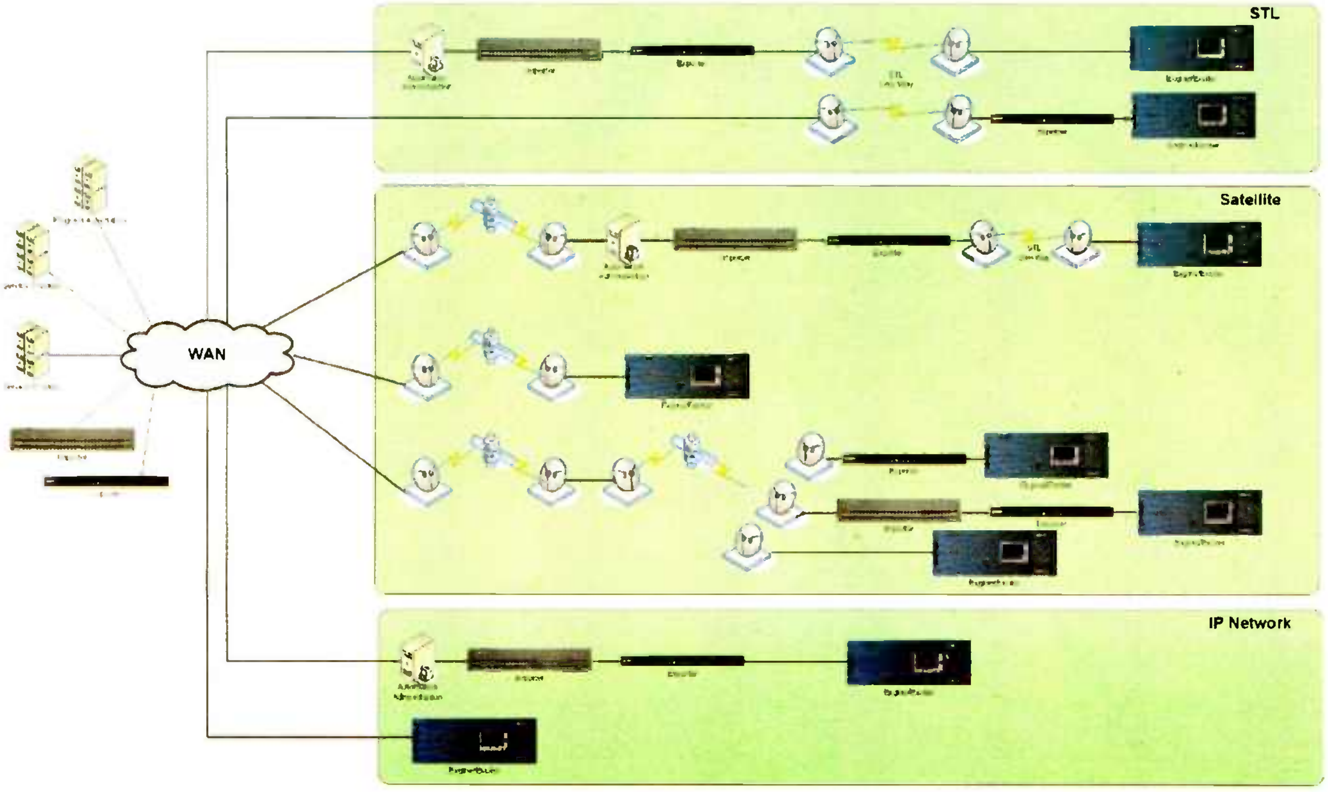

Fig. 7: HDP Networking Configuration

HDP is an extensible, general-purpose protocol for use over unidirectional and bidirectional links, and is now the standard protocol underlying the HD Radio broadcast system architecture.

HDP also improves security by enabling the ability to digitally sign messages being received from other broadcast components and systems.

Increased flexibility also has been added by allowing the Main Program Service codec to be configured as low as 32 kbps leaving 64 kbps for supplemental audio and data services in MP1. This allows for a 32 kb Main Program Service and 32 kb for HD2 and HD3 supplemental audio services.

An additional feature added by Harris through the HDE-200 Control Center software is the ability to "discover" the other Harris HD Radio components (Importer and Exciter) on the network. This allows easier setup and maintenance of the signal chain.

HDE-200 UPGRADES

Three optional upgrade kits are available: Profanity Delay Upgrade kit; Arbitron PPM Encoder Interface Kit; and Combined Profanity Delay/Arbitron PPM Encoder Interface kit.

POSSIBILITIES

Multi-Point, Multimedia Origination and Distribution

The addition of HDP supports unidirectional and bidirectional network configurations for content distribution to the various HD Radio system components. HDP content also may be generated locally from the studio administration equipment and directed to various program paths. Within the HDP structure, content can be anything that might be transported over HD Radio. This could include weather, traffic, navigation or digital signage data, audio, video, pictures, audio files and program metadata.

Fig. 7 shows the diverse possibilities for origination and distribution.

Encoded Host Audio Transport is an expansion of the E2X protocol, whereby an additional high-bandwidth, low-latency audio stream is encoded into the existing HD streams for transporting the main legacy analog program over the E2X/IP stream, with the analog host audio program being extracted at the Exgine.

It is expected that the HAT will provide up to a 256 kb, HDC-encoded stereo audio channel, and will require approximately 500 kb of additional transport bandwidth. This could result in an overall HD+FM system transport bandwidth reduction of 600 kb, freeing up precious STL resources for additional services and increased system headroom.

ERROR CORRECTION AND TRANSPORT ROBUSTNESS

By embedding low-density parity-check (LDPC) codes or turbo codes into the optional HDP Protection Fragmentation Transport layer, along with packet filtering and Quality of Service mechanisms, it is possible to greatly improve the performance of the unidirectional UDP E2X link as part of the Exporter/Exgine architecture to reduce component count, system complexity and cost.

GENERATION 3 AM HD

The HDE-200 Exporter will support AM HD Radio modes as well as FM modes. Development of an Exgine-based AM exciter will support Generation 3 architecture on AM.

SUMMARY

Realization of the embedded exporter demonstrates how industry cooperation and investment can advance the HD Radio architecture and hasten HD Radio rollout. With the introduction of the FlexStar HDE-200 exporter at the 2008 NAB Show, HD Radio broadcasters now have an exporter that boasts a unique set of features to better support multiple HD Radio streams over a single, dedicated IP connection.

The lower cost of the embedded exporter platform could result in saving broadcasters more than $100 million implementing HD Radio over the coming years. While reducing the cost of HD Radio implementation and fortifying the robustness of the system have been the prime motivators, continuing development has and will continue to bring many new and exciting applications and features. ■

READER'S FORUM

LIKE MARCONI HIMSELF

I really enjoyed the interview with Larry Cervon in the April 16 Engineering Extra ("A Lifetime in Broadcast Equipment").

In 1999, I had just gone to work for SCMS Inc., and we were at the fall Radio Show in Orlando. One day at breakfast, my boss Bob Cauthen introduced me to Larry Cervon.

Being a career radio geek, I of course knew who I was talking to, and could not have been more in awe if it had been Marconi himself.

I had a few occasions to talk with Mr. Cervon, and enjoyed hearing his stories and reflections on Gates and BE. I also was totally surprised at his crystal-clear memory of events large and small.

When we were at the airport wrapping up a conversation about pictures of gear in the various catalogs,

I made a comment about the one-of-a-kind console Gates built for WABC, off the top of my head saying that the picture was in (catalog) number 98, the green one.

No, he replied politely, 98 was orange. That catalog was printed in the '60s!

Bob Mayben
SCMS Inc.
Pineville, N.C.

Take a Bigger Slice of Net Income Pie

Radio, Still Green to Web Streaming and WiMax, Must Embrace New Media If It Is to Compete With It

Every NAB Show reinforces the realization that our industry will always be blessed, and at the same time held hostage, by the marvels of electronic technology. Content may be king, but it will forever be transmitted and received by wireless or wired communications devices.

Although over-the-air radio has enjoyed 90 years as the primary delivery method, it's becoming clear we are at the forefront of a paradigm shift. Streaming and the Internet are beginning to share the load.

To remain competitive, no form of electronic media can afford to ignore the imperative and force of advancing technology. But as broadcasting grapples with how best to harness the Internet, streaming and other new digital opportunities, typically nine-tenths percent or more of its ongoing revenue and business model is based on supporting its traditional over-the-air product. Digital asset income may be increasing, but it's still a tiny part of the net income pie chart for radio.

Just how much effort and financial resource should be devoted to new initiatives is a vexing question for management in any size station or market. Early adopters traditionally lead the industry and often get rewarded, but they always take on the most risk and sometimes get burned. Radio stations everywhere continue to wrestle with deciding if and/or when to convert to HD. Practically every station has a Web site, but most small-market stations still do not stream over the Web.

Enhancements in Internet streaming, wireless/mobile and HD technologies again dominated this year's NAB Show and continue to push broadcasting at warp speed.

CONTRARIAN THINKING

For many cost-conscious radio owners and managers, their Internet product is more of a distraction and cost burden than a significant contributor to the bottom line.

Except for Google and online marketers like Amazon, few businesses have figured out a model that makes real money from their Internet presence.

Just before the dot.com bust, then-CBS boss (and now Sirius CEO) Mel Karmazin proclaimed that the Internet was merely a very big electronic Yellow Pages. He thought Web sites were little more than a value-added accessory for radio, and did not even allow CBS stations to stream.

But nowadays if you don't have a decent Web site and online stream, many advertisers conclude you are not where they think their customers are spending lots of their time. Unless you have a compelling ratings story to tell, not being available on the Internet may leave you off the buy.

Most managers who live and die by quarterly performance figure it's simply much too early to worry about wireless Internet competing head-to-head with radio. It's true that we have a lot of issues to sort out, as the various players in the wireless mobile space jockey for position. WiMax is being pushed hard by the revived Sprint/Nextel and Clearwire partnership, using both 3G and 4G technology; $14.5 billion is being ponied up to develop their nationwide WiMax network, including support by heavyweights Intel, Google, Comcast and Time-Warner.

A brand-new technology certain to compete with WiMax called LTE (Long Term Evolution) is now being developed in Europe. AT&T Wireless and Verizon, the largest U.S. wireless operators and the winners of the big FCC spectrum auction, have just indicated they are choosing LTE for their mobile Internet service of the future.

The collision of different and competing technologies will slow down the rollout of new consumer electronics platforms. New-generation wireless will need some kind of standardization in order to become widely adopted and successful.

AT&T Wireless and Verizon are choosing LTE (Long Term Evolution) for their mobile Internet service of the future. Guy says the new technology is certain to compete with WiMax.

SITTING ON THE SIDELINES

Quite a few radio decision-makers have decided that until HD-R receiver sales and penetration start to show up on their radar screens, adding HD Radio is not yet justified as an investment to grow their business. They're content to leave HD-R evolution to Ibiquity stakeholders, and will continue to rely on the same basic AM-FM formula that has served them well for many, many years. Lots of stations continue to churn out tons of cash with the old tried and true, making up to 50 percent of the bottom line.

The recession aside, radio profit margins may have fallen a little but still are lofty compared with most other businesses.

SEE GUY WIRE, PAGE 35


What is the best kept secret?
Some manufacturers write about advances in modulation monitoring, but at Belar we've been doing it for years.
Our FMHD-1 HD Radio monitor uses the latest advances in digital techniques, providing the broadcaster with the state of the art, today.
HD Radio
BELAR
Some Technical Features
• Direct A/D Undersampling of the FM Carrier
• Digital FM Carrier Demodulation
• Digital Stereo Decoding.
• FFT Power Band Calculations
BELAR
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Belar Electronics Lab., Inc.
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by Bob Henry

Tx Sites Young and Old Require Routine Checks

No Matter How Modern, Transmitter Sites Need Regular Maintenance

These days, for whatever reason, the practice of regular maintenance of radio station facilities seems to be a thing of the past. This was observed after recently doing work for a local radio station in need of much attention. Regular maintenance had not been done in a long time. The former engineer had passed away and the owner was not able to do the necessary maintenance. I no doubt had my work cut out for me.

During a windy night, I noticed an unusual phenomenon was occurring at the AM transmitter site; the antenna ammeter readings were mysteriously and gradually changing.

I briefly cut the modulation to observe the symptom more carefully. As the wind blew harder, the ammeter reading would vary up and down with the wind variations. Obviously, wind is not supposed to have any effect on RF ... that is, unless the wind is making something to move to cause it. This is exactly what was happening only I didn't know how it was happening at the time.

The next day I decided to examine the transmitter facility to find the probable cause of this phenomenon. After walking out to the tower (located some 100 feet away from the transmitter), there it was, the source of the problem: the door of the ATU was wide open.

Evidently, this door had been blowing back and forth in the wind, causing the tuning to vary with the blowing of the wind. I wondered how it opened as it did. After some more investigation, I noticed someone had cut the lock hasp to open the ATU door for access, but it was never repaired. It was obvious that it had been this way for a long time, allowing the elements of the weather and the environment to enter the ATU housing.

Fig. 1: This was how the ATU was found — with the ATU cabinet door wide open!

After closer investigation of the inside of the tuning unit, I noticed heat emanating from one of the tuning coils. Looking closer, I noticed visual signs of charring caused from excessive heat at the coil tap (see Figs. 2a and 2b). This was a clear indication of a bad connection. The coil was charred at the tap point and causing some power to be lost in heat.

Buying a new coil was not an option at the time. To fix the problem, I was able to

SEE MAINTENANCE, PAGE 37

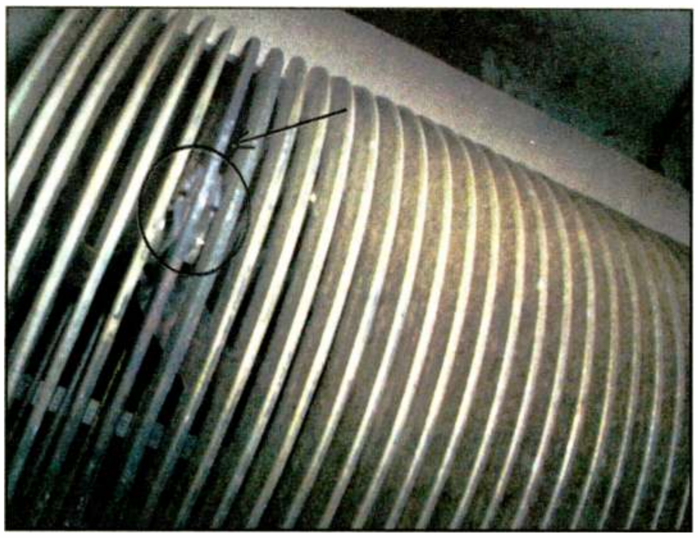

Fig. 2a: Close-up of defective coil tap.

Fig. 2b: Defective coil tap as viewed inside the coil.

Guy Wire

CONTINUED FROM PAGE 32

Overall ratings also may be down a little, but everyone who is paying attention realizes 225 million listeners still use and depend on our product every day, in every nook and cranny across America. This "treading water" mode of thinking seems to have considerable support, especially outside the larger markets.

Unfortunately, Wall Street has punished broadcasting because it is not growing. Broadcasting also is being squeezed by the glitzier new technology mass media entrants for attention. Many of those new technologies have yet to attract significant or sustainable audiences or make a profit. Ad agencies and buyers are caught up in that same ripple and, like Wall Street, seem overly enamored with the Internet and new tech while they ignore or forget radio's strengths.

TO CHANGE OR NOT TO CHANGE

Continuing to run radio by the methods and strategies that have always worked in the past certainly provides the path of least resistance with apparent minimal risk. Nobody likes change if it creates uncertainty with unpredictable or money-wasting results. But resisting change in a business that thrives on and showcases the new and novel will always become even more risky sooner than later.

Both the programming and technology histories of radio are highlighted with new introductions that began as experiments and eventually became staples of enduring success. That pattern is one thing that will probably never change.

Innovation is the mother of change and has a hard time slowing down or waiting for better economic times, especially with personal electronics. Enhancements in streaming, wireless/mobile and digital technologies again dominated this year's NAB Show and continue to push broadcasting.

Some of these are poised to create more competition to traditional broadcasting while at the same time offering us opportunities to make our own products better or to partner with competitors. The cumulative changes the industry has had to embrace over the past five years rival those of the previous 20 years. And there are more coming every day.

Many managers, PDs, AEs, production folks and engineers are spending a lot of time and effort managing their burgeoning digital assets, including HD channels. Most of those are producing little or no revenue or audience compared to their primary over-the-air programming. That's going to be the price we'll have to pay to give these new platforms a chance to build audience and create results.

THE 10 dB BUZZ

There is little doubt that FM-HD continues to make important gains, growing and expanding its supplemental channel format offerings in many markets. The vitally important HD consideration buzzing everywhere at NAB was the proposed 10 dB digital power increase. The higher digital power is required to improve indoor reception and make supplemental channels more viable.

Several Ibiquity partners conducted field tests of the proposal earlier this year including Greater Media and CBS. Co-channel stations, especially those short-spaced, are the most likely to receive increased interference. Many first adjacents also will feel the pinch. But the overall conclusions of this first round of tests were promising.

There is no question that primary coverage areas for digital reception will expand substantially with such an increase and all HD channels will perform much more reliably. That's a very positive shot in the arm, not only for HD Radio but for radio in general. This is a case of the greater good outweighing the more limited downside of isolated increased interference.

Just how much of the 10 dB increase will eventually be allowed and how it's implemented will be the industry hot topic in the months to come.

It seems reasonable that the Federal Communications Commission will allow up to 10 dB but will place limitations for stations in congested areas based on projected contour overlap using computerized modeling methods. Or, as it has done with AM-HD, there's always a chance it will let interference issues be handled first by the stations themselves bilaterally after the ground rules are established. Then if that doesn't work, the commission will step in on a case-by-case basis.

BACK TO THE PRESENT

Ibiquity showcased 60 new HD receiver models in its NAB booth this year, including several with Apple's iTunes tagging. That feature, along with display data, extra channels and on-demand programming, are among the key ingredients that should make HD Radio a desirable upgrade as time moves on. Enhanced audio quality is a bonus.

AM-HD continues to fight a precarious battle for acceptance. Nautel showed its impressive new NX-50 transmitter at the NAB Show, designed specifically to optimize and maintain high-quality HD performance. It even won a "Cool Stuff" Award. All the major equipment manufacturers offer excellent options for AM-HD hardware solutions. Yet the growth of AM-HD stations coming on the air seems stalemated.

We are hearing that several major groups including Bonneville are now pulling back on AM-HD and re-negotiating their commitments with Ibiquity. As RW noted in a recent editorial, if true that development is not good news for AM as the service struggles to remain relevant in a digital world. AM-HD may be flawed in various ways, but it remains the only game in town selling tickets for tomorrow's show.

The primary players of the HD rollout appear steadfastly committed to a long and steady effort in spite of the slow uphill climb. But without critical-mass acceptance, deployment and promotion of HD by more stations across markets of all sizes, the receiver folks are not yet willing to stamp this technology a winner. The car radio still holds the key that will start this engine and keep it running.

We've heard a lot of talk and promises from Ibiquity and the HD Alliance. A few car companies have stepped up to play, but until all the Big Three U.S. car companies supply HD Radios as standard OEM equipment without option surcharges, HD demand, receiver sales and market penetration are not likely to accelerate.

Consumers have been comfortable buying radios for less than $20 for many years. Convincing them to buy a new and improved model for $100 or more is not an easy sell. It's just the nature of the beast.

GETTING TO THE FUTURE

In a way, we are caught in an HD Radio Catch-22.

Apple's iTunes tagging along with display data, extra channels and on-demand programming are the key ingredients that should make HD Radio desirable. Enhanced audio quality is a bonus.

While we cannot predict the future, many hope it could come sooner than later. The stakeholders and big boys are trying to do their part but the benchwarmers sitting on the sidelines are not helping.

Many of them would just love to wake up tomorrow and see HD Radios in every store and every car so their decision to buy the hardware and the licensing would be a no-brainer. If only the 10 dB digital power increase would be authorized very soon. If only cheaper and better performing HD receivers, including stock car radios were available now.

The future that HD proponents dream about could be just around the corner. Or it could get stalled and eventually derailed. It's still mostly up to us. Radio needs to do a lot more heavy lifting with much better execution and promotion of the service to convince consumers HD Radio is worth having. Unless we do our part and make sure HD programming is compelling and reliable, the future for radio that includes a successful HD service may not come.

Staying with the analog status-quo indefinitely, especially on FM, simply makes no sense for stations and their listeners, or for receiver manufacturers, car companies and retail vendors who want to sell anything new and improved. HD remains our only shot right now in giving radio a desirable new feature set to better serve consumers in an all-digital multimedia world.

One last possible caveat to ponder: A lot of radio folks are thinking that even if HD catches on, it probably won't get anything close to the long and storied run AM and FM have enjoyed. The times have changed. Significant technology advances that used to take 20 years to mature and become entrenched now appear and then disappear in less time than that.

Wireless Internet has the potential to absorb and ultimately replace traditional radio broadcasting as we know it. Las Vegas should consider offering odds on if and when that will actually happen. The platform that might eventually become the dominant nationwide wireless standard is unknown and will take many more years to evolve.

Hoping for the future to arrive quickly may not be what we really want after all. The clock is ticking.

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

MARKETPLACE

Staco: FirstLine OC Reduces Installation Time, Costs

Staco Energy Products says its FirstLine OC power distribution cabinet is customizable to fit most applications, and reduces installation time by providing maintenance bypass, branch circuit distribution and voltage transformation in a single cabinet.

With up to 96 branch circuit breakers with or without main panel disconnect circuit breakers, the FirstLine OC eases the installation, moving or changing of electrical equipment.

The company says safety is assured with true wraparound bypass for systems maintenance. Three interlocked switches provide removal of power from the UPS cabinet without dropping the critical load. With top, bottom and side cable entry options, FirstLine can be installed in raised floor or non-raised floor environments.

5 x 7 FirstLine OC

Snap-in breakers ease installation of branch circuits; spacious wireways reduce the cost of installation. Computer-grade grounding eliminates the need for additional grounding, according to Staco, thus saving installation time and costs.

A brochure, available at *www.staco-news.com*, details the product line including power correction and harmonic filtering, single-phase and triple-phase UPS, voltage regulators and power conditioners. Information on its custom engineered solutions to most electrical power problems also is provided.

For more information, contact Staco Energy Products at (937) 253-1191 or visit www.stacoenergy.com.

TECH-Mart

One Stop Shopping for all your Technical Broadcast Engineering Needs!

MARKETPLACE

BE Adds FXi Exciter to FMi T, HD-R Lines

Broadcast Electronics says its FXi 60/250esp digital exciter for FM, FM+HD or HD Radio broadcasts includes features such as ESP digital adaptive correction, dual RF outputs for redundancy and Ethernet IP control. Available in 60 W and 250 W versions, the direct-to-channel FXi comes standard in BE's FMi T and FMi HD Radio transmitter lines, and as an upgrade option for its FMT, C and S series transmitters.

ESP corrects linear and nonlinear distortions for the transmitter system, providing adaptive correction for FM+HD and HD-R, and corrects for group delay in a multi-station, combined antenna application.

Additional features of the FXi 60/250esp include dual RF outputs; one exciter drives two transmitters, a separate HD Radio transmitter and an FM transmitter or a backup and main transmitter. Also, the FXi 60/250esp offers dual AES/EBU inputs with True Silence Sense for primary and backup audio inputs.

More than 45 settings facilitate on-the-fly configuration changes, switching between stereo and mono, and other user-defined settings.

Other highlights include RDS; stereo generator; composite clipper; and high-resolution spectrum display of transmitter system, providing RF mask of the FM only and/or HD Radio signals.

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Maintenance

CONTINUED FROM PAGE 34

rotate the damaged coil horizontally 180 degrees so the other end of it could be used, as it was not charred. After burnishing it with an emery board, the tap was then placed back on the coil at the proper tap point.

I then powered up the transmitter and checked tuning and operating parameters. Meter readings were very close to those originally logged and posted on the transmitter. No more fluctuations were noticed with the antenna current readings.

No matter how new and modern (or old) they are, transmitter sites still require routine maintenance to avoid such problems.

Bob Henry is SBE CBT broadcast engineer at KNME(TV) in Albuquerque, N.M. ■

Fig. 3: View of coil assembly after being repaired.

Blesser

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applying a value system and executing the appropriate tasks.

Task assignment nominally is the responsibility of those with a managerial title, but the staff can easily skew such assignment by their willingness to take on a task. When the value system of the individual contributor is inconsistent with that of the decision-maker, the process deviates from the plan.

A repair engineer who loves to fix equipment may avoid the obvious conclusion that the defective equipment should simply be replaced with a new one. Or conversely, the engineer who is incompetent at fixing the equipment may recommend replacing it.

THE CIRCLE BACK

Decision-making becomes even more complex when we consider that at each step there will be surprises and changes.

As the process advances, new data will appear, a viable choice will be blocked, value systems will get resorted and a routine task suddenly becomes very complex.

In a remodeling, one suddenly discovered that the wall to be removed actually contained structures that held the roof up. Perhaps a political shift changes the criteria in the midst of executing a previous plan, such as a proposal for a leveraged buyout. A new set of decisions must be made but starting from a point in the middle of a previous process.

The biggest obstacle to reaching a decision often results from contradictions within the data, choices and value system. It is like searching for a number less than 5 and greater than 10. You could look forever and never come to closure.

Having identified the four major steps in decision-making, it becomes readily apparent that different skills and temperament are required for each. I have never met anyone who is equally good at all steps. Ideally, decision-making should be in a group where the skills are present.

The most egregious example is that of an engineering manager who does not understand the technology but who is trying to manage engineers with a different value system. Hence, Dilbert was born.

At this point in the discussion, we can readily see why an organization might provide unbelievably high rewards for a CEO that was really good at decision-making. But on the other hand, one also can see why optimizing decisions is extremely difficult, and few individuals actually possess the skill to do it well. In most decision-making, we see a manifestation of one fundamental problem: how to reconcile disparate values systems.

Those who are promoted to the role of manager, mostly as career advancement, rarely receive training in the skill of decision-making. Yet the art of decision-making is so valuable that is should be part of our basic education, not just in a professional context but as part of our life skills.

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by Barry Blesser

What Does It Mean to 'Manage'?

New Managers Rarely Are Trained in What Should Be Regarded as a Necessary Skill: Decision-Making

Most experienced engineers observe that their status and compensation are significantly smaller than those of managers and executives, who are treated as if they were making more valuable contributions to the organization.

Engineers often describe managers as being overpaid because they are not doing "real" work. Yet, when given the invitation to join the elite ranks of managers, executives and directors, though engineers delight in the prospects of more power and money, others dread the thought of having the responsibility of navigating a world of conflict and confusion.

While the expertise of an audio or broadcast engineer is relatively clear, the skill of managing can appear both mysterious and trivial.

What does it mean to manage? Are engineering skills transferable to managing? Should a new manager automatically be given training and mentoring? Let us take a fresh look at the concept.

FOUR STEPS

The word "managing" is nothing more than a semantic alias for decision-making.

Anyone who makes a decision, and that includes all of us, is functioning as a manager. When you choose employment in a particular company, you are managing your career. When you shop for groceries, you are managing your lifestyle. We manage ourselves, peers, bosses, subordinates, spouses, children, pets, etc.

This simple conclusion immediately leads us to the question: What does it mean to make a decision, or at least to make a good decision?

Decision-making involves four distinct sequential activities: (1) collecting the relevant data, (2) enumerating the choices and their properties, (3) applying a value system to sort the choices and (4) executing a plan to get to achieve the desired outcome. All four steps are critical to making a good decision, and we will examine each phase of the process.

Step 1. Data collection is the art of gathering relevant information, which especially includes constraints and limitations.

Perhaps there are budget, time and resource limits; perhaps a critical piece of test equipment is out for repair; or perhaps the needed expert is on vacation. A transmitter is intermittent, and the relevant data is the frequency of occurrence, properties of the failure, inventory of spare parts, cost of a replacement and so on.

I have one colleague who has the proclivity to collect data forever; I have another colleague who never bothers with any data collection. What is optimum?

Decision-making becomes even more complex when we consider that at each step there will be surprises and changes.

Collecting data is recursive because a decision-maker must decide how to collect data; he must decide what data is relevant; and he must decide when there is enough data to go to the next step. Data collection consumes time and resources.

Step 2. With enough data, one can begin to look at the implications, which are nothing more than a catalog of choices and their "if-then" relationships.

If I replace the transmitter with a new model, then we are covered by a factory warranty. But we may experience the unreliability of using a new product that has had very little run-time in the market.

If we replace the failed part, we may have solved the problem, but the failure may have been caused by another factor and the repair may fail again.

If I assign George to the task of designing a new studio, he will be unavailable evaluate the transmitter.

Building a comprehensive set of if-then relationships creates a tree, with each leaf being a possible outcome and each branch being an if-then choice. A decision-maker creates a tree structure of choices and outcomes.

If we install the routing system, then we are at risk of a studio being off-line for some period, and that will force us to rent facilities at a neighboring studio. If we hire two new engineers, that will deplete our equipment budget. If we terminate a support group, their tasks will be distributed to others who may be overloaded, and they will have to discard tasks that they would otherwise do.

Like data collection, building decision trees is expensive. How many levels of if-then should be explored? How many choices should we consider?

Brainstorming often results in discovering hidden choices. Pruning the tree makes this job simpler but one needs a criterion for the pruning, and the quality of the result depends on having sufficient data with a reasonable level of confidence in its accuracy. A useful branch that was prematurely pruned, even for good reasons, may remove a great solution. Aggressive pruning can result in no possible solutions, the so-called null set.

Step 3. Assuming that we have identified several choices, what value system should be used to make a decision? Are we trying to optimize cost, so therefore we should select the cheapest solution? Do I want to best return on investment?

These are the publically acceptable values. However, there are numerous private values, mostly involving career advancement.

Which choice is likely to raise the probability of a salary increase, or which choice has the least risk to my reputation or which choice has the lowest stress level? We even get simple criteria such as which choice is least likely to collide with my vacation. If our staff is overloaded, the criterion may be to shift the work to another department regardless of their work load.

INDIVIDUAL VS. ORGANIZATION

Individual values and organizational goals sometimes collide because individuals operate with their own enlightened self-interest, which rarely matches the goals of the organization. In fact, one could say that the goals of the organization are nothing more than the goals of those who have more control.

The CEO may be trying to optimize the likelihood of reaching a level of profitability for the quarter in order to trigger a bonus. The engineer may try to engage in an activity that results in a conference paper because he wants to look for new employment.

Nominally, values systems are a given; each individual simply prefers one outcome over the others. When we drill down, however, clarity becomes cloudy.

Who has really considered if a choice that raises income is best when it also creates hostility among colleagues? Do you really value having a new car and dreading going to work each day? For most of us, the answer is no. Economists routinely get this wrong.

Step 4. Having selected the optimum choice, how do we then assign tasks, define milestones and control activities that will get us to the selected goal?

To use an analogy, we have selected the resort where we want to take a vacation (end point), but we have to design a way to get there (travel plans). Instructions have to be given to the individual contributors so that the various tasks can be synchronized. And again, we find the process recursive.

The step of executing the specifics in a plan, which is typically assigned to individual contributors, also involves the four steps: data collection, cataloging choices,

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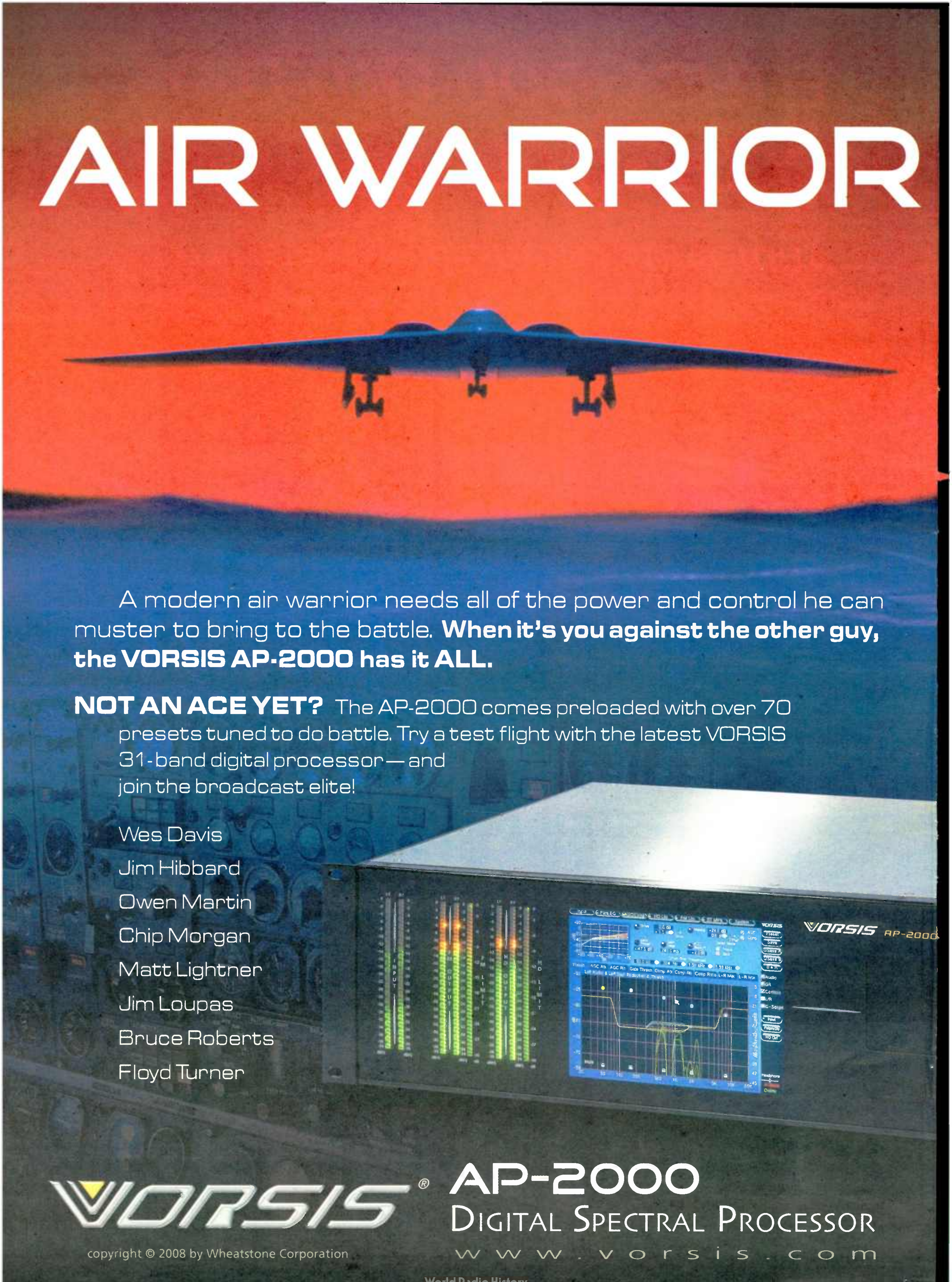
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