Radio World
ENGINEERING EXTRA
August 22, 2007

PROJECT PROFILE

WOR Builds New Studios in Manhattan

Opting for Classier Digs Than the Basement at 1440, WOR Kicks Off a New Era at 111 Broadway

by Thomas R. Ray, III

In the spring of 2004, WOR(AM) was starting the renewal process of the lease of our space on the 23rd and part of the 22nd floor of 1440 Broadway in New York City.

The building's new management had made many upgrades, including a completely renovated lobby and updated elevators. But the new owners thought they had built the Taj Mahal. Their offer to WOR would have increased our rent immediately by 2.8 times.

The building owners would not bend from their demands unless WOR agreed to move to the basement to keep the rent the same.

Psychologically, this did not sit well with Buckley Broadcasting President Richard Buckley, taking a legendary radio station and relegating it to the basement of the building. Second, the N/R/W subway lines run under Broadway, as close as 50 feet under the building foundation. Putting radio studios in the basement would be far too noisy; and they would be prohibitively expensive to noise-proof.

THE SEARCH BEGINS

In a city like New York, one does not go out on their own and rent office space. You need a real estate broker.

First, we needed to establish our criteria:

- The rent range we were willing to accept.
- The space, at least 23,000 square feet of space on one floor.
- Adequate power for the studio area.
- Roof rights to install antennas for reception and STL.
- The ability to tie in to the building's emergency generator, if it had one, or the right to install one.
- Our own air conditioning system for the studio area.
- Proper telephone facilities, in particular access to fiber.
- Easy access 24/7.

Several buildings were located. Rick Buckley, VP/General Manager Bob Bruno, VP/CFO Joe Bilotta and I went on hours of tours. We vetoed numerous buildings immediately for various reasons: They would not allow the installation of a generator; or the required that visitors pass through metal detectors and X-ray machines, which would not sit well with our high-profile guests.

We finally settled on three buildings. The overall deciding factors for our final choice at 111 Broadway were that the building was willing to work with us to make our move happen, whatever it takes; the building is two blocks north of Wall Street in a good and accessible area of New York; the rent agreement was very good; and the building is a restored turn-of-the-century building that is absolutely beautiful, with

SEE WOR, PAGE 10

Fig. 1: WOR's New Home: 111 Broadway, New York City.

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FROM THE TECH EDITOR

by Michael LeClair

Handbook Belongs in Your Engineering Toolkit

Latest NAB Handbook Adds Chapters on Digital Radio, Webcast, AM/FM Antenna Systems

This summer marks the release of the latest version of the NAB Engineering Handbook. This is the tenth edition of the handbook to be published. For more than 70 years this has been the reference that defined current engineering practice in the field of radio broadcasting. Covering all aspects of radio and television engineering, the NAB Engineering Handbook is a comprehensive guide to the foundation of the broadcasting business: the technology we use to communicate to our audience.

The handbook is an essential resource for anyone working in radio engineering. This marks the fourth version of the work that I have owned and each successive version has proven valuable in my career. I can recall the first time I used the handbook to design and build a microwave STL. I routinely refer to it whenever I have a question about how a particular technology works.

Periodically the handbook is updated to reflect the changing conditions in our industry so that it remains the standard reference on radio engineering. I was fortunate enough to get an early copy so that I could dig in to see what new topics they have in store for us in the latest edition.

A NEW CHAPTER

The 10th edition checks in at a muscle-straining 2,000 pages, about a third longer than its predecessor. It replaces the 9th, issued in 1999. It is interesting to reflect on the changes and developments that have occurred in the eight years since the previous version came out. This was a time of particularly rapid technology change.

The most obvious new technology to come into being during that time is digital radio broadcasting in both terrestrial and satellite forms. The latest edition features an entire chapter on the basics of this technology and that alone is worth getting a copy. Information on all aspects of HD Radio as adopted by the FCC in March is spelled out in detail. Need to look up the latest mask requirements for AM or FM IBOC? Wonder about how the system will change as we evolve to all digital? It's all here.

Another significant change has been the continuing improvements in the design of digital audio codecs. They are now as ubiquitous as the cart machines of an earlier era. It wasn't that long ago that all that you needed to know about was the MPEG 1 Layer II or Layer III standards on an ISDN contribution link.

Lately codec development has proceeded at a breakneck pace, driven by the many new forms of digital broadcasting direct to the listener. Digital codecs are the enabling technology that has driven digital broadcasting. The 10th edition features an entire chapter on this rapidly changing technology that has been greatly expanded to cover the latest work on codecs from the MPEG-4 standards to the new HD codec and surround systems.

How about the use of the Internet for broadcasting? It's hard to believe but this was just an experiment before 2000. There is a new chapter covering the enabling technologies behind this revolutionary method of content distribution.

Most of us are responsible for some aspect of streaming audio in our facilities and this technology has sprung up overnight and promises to be a key part of broadcasting for the foreseeable future. Another essential topic from the NAB Handbook.

I could go on but it isn't hard to get the point: the engineering side of broadcasting has changed dramatically and the new edition keeps you up to date on these changes.

GUIDELINES

For those who haven't owned a copy of the handbook before, I also should mention the updated and expanded chapters on the classic fundamentals of broadcast engineering.

There are chapters on the design of studio facilities, including a detailed explanation of basics of acoustical design and specification. The chapter on radio transmission facility design is co-authored by our own Cris Alexander, who writes our regular column, "Day in the Life." These chapters offer solid guidelines to assist in planning for those essential large projects that might only occur once or twice in the career of a radio engineer.

There also are chapters on audio production and recording that reflect the latest technologies and techniques for radio broadcasting. Digital recording and storage is now at the heart of most radio stations and it has allowed us to do more and better work with less effort. The handbook covers all aspects of this topic, from CDs to hard drives to Flash RAM cards.

Want to learn more about transmitters? You can learn about the basics of their design from industry masters like Geoff Mendenhall of Harris and Daniel Dickey of Continental Electronics, both of whom have also contributed to RW Engineering Extra. With the widespread installation of IBOC, transmitters are undergoing their most significant change in design since the introduction of solid-state amplifiers. Linear designs and adaptive equalization are just two examples of new requirements to learn about for modern designs.

Finally, there are comprehensive sections on both AM and FM antenna systems. Of particular note is the expanded chapter on FM combining systems by frequent Engineering Extra contributor Bob Surette.

Designs of combining systems have evolved substantially over the last 10 years and there are few major market engineers whose job responsibilities don't include the need to understand these important transmission systems. The need to pass IBOC digital signals also has changed combiner design in fundamental ways. The basic information you need to maintain these complex systems is all contained in this chapter.

It belongs in your engineering department.

THREE YEARS AND COUNTING

This issue marks the third full year of publication for Radio World Engineering Extra and it has been our best year yet. I am sometimes amazed to look at the wealth of technical information and engineering tales that continues to come our way. I want to thank our readers and advertisers for making this a success, and I look forward to bringing you the latest in engineering technology in the year ahead.

This issue is no exception. We have a pair of papers with the latest from the NAB Broadcast Engineering Conference. Phillip Schmid describes the new protocol developed by Nautel to improve on the Exporter to Exgine connection in HD Radio, with background on the basic network communications needed to make this work. Tom Ray gives us a Project Profile on the recent move of New York City powerhouse WOR into its new studios.

Also in this issue we have Ira Wilner on the topic of RF sleuthing, Tom McGinley talks with Wheatstone about its new line of audio processors, Cris Alexander tells the story of how to handle a real-world disaster of the worst kind, Guy Wire explores the new iPhone and Barry Blesser finishes up his thoughts on the Long Tail phenomenon and radio. Enjoy.

We always like to read your comments and suggestions. Don't be shy; drop us a line at *rwee@imaspub.com* and let us know what you're thinking. ■

IN THIS ISSUE

WHITE PAPER

by Philipp Schmid

E2X Bandwidth, Bit Error Needs for Multicast HD

Introducing a Reliable Real-Time Point-to-Multipoint E2X Transport Protocol

The author is research engineer for Nautel Ltd., Bangor, Maine.

The introduction of the third-generation digital radio broadcast architecture transforms the broadcast system from an audio-based system to a digital data system that carries audio content along with Advanced Application Services (AAS). The transition to this architecture necessitates changing traditional audio-based studio-transmitter links to generic, IP-based data links.

While IP streams are ideal for transferring arbitrary digital information, many of the challenges inherent to IP-based streaming are now imposed on this architecture. The nature of this system places stringent requirements on the STL that can cause significant on-air data outages.

The network and bandwidth requirements of carrying the data stream to the exciter have already been well analyzed and published. However, to deploy a system that is successfully synchronized based on the data stream rather than external GPS-based synchronization brings an additional set of challenges, which are presented in this article.

An alternate to UDP or TCP/IP transport protocol is presented that drastically improves data loss across the STL by implementing an automatic repeat request (ARQ) scheme. This protocol takes into account the impact on studio-to-transmitter synchronization due to retransmissions.

The protocol operation is detailed and its capability of addressing multiple exciters with a reliable data stream is illustrated. The article demonstrates a main/standby configuration and a dual station topology.

GEN 3 IBOC SYSTEM

The third-generation IBOC system architecture differs from previous generations in that most of the IBOC functions and equipment are moved from the transmitter site to the studio site. Fig. 1 provides a basic overview of the architecture.

The only function in the IBOC system that remains at the transmitter site is the digital IBOC modulation performed inside the exciter engine (Exgine). Keeping the modulation function at the transmitter site is necessary. IBOC modulation generates a discrete-time signal that requires the equivalent of 23 Mbps to be transferred across an STL. It is inefficient to carry this amount of data across bandwidth-limited STLs.

The transmitter site receives two data feeds from the studio: an audio feed for traditional FM broadcast, which may be carried in any digital or analog industry standard, and an Ethernet-based digital data stream for IBOC modulation. This digital data stream is not limited to carrying audio data and may contain program service data or other data services along with one or more additional compressed audio streams.

The major IBOC system components at the studio site are the Exporter, Importer and system synchronization unit. The Exporter's responsibilities include delaying the analog audio to match the digital on-air delay and passing the audio signal to the STL. On the digital side, the Exporter performs the audio encoding of the digital main program and the multiplexing of all digital content, including program service data for the main program and digital content originating from the Importer.

The Importer can capture two additional audio feeds for secondary program services that are encoded in the Importer and passed to the Exporter along with their corresponding program service data.

The broadcast architecture is synchronous in nature in that a discrete number of audio samples captured at the studio translate into a discrete number of digital symbols produced at the exciter. The synchronization unit synchronizes the incoming audio feed to a GPS-based timing reference, which in turn affects the timing of all operations in the system.

The STL link must now be able to carry Ethernet/IP-based traffic along with traditional audio streams. Many stations have already transitioned to digital STLs in favor of a digital audio feed over an analog feed for improved audio quality.

Most STL vendors now provide upgrade paths to share existing digital STL bandwidth between audio paths and Ethernet-based paths. However, since most STLs have traditionally been unidirectional in nature, many STLs today only provide a unidirectional Ethernet path. It is important that the digital data stream protocol does not require a bidirectional data path, but it may make use of a bidirectional link if one is present.

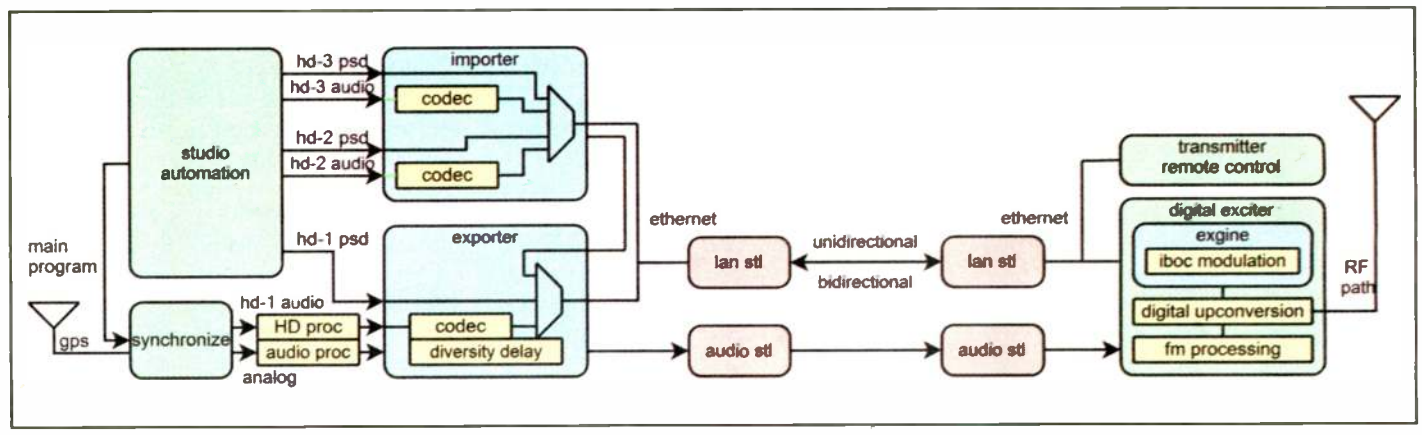

Fig. 1: Generation 3 IBOC FM Radio Broadcast Architecture

Most STLs have traditionally been unidirectional in nature, so many STLs today only provide a unidirectional Ethernet path.

Classifying the bandwidth requirements of the data portion of the digital data stream is relatively straightforward and Ibiquity Digital Corp. has sufficiently detailed these requirements. The bandwidth requirements for the synchronization stream, on the other hand, are more difficult to determine.

SYNCHRONIZING THE IBOC DATA STREAM

The digital data stream across the STL is a generic bit stream rather than a discrete-time signal. This means that this data stream cannot be sample rate converted, as each bit must remain unaltered. Consequently, both the Exporter at the studio and the Exgine at the transmitter must remain frequency locked in order to process the data at precisely the same rate.

At the transmitter site, the reception of the data stream is coupled closely to the digital modulation stage and, therefore, the data

SEE E2X, PAGE 18

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by Ira Wilner

Saga and the Case of Liz the Meter Reader

Thanks to Detective Work, Saga Communications Finds Source of Interference Taking Down STLs

For about two years Saga Communications in Keene, N.H., had been experiencing occasional interference with our two Moseley Starlink digital microwave studio-to-transmitter links.

The interference occurred regularly, once a month at midday for approximately 15 minutes. At first I thought it might have been related to a monthly equipment testing and/or maintenance cycle, cellular, two-way radio or paging. But I was never able to find technicians at any of the tower sites in the area on those days.

Our WKNE(FM) main and auxiliary transmitter sites are approximately one mile apart. The auxiliary site is more to the south, thus its dishes look away from the main tower site. We knew the problem was not limited to equipment at either tower as both were seeing the interference.

The interference usually would begin at our main transmitter site and progressively get worse until our auxiliary site also was receiving hits. On a bad month we'd experience audio dropouts on both our STL channels 950 and 951.5 MHz.

Each STL carries one of a pair of stereo program channels for each of four radio stations. Thus the loss of an STL will result in the loss of only one half of each program audio feed (L or R) rather than silencing a program feed entirely.

The receive dish at WKNE's main transmitter site is higher up. So we began to suspect the problem was not in the immediate vicinity but possibly more on the horizon, towards the south, and coming from Keene.

This was becoming a needle-in-a-haystack problem quickly. How could we police an area of several hundred square miles centered on our Walpole, N.H., tower sites?

Instead we took the quicker, though more expensive, solution and installed a pair of Crescend 10 watt linear amplifiers to give our STLs a 10 dB boost, hoping that would be sufficient to eliminate this occasional interference. This brought our received signal level (RSL) up to a respectable –46 dBm. This reduced but did not eliminate the problem. Now, only our STL bearing the right channel was being affected.

Better, but still not satisfactory. I continued to do some sleuthing in my spare time.

I spent several days manually searching through the FCC's Wireless Telecommunications Bureau database for every licensee in Cheshire County, N.H. Armed with a list of all the cellular, paging and two-way radio users, I placed calls asking about their equipment maintenance schedules. To my surprise I found that nobody had a routine monthly maintenance cycle. Perhaps another dead end?

One of the licensees in the 900–960 MHz band was the town of Walpole itself. I called its town utility department, which held a license for telemetry used in its water management system, but was again told it did not operate in a cyclical manner. However, the department suggested I contact the power company, as it was now wirelessly reading kWh meters.

Light bulb goes off!

AUTO METER READING FROM THE GRID

My FCC research did show that National Grid was licensed for some 952 MHz equipment. And the monthly nature of the interference and its duration sure seemed to fit what we might expect from roving remote meter reading equipment.

A Google search did not come up with any specific manufacturer of equipment. However the term AMR (automatic meter reading) did come up along with a discussion of the technology.

After several phone calls to the local offices of National Grid I was put in contact with a local engineer, who initially was not apt to take my complaint seriously. He did, however, confirm the use of AMR equipment in Walpole. A National Grid manager contacted the meter reader on the Walpole route, who confirmed she was in the area monthly, in the vicinity of our towers, taking readings around 11:30 a.m. for approximately 15 minutes.

Now there was reason to believe my

SEE LIZ, PAGE 8

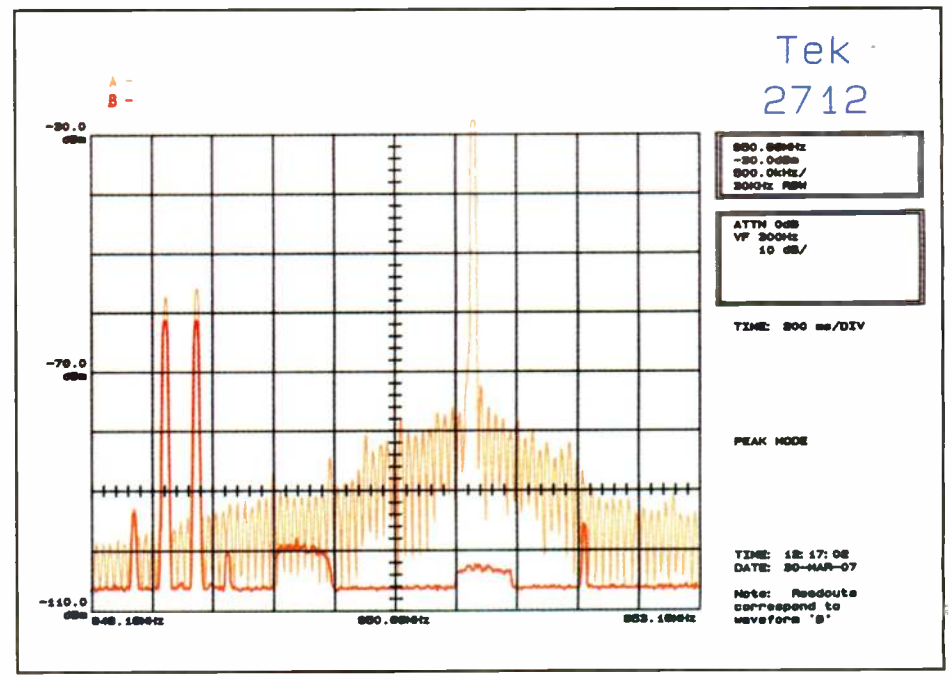

Fig. 1: Spectrum analysis overlay of WKNE's Moseley Starlink haystacks and the AMR wakeup signal.

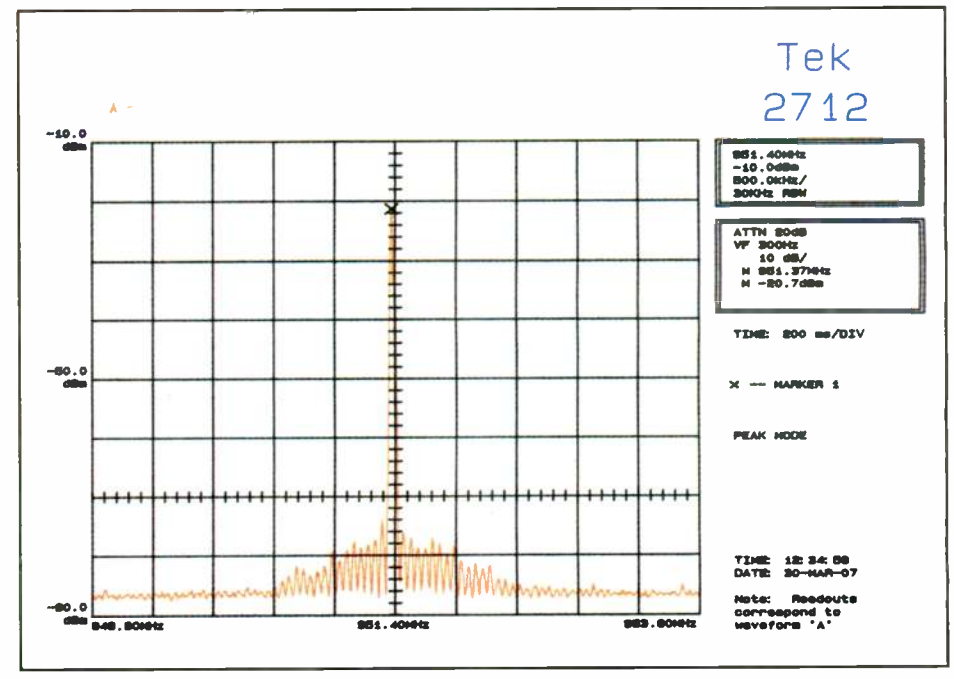

Fig. 2: Measurement of the AMR carrier attenuated to fit on screen.

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Liz

CONTINUED FROM PAGE 6

complaint had some merit.

National Grid contacted me so I could rendezvous with its meter reader, Liz, on her rounds in Walpole. I warned my staff to listen for program audio dropouts and to call me via cell phone the moment it happened.

Meantime, I brought along my Tektronix 2712 spectrum analyzer, operating it from an inverter in my vehicle. I scanned the RF spectrum near my tower sites on the hill and was able to see both the haystack-shaped signals coming from my two digital STL transmitters down at our Keene studios using a hand-held 900 MHz Yagi antenna.

Eventually, Liz met me with her AMR van. The moment she parked near our auxiliary tower, my cell phone rang. The stations relayed through that site were experiencing massive right-channel dropouts. And my spectrum analyzer display filled with grass! We finally had the smoking gun.

Liz graciously showed me her AMR equipment, turning it on and off as we looked at the BER alarms on the Moseley STL receivers — 100 percent correlation. The spectrum analyzer showed a very dirty signal coming from the van. The AMR controller screen indicated a carrier frequency of 952.406 MHz for its meter transponder wakeup signal, but the spectrum analyzer showed it to be smack in the middle of my upper-frequency STL haystack.

I was put in contact with a local engineer, who initially was not apt to take my complaint seriously. He did, however, confirm the use of AMR equipment in Walpole. Now there was reason to believe my complaint had some merit.

My 2712 analyzer has a precision frequency counter option with which I used to measure the AMR signal. The electric power meter reader was precisely 1 MHz off frequency at 951.407 MHz. Amazingly it was still triggering the kWh meter transponders. I only can surmise the transponders have very broad front ends and the dirty AMR signal was broad enough to trigger them from 1 MHz away. See Fig. 1.

The red traces are our STL signals including the analog return signal from our auxiliary site tower. The orange is the AMR wakeup signal with lots of trash. The higher frequency haystack is directly under the AMR carrier!

Even at a lower analyzer gain the AMR signal shows significant artifacts 60 dB below carrier level (see Fig. 2). Also note the rough on-screen frequency measurement of 951.4 MHz, which is clearly out of tolerance by 1 MHz.

RADIO SLEUTHING SAVES THE DAY

In conclusion, when we began to suffer what appeared to be random digital microwave radio RF interference problems, it looked to be an impossible problem. With some sleuthing and a bit of luck we were able to find the culprit and make definitive tests and measurements to identify the source.

I submitted a report to the power utility. They responded by promising to escalate it through management to get it resolved promptly.

As of this writing we've gone through one new meter reading cycle with no dropouts. And according to the status screens on my four Moseley Starlink STL receivers, post FEC uncorrectable errors for the month have been zero. So National Grid did make good on its promise and I can take one more nagging issue off my to-do list.

Ira Wilner is the director of engineering for Monadnock Radio Group, Saga Communications of New England. ■

MARKETPLACE

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WOR

CONTINUED FROM PAGE 1

gold-trimmed ceiling ornamentation in the lobby and stained-glass windows in most of our offices. It has the class that is WOR.

An agreement was reached and planning began.

BUILDOUT PLANS

Things began to move rapidly in the fall of 2004.

We decided to keep a good portion of the offices and the lobby as they were on the south side of the floor. We'd have to pretty much gut the west end, where producers and talent were to be located; the east end, where sales would be; and the north side, home of the studios and Master Control Room.

We decided to put the technical area, studios and Master on a 6-inch raised computer floor. This would facilitate wire runs and keep them out of the ceiling, which would be packed with air conditioning ducts.

That presented another problem: 111 Broadway is a landmark building, one of the original high-rises in Manhattan. There are strict conditions on what you can and cannot do to landmark buildings. The floor we would be on had louvers in place, which could be used for the studio air conditioning, but this space was limited and the air conditioning units barely fit.

For construction of the studios, we literally took a page out of the Lucasfilm THX manual and designed the studios to its specifications. They are constructed of two layers of 5/8-inch sheetrock attached to the studs, fiberglass insulation blankets, another set of studs (not connected to the first set of studs), two more layers of 5/8-inch sheetrock and Armstrong Soundsoak.

The sheetrock goes deck to deck and is sealed to the decks with sound-rated caulk. The ceilings are 2-inch thick fiberglass tile. The space above the ceiling is lined with "duct liner," a thick fabric normally used for lining air conditioning ducts to reduce noise transmission. The entire space is lined.

Fig. 2: The entry hallway into WOR's new location.

Fig. 3: This area would become the new master control room.

The air conditioning returns cascade through the studio ceilings. There is a duct in the shape of an "S" between each room. The "S" points down in one room, and points up toward the lining material in the next. All air conditioning ducts are lined. This has effectively kept noise transmission between rooms to almost zero.

One advantage the studios at 111 Broadway have over the studios at 1440 Broadway is that they have windows. Granted, they look out onto Thames Street, a very narrow street that runs between 111 Broadway and its sister building at 115 Broadway, but there are windows nonetheless.

The building replaced every window on the floor when we started construction. I distinctly remember the conversation with Rick Buckley about having to soundproof the windows.

I was not pleased with the street noise I was hearing through the windows. He responded, "This is New York. People are used to hearing noise in New York. It's not that bad." As luck would have it, the high school on Church Street let out just then and we could clearly hear every "F" word shouted. That would have played really well given the FCC's crackdown on obscenity.

We decided to leave about an inch or so of air space to the building's windows, and placed a 1/2-inch-thick piece of plate glass over the window in a frame. This effectively took the outside noise down a good 70 dB. It was fortuitous we did this. We were building in winter; as it turned out, in summer the restaurant downstairs hires local rock bands to play on Thames Street. That would have made the studios unusable.

We decided to go with Studio Technology furniture. Being in the Philly area, the company is local and can do the installation.

The company's Vince Fiola came in one afternoon to do a final measurement on the rooms to make sure our furniture would fit. This was before the computer floor was in; a mockup of the studio windows was in place. There was only one problem: the mockup looked too high in the wall between the control room and studio. Vince measured. It was a foot too high even when the computer floor was taken into account.

We called the architect and told him the window needed to come down a foot. He said he put it at that height so "if anyone puts stuff on the counter, it won't be seen in the other room." So I asked him what I was going to do about our five-foot-tall producer who wouldn't be able to see above the bottom window frame and therefore couldn't communicate with the host visually.

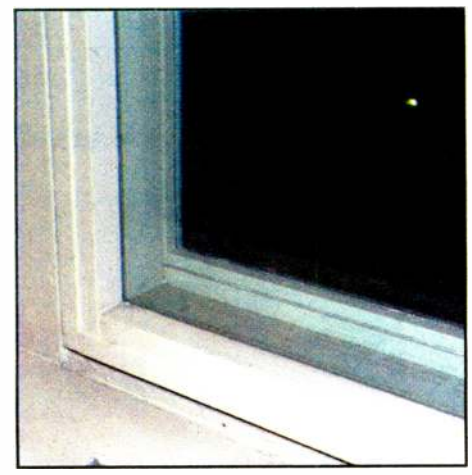

Fig. 4: This inside plate glass window reduced outside noise by over 60 dB.

Even though he had sat in on our studio operations at 1440, it didn't strike him that the personnel in the control room and the talent in the studio relied on seeing each other. I'm glad we caught this while it was only roughed in.

MOVIN' OUT

WOR wanted out of 1440 Broadway as soon as possible.

But because of construction schedules and the fact that Engineering is responsible for not only the studio area but all phone systems and computer systems — and because moving 100 people itself would be a major undertaking — we didn't want to attempt to get the studios online at the same time as the office move. It was decided to move the offices first.

We met with the local phone company, Verizon, and our reps from AT&T. The PBX is fed from four T1 circuits through AT&T. We needed two T1 circuits to ABC Radio Networks at 125 West End Avenue uptown for uplink of The WOR Radio Networks.

We needed two T1 circuits, taking completely different paths out of the city, to the transmitter site(s), one in Lyndhurst, N.J., and the one which was being constructed in Rutherford, N.J. We needed three other T1 circuits for the various POTS lines from AT&T. We needed about 18 POTS lines from Verizon. And we needed 30 ISDN circuits, as we use Telos TWOx12 phone systems and feed them with ISDN. Verizon got busy installing fiber and a multiplexer on the third floor.

While all the above was going on, it was time to figure out how to outfit the studios. I went to visit or talked with several major vendors, including in-depth conversations with Kirk Harnack, Frank Foti, Mike Dosch

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WOR

CONTINUED FROM PAGE 10

and Steve Church of Telos/Axia/Omnia.

I decided to take a chance on being the first large-scale integration of the Axia system. There were several things I liked about the system, among them having no single point of failure, being able basically to design the amount of redundancy I wanted into the layout, and having to only run one cable to each studio. This would be a major plus, as we were short on time and didn't need to run and punch down cumbersome multi-pair cables.

Plus, the Axia system interfaced directly with the Radio Systems StudioHub system, simplifying and speeding up installation as readily available off-the-shelf CAT-6 patch cords could be used to connect studio equipment along with Radio Systems XLR-to-RJ-45 dongles.

We also would need a systems integrator because of all the work that needed to be done with the office side, plus laying out of the studio side, plus having to constantly check on what was happening at the transmitter site, all on top of our busy remote schedule.

I chose Andrew Rosenberg from Creative Studio Solutions of Wheat Ridge, Colo., to perform the integration. I had worked with Andrew and knew that we could work well together, as I had specific ways I wanted certain things done.

In making this move we said goodbye to vintage models such as Pacific Recorders & Engineering System 1 consoles (*very* early serial numbers, like 1 to 5), a PR&E router/studio switcher and a 1A2 telephone system, etc. These items were installed in 1978.

Right after Christmas 2004, while the studios were still being put together construction-wise, we started integration.

Fig. 5: The new lobby entrance.

Fig. 6: The author in a soon-to-be completed Studio 4.

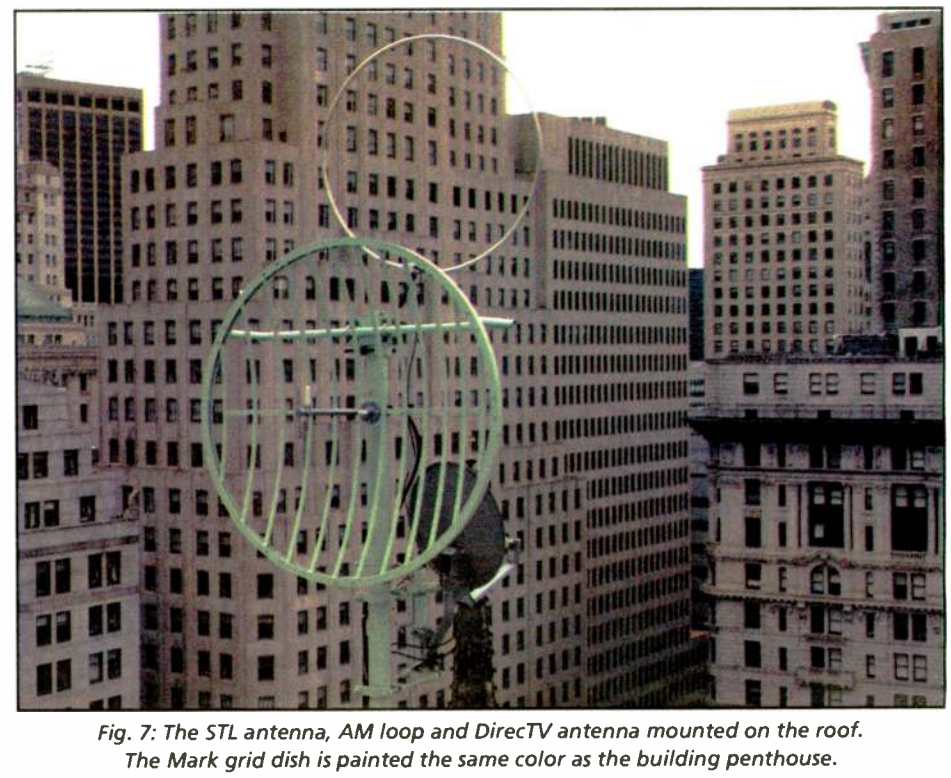

Fig. 7: The STL antenna, AM loop and DirecTV antenna mounted on the roof. The Mark grid dish is painted the same color as the building penthouse.

BACK TO THE OFFICE

Because the studios would be remaining at 1440 Broadway to start, certain personnel would be left up there, among them the program director, the producers and talent, the operations director, the news department and the technical shop. The PBX would be moving to 111 Broadway with the offices, so we needed a plan where people would still have telephones. The studio call-in lines would not be a problem, as they were separate from the PBX.

We ordered in 35 Centrex lines from Verizon with voice mail attached. When the PBX moved, we would cut over these lines to the remaining phones, then "sling-shot" the normal phone numbers for the persons left at 1440 through the PBX. In this way, there would be no number change for anyone dialing those left behind.

All phones and computer network connections in the office areas were pre-wired before anyone moved, including several WiFi access points. We mapped out the PBX and made sure that the wiring to the punch blocks matched up with the correct extension numbers.

Meanwhile, construction on the office area was nearly complete, and we were ready to move the offices. On Friday, Feb. 25, 2005, everyone who was making the initial move was told to pack up; at 5 p.m. the PBX was disconnected.

The trucks were being filled all day. It still took two hours from the time the PBX was disconnected until it rolled out of the freight elevator at 111 Broadway (keep in mind the new location is only 3.6 miles from the old location). The PBX was connected, the T1s lit up and a call to AT&T showed that all was well.

The following day, Saturday, we spent plugging in phones, correcting any errant wiring and getting computers up and running, while the staff set themselves up. First day of business at 111 Broadway was Feb. 28, 2005.

Meanwhile Creative Studio Solutions was making progress on cable runs and putting things together in the studios. I tackled Master Control and started populating racks. Axia was on site briefly to get us going with the system, but we were far from ready to program things and make them work.

We determined early on that we would not be able to see the transmitter site from our new location. We rented space on 4 Times Square for an STL repeater and planned to shoot through a narrow window up to Midtown, then over to Jersey. I found what could be the last available STL frequency in the city for the link to 4 Times Square.

The T1s to the transmitter sites were installed. We brought the backup Intraplex unit over to 111 Broadway and were soon "talking" to Jersey. All of our satellite equipment is at the transmitter, so "Y" adaptors were added to feed both Intraplex units. We now had external audio coming into the studios! We could play and start programming the Axia system.

STILL MUCH TO DO

They say the devil is in the details, and that is exactly what needed attention.

Arrangements were made to put the STL antennas on the roof of 111 Broadway and 4 Times Square, and get the link from 111 Broadway aimed. However, we wouldn't be able to aim the link from 4 Times Square to Jersey until last minute. All this was done by the first week of April, and the link to Jersey was aligned the Friday morning of the studio move at the end of April.

We were using Axia Pathfinder as a studio switcher, and right after NAB, John

SEE WOR, PAGE 14

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There's a reason why more of the world's powerhouse AM radio stations have turned to Omnia processing...It just sounds better! Additionally, Omnia continues to lead the industry with constant innovation. We pioneered the first non-aliasing digital clipper. (Some still feel it's the only one!) We introduced combo processing for HD-AM broadcast – dedicated processing for conventional AM, as well as a separate processor for HD Radio.

Omnia.5EX HD+AM has a powerful toolbox. 5-Band limiting for conventional analog transmission, along with a powerful oversampled, distortion-controlled, non-aliasing clipper that delivers loud, clean, and competitive audio. Output filtering that is suited for NRSC, ITU, or HD Radio requirements.

Processing for HD Radio/DRM is smooth and clean, thanks to a precision look-ahead limiter that reduces unwanted intermodulation distortion (IMD). This enables one box to generate two incredible sounding signals.

And for convenience, Omnia.5EXi HD+AM offers built-in Diversity Delay, which reduces redundancy, and points of failure in your transmitter plant. (BTW: It was our idea to put the Diversity Delay in the audio processor.)

Analog or digital, it doesn't matter. With Omnia.5EX, your signal will be remarkably clean and clear, with punch and presence that makes AM radio come alive!

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WOR

CONTINUED FROM PAGE 12

Makely, Mike Dosch and crew arrived for the final touches. We spent countless late hours designing paths, testing studios, testing switching, deciding what sources each studio needed access to and creating those sources in the system.

WOR has unique uses for Pathfinder. This is a talk station; we don't believe in dumping delay unless someone says something really bad. We'll bleep out the word or the offending call letters of our competition.

At 1440 Broadway, we had an analog switcher in the delay line in each studio. If something needed to be bleeped, the operator would monitor the outgoing audio; press the bleep button, which would put an oscillator on the air; and release the bleep button when it was safe to do so, putting program audio back on line.

Having everything in the digital domain would not allow for analog switching. The Axia crew designed a method for Pathfinder to intercept the button press for a bleep, determine if this studio were on the air or feeding one of the WOR Radio Networks, and route a bleep tone to the appropriate output buss. When the operator releases the button, Pathfinder remembers which studio was on what buss and puts the studio audio back online.

We also use Pathfinder to create various intercom paths such as giving the producer direct access to a talent's headphones. This is possible through the GPIO nodes in each room.

Fig. 8: Lynn White and Ellis Henican of 'Henican and White' in the new Studio 4.

We have Pathfinder route the cues for The WOR Radio Networks from the studio or ENCO system to the cueing encoders, which feed to ABC and then to the local station's StarGuide receiver. This was a big change from 1440 Broadway, where we generated sub-audible tones in each studio, which were decoded in Master, then pulsed the cueing encoders to ABC. Because we operate a live show in profanity delay, the cue buttons in each room are routed through the AirTools delay units, which will delay contact closures by the delay amount.

This solved another problem we had at 1440: We couldn't go to break on either network if we dumped delay and were ramping back in. The delay units would pitch shift the sub-audible tones just enough that they would not decode in Master. By being able to send straight contact closures and have them delayed correctly, life has been made much easier.

DIDN'T MISS A SECOND

WOR uses an ENCO Digital Audio Delivery system, which was not replaced for the move.

On the Thursday before the move, we brought the backup server to 111 Broadway. Operators were busily making backup CDs of the entire log for Friday night, Saturday, Sunday and Monday, just in case. We also planned on operating with entirely recorded programming after the morning show on Saturday, and again on Sunday, so we wouldn't have talent tripping over us and vice versa. Only the newscasts would be live.

ton to switch locations.

Bob Gibson had the final words from 1440, announcing that he was doing the final newscast from those studios, ending with, "And you're listening to WOR, New York." The operator hit the button on the remote control, the audio switcher at the transmitter site switched to the Intraplex from 111 Broadway and the new facility was completely on the air at 12:06:40. We missed zero airtime.

And then there was sadness. I visited the 1440 location near the end of the first week of May to make sure everything that needed to be saved was out of the racks and my old office, which I hadn't seen since January. It was sad looking at the original, 25-year-old Pacific Recorders consoles that would be sent to the dumpster.

It was amazing to see the bundles of wire in the racks. God knows how any equipment ever fit in there. There had been a tremendous amount of history for WOR at 1440 Broadway.

IF THESE WALLS COULD TALK

WOR had been located at 1440 Broadway since the building was new: 1926. Over the years, we had been on various floors, had an associated FM — WOR(FM), now WRKS, Hot 97, and owned by Emmis — and a TV station — WOR(TV), now WWOR(TV) Channel 9 and owned by Fox. WOR had been on the 23rd floor since 1978.

WOR was one of the founding stations of the Mutual Radio Network; "The Cisco Kid" was originated at the WOR studios, along with many other programs during the Golden Age of Radio. Incidentally, WOR originated the first broadcast of the Columbia Broadcasting System from the WOR studios in the late 1920s, with a temporary control room set up in the men's room (seriously).

Though the architect had sat in on our studio operations at 1440, it didn't strike him that the personnel in the control room and the talent in the studio relied on seeing each other.

On Friday morning of the move, after the morning show signed off the air, we disabled several studios at 1440 and brought the ENCO workstations, which were freed up to 111 Broadway.

After the ENCO workstations were connected and levels verified, we had the operators come in and touch the consoles, the first time they had been able to do that. Talent came in and got used to the sight lines and the sound of the new facility. What could be packed up at 1440 in the studio area, was. The producer's desks and other areas were not a problem to pack.

On Saturday, April 30, 2005, I called ABC Satellite Services at 10 a.m., and they cut WOR Radio Network One over to 111 Broadway. The first program aired on WOR Radio Network One at 10:06:40.

At 11 a.m. I called ABC again, and we cut over Network Two. At 11:06:40, both WOR Radio Networks were operating out of 111 Broadway.

I called Master at 1440 for the last time at noon. Near the end of the live newscast, I told the operator to position the mouse over the correct button on the transmitter remote control screen, as with the HD delay, I wouldn't know when to hit the button.

I think of John B., John A. and John R. Gambling (father, son and grandson); Vincent Price; Frank Sinatra; Arlene Francis; Bernard Meltzer; Barry Gray; Larry King; Bob Grant; Joan Hamburg (who is still here); Dr. Joy Browne (also still here); The Fitzgeralds; and Bob & Ray.

When we pulled apart Talent Studio 2, we found a strange thing across the mic circuit. I was told it was Bob & Ray's telephone filter, to make one of them sound like they were on the phone when they were doing bits.

Other people who had spent time at WOR: Leonard Nimoy; Hillary Clinton; Gene Simmons; Joan Rivers; Neil Sedaka; Diana Degarmo of American Idol; Joe Franklin (a name you may have heard on the Simpsons; Krusty the Clown is usually interviewing Joe when Bart is channel surfing); just about every star on Broadway; Henny Youngman; and Dee Snyder of Twisted Sister. To name a few.

Paul Stewart was chief engineer when the facility was built. Other engineers have included John Lyons, Herb Squire, Art Marko, Mario Sfogliano (still here) and many others in New York.

SEE WOR, PAGE 16

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

(Just add Cisco.)

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

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

Automation station • Wouldn't it be cool to have a **self-monitoring air chain with silence-sense** that can fix problems the ... [illegible] ... To be able to switch your program feed from Studio A to Studio B with one button? Or build custom switching apps and scheduled scene changes based on Boolean logic and stacking events? PathfinderPC software does all these things and more. But unlike HAL 9000, it doesn't talk back to you.

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

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

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

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

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

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

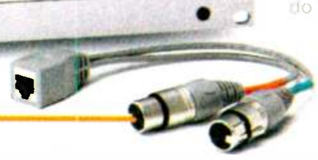
AES yes • You like your audio to stay digital as much as possible, right? We get that: our AES/EBU Audio Nodes let you plug AES3 sources right into the network. Studio-grade sample-rate converters are inside: anything from **32 kHz to 96 kHz** will work. Oh, and there are 8 AES ins & 8 AES outs in each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

Heavyweight champion • This Axia StudioEngine works with our Element Modular Consoles (the fastest growing console brand in the world) by the ... [illegible] ... multiple simultaneous inputs and outputs, mix audio, apply EQ, process voice dynamics, and generate multiple mix-minuses and monitor feeds on-the-fly. To make sure it delivers the reliability and ultra-low latency broadcast audio demands, we powered the StudioEngine with a robust version of Linux — so robust that **total input to output latency is just a few hundred microseconds**. ... [illegible]

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

You got to have friends • ... [illegible] ... products like ENCO, Prophet, BSI, BE, MediaTouch, DAVID Systems and more all have products that **work directly** with Axia networks. So do hardware makers like AudioScience, International Datacasting, 25-Seven, Telos and Omnia. Check out the whole list at AxiaAudio.com/partners.

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



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Routing

WOR

CONTINUED FROM PAGE 14

In the movie "Ghostbusters," Larry King is seen on the air in a radio studio talking about the ghost infestation. The studio you see is the former Talent Studio 3 at WOR at 1440 Broadway.

A baby elephant even visited the WOR studios. It was arranged as a joke for John A. Gambling by the staff when Ringling Brothers was in town. They brought it up in the freight elevator and it stunk up the place.

So there was a sense in the move that it was the end of an era.

The studios had been designed for a different era of talk. The rooms were oversized for their use and for a time when you had a bunch of people working on one show. The talent who had passed through those rooms over the years is mind-boggling, as is the fact that a facility built in 1978 was still on the air —sounding good — and the equipment still worked when it was common to have all studios doing something practically 24/7.

Among the news stories that were covered at 1440 was the opening of the George Washington Bridge in 1931; the stock market crash of 1929; World War II (the bombing of Pearl Harbor was announced during a football game); the Korean and Vietnam wars; the homecoming of the Iranian hostages; the election and assassination of John F. Kennedy; the resignation of Richard Nixon; a man on the moon; several epic power failures in New York City; the Beatles; and most likely the opening of the Empire State Building.

Also covered: the World Trade Center bombing in 1993; the attack on the World Trade Center on Sept. 11, 2001, when we watched the towers collapse from our newsroom windows 3.4 miles away; and every Macy's Thanksgiving Day parade that passed by the 1440 Broadway studios from when Macys started them. (Macy's may have started them before 1926, but when WOR was located to 1440, they would have been covered.)

Engineering "firsts" at 1440 include the development of the digital profanity delay, which was tried and perfected using the WOR studios, and experimentation with stereo transmission, with one channel on WOR, the other on WOR(TV).

GENERATOR GYMNASTICS

I wanted to install a 50 kW generator on the roof of the building but there was a problem.

There are subway lines running under Church Street in the rear and Broadway at the front of the building. The Trinity Church graveyard is on the south side, and Thames Street is too narrow for a crane. Because of the subway lines, a crane is not allowed on Church Street or Broadway. Any generator would need to be disassembled and brought up the freight elevator. And a 50 kW unit wouldn't fit. A 35 kW unit would.

So we installed a 35 kW unit with a 125 gallon diesel tank under it. There are no natural gas pipes going to the roof of the building, and the city only will allow 125 gallons of diesel. Propane is a no-no.

It was quite the sight, seeing this genny dismantled, crammed into the elevator, removed on the 21st floor, then hoisted with a block and tackle one flight to the roof.

Incidentally, we have used it twice, as the building had to replace two 5,000 amp switches for the electric utility in the basement — switches that had been in service since 1919! We discovered that 125 gallons will last in excess of 45 hours under full load.

To refuel, we need to bring the diesel up the freight elevator in 5 gallon cans. We can bring it as far as the 21st floor, then carry it up one flight to the roof.

We found a few quirks along the way, the funniest of which was the newsroom.

Originally, we were considering doing newscasts in the center of the newsroom, but it is too noisy. So rather than build an edit booth in News, we chose to use it as the air studio.

No one noticed that on the other side of the wall in this booth is a bathroom. You can imagine the look on everyone's face in Master Control the first time someone in the bathroom flushed the ol' commode and we heard it on the air.

Needless to say, there is now a modified on-the-air light in the bathroom that says "Don't Flush" when the newscaster's mic is on.

Another quirk is that with the AM loop antenna on the roof pointed in the direction of the transmitter site, we have absolutely no signal. The antenna is 45 degrees off-axis where the signal peaks. All I can figure is that it is some phenomenon with the way the signal propagates around the buildings.

SUMMER IN THE CITY

Summer of 2005 arrived with a very hot spell — and it got very hot in the studios and Master Control room. Something was obviously wrong. And what was wrong was that the air conditioning engineering firm screwed up.

When we were planning, I repeatedly told them I wanted 20 tons of air conditioning for the studios and Master. They repeatedly asked for heat load on all pieces of equipment — impossible for something like a CD player or computer. The manufacturers just don't provide that information.

So I added up the total power consumption of everything in the room and presented them with a number in kilowatts for just the equipment, as a piece of equipment can't generate any more heat than the number of watts it is consuming. This did not include a calculation for people or the sizes of the rooms.

The HVAC engineers had only put 10 tons of air conditioning in. They had no clue as to what was really required.

I did the calculations and determined that the 10 tons that were installed were perfect — for the studios only. Add Master Control and the newsroom to the equation, and we were 5 tons short.

We decided to tap into the building's cooling water supply and use a water-cooled air conditioner to feed the Master Control Room and News. The existing units were rerouted to feed only the studios.

We also found that we needed to install filters between the outside air and the air conditioning units. The air in Manhattan is so dirty that the condenser coils were becoming clogged and severely reducing efficiency monthly.

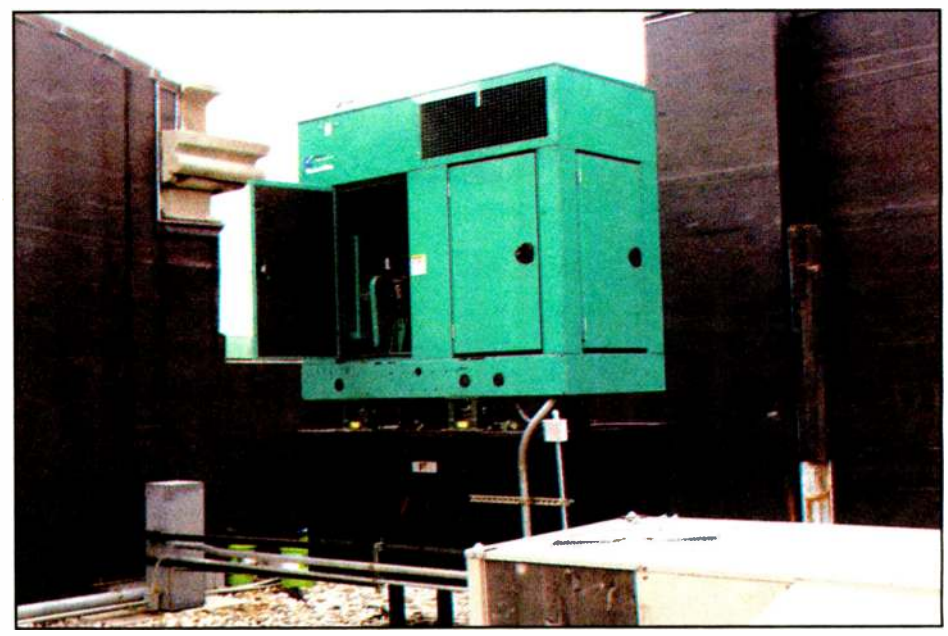

Fig. 9: The generator sits in the southwest corner of the roof, hidden by the façade.

IT-BASED OBSERVATIONS

The overall experience using an IP-based system has been very positive. The flexibility is wonderful. This became obvious when "The Dr. Joy Browne Show" started simulcasting with Discovery Health television. The TV crew wanted all the mics, the telephone mix and certain other items in the studio broken out: seven items in all. I simply handed them an Axia audio node, programmed seven outputs and made them very happy. No multi-pair, no rewiring.

It also is easy to reconfigure the system in any way with a standard Web browser. We can check system parameters on the audio engines this way, add or subtract what the operators can see for sources and change monitoring assignments. Each operator can set up his console the way he likes it for his particular show, then simply load his or her own profile when they set up a studio. It has proven to be a good choice.

From concept to on-air, we built an entire facility in six months. The facility is working out well and gives WOR the flexibility for whatever may come down the road.

There was a lot of history that happened at 1440 Broadway. It is indeed the start of a new era. Building this facility, we needed to keep the historic and proud past of WOR in mind, but I did not feel I had a ghost looking over my shoulder, as I would have if we had rebuilt the studios at 1440.

Thomas R. Ray, III is the vice president/corporate director of engineering for Buckley Broadcasting in New York.

This article was adapted from a paper presented at the NAB2007 Broadcast Engineering Conference. ■

Sit a Spell With Tom Ray

When you work around the studios of a legacy New York AM, you encounter notable names and learn lots of history. WOR's resident raconteur shares:

• "CBS and NBC were up around the upper 40s/mid 50s (street reference) in the 1930s. It was very common for an actor to have bit parts in several radio productions on the same night, sometimes during the same time period. They would sometimes do a line or two at NBC, then hoof it over to CBS, arriving in time to do a line or two on another program during the same time slot.

"WOR was at the southern end of Times Square. The actors who would need to shuttle to WOR would sometimes hire off-duty ambulances to get them from the 50s to 40th and Broadway ... and many would literally walk in barely in time to deliver that one line." ...

• "To this day, you never know who you're going to bump into in the hallway.

"I walked through the lobby one time at 1440 and Richard Simmons was sitting in the lobby. I was limping, as I had pulled a muscle in my back.

"Simmons immediately piped up, "Oh, what's wrong? What DID you do? C'mon ... on the floor ... we're going to exercise that limp out of you."

"He and I were on the floor, in the lobby, doing leg lifts to stretch the muscles. I'm glad no one had a camera handy.

'Franklin Delano Roosevelt dedicated and opened the George Washington Bridge in 1931, and WOR was there with not one but three microphones to capture the event. In 1935, FDR threw the ceremonial switch that brought WOR to 50,000 watt class,' said Ray.

• "I also have a Gene Simmons story. I had a friend whom I had met in middle school. Chris Williams unfortunately passed on at the age of 42 from throat cancer (he never smoked). He was THE ultimate fan of the group KISS.

I found out Gene was going to be on 'The Joan Rivers Show' one night, so I bought his book and offered to greet him — the intent being to have him autograph his book for my friend's last Christmas. Gene showed up an hour ahead of time.

"So I brought the book in, asked him to autograph it and told him about Chris. Then I figured, all he can say is no, so I asked if he'd give Chris a call. He called Chris (who initially thought it was me screwing around) and talked to him for 15 minutes. Chris at this point could barely croak out words [due to his illness].

"When he got off the phone with Chris, Gene put his head down and cried. Yes, the big bad rocker Gene Simmons.

"Chris talked about that phone call until the day he died."

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- Display real time measurements and plots on the PC
- Control the analyzer from the PC
- Firmware updates via PC
- MiniLINK USB interface is standard on AL1 Acoustilyzer

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CONTINUED FROM PAGE 4

stream indirectly dictates the digital symbol rate. Disciplining the exciter with a second GPS receiver at the transmitter site does allow for effective frequency synchronization and relieves STL requirements somewhat. However, this approach increases the overall component count and does not control digital signal throughput delay.

This synchronization requirement fundamentally differs from standard network communications, where data exchanges are often flow controlled by the receiver as in the case of TCP/IP, where transmission rates are controlled by the receiver's ability to receive more data. While synchronization units could be placed at both locations, only placing it at the transmitter site would require a bidirectional STL in order to rate-control the studio. Placing the synchronization unit at the studio accounts for unidirectional STLs and allows for the extension of the architecture to synchronize multiple transmitter sites simultaneously.

Fig. 2 depicts a source-synchronous clocking scheme operating across an asynchronous transport medium, such as an Ethernet or IP-based link, which recovers the source processing rate in order to rate-lock the digital modulation process.

The system is disciplined by a high-quality reference frequency, such as the 1 Hz signal generated by a GPS receiver; all other processes fall into place with respect to this reference signal. The audio feed is re-sampled to ensure frequency stability. The re-sampled audio feed is encoded and other digital processing is applied to create the data stream to traverse the link. After a fixed number of audio samples, clock packets are inserted into the data stream.

At the transmitter site, the exciter uses the clock packets to: a) recover the studio's processing rate by a frequency-locked loop or a phase-locked loop to reject high-frequency clock packet jitter introduced by the link; and b) maintain a constant throughput delay by estimating an appropriate starting time based on averaging an initial number of clock packets.

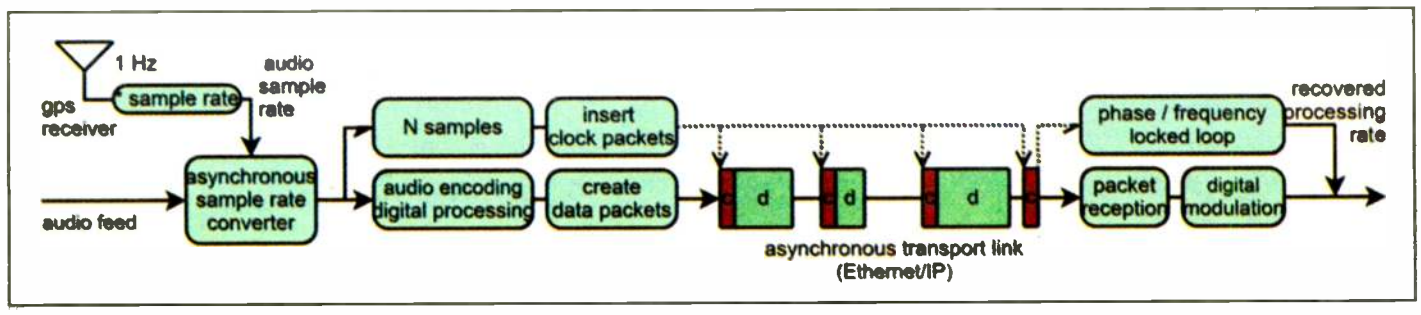

Fig. 2: Source Synchronous Clocking Across an Asynchronous Data Link

Clock packet jitter normally falls in the range of milliseconds, but in extraordinary circumstances can be as high as several seconds or more, depending on the situation and type of STL. Therefore, it is not prudent to determine the initial digital modulation based on a single link-dependent event. A phase-locked loop can correct for this initial phase offset error, but a frequency-locked loop will maintain this error indefinitely.

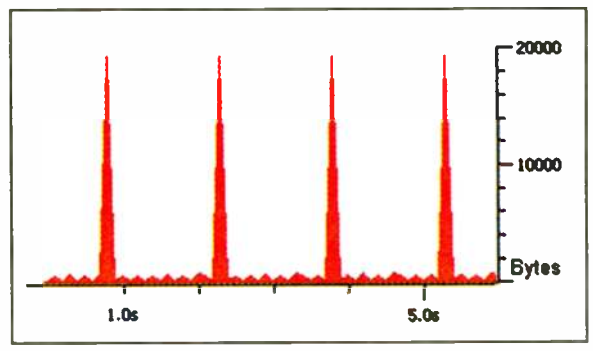

Fig. 3: Service Mode 3 Bandwidth Utilization

Exciter synchronization does not generally care about link throughput delay. It will, however, react to long-term changes in throughput delay. STLs that adjust modulation schemes dynamically based on transmit conditions are generally undesirable for this application.

Using separate clock packets minimizes the impact of packet serialization delays through a smaller packet structure. However, in order for clock packets to represent a true measure of throughput delay, the intermediate data packets must not impact clock packet timing, so we can determine a dedicated link bandwidth rate of:

$$\text{dedicated link rate} = \frac{8 \times \max(\text{data bytes})}{\text{clock packet period}} \text{ bps}$$

A lower link rate may be sufficient to transmit the average data stream, but significant delays are then added to the clock packet stream making it very difficult to meet the Ibiquity-defined synchronization requirements (see ref. 1).

EXPORTER TO EXCITER PROTOCOL

The data stream protocol between the Exporter and exciter components is termed the E2X protocol and is defined as part of the standard IBOC Radio System Broadcast Architecture. It implements a source-synchronous clocking scheme similar to the one described in the previous section. The FM IBOC system transfers its payload data in Layer 1 frame intervals of 1.48 seconds. This frame is broken into 16 data packets sent after a clock packet sent every 92.8 ms. However, the payload is not evenly distributed across all 16 data packets in the L1 frame as shown in Fig. 3.

With a maximum data packet size ranging from 18,788 bytes to 19,330 bytes, the minimum dedicated link bandwidth is around 1.5 Mbps using the relationship developed in the preceding section. Even though these data packets are broken into smaller IP packets they are delivered to the STL at the same time, creating a temporary congestion condition. On a 256 kbps link, this congestion period can be around 600 ms affecting several subsequent clock periods. The exciter's receive buffer must be sufficiently deep to absorb this data imbalance; a receive buffer of at least one Layer 1 frame of 1.48 seconds is recommended, bringing the overall analog-to-digital delay to just under nine seconds.

The E2X protocol follows the standard Open Systems Interconnection (OSI) networking model and limits itself to the application, presentation and session layers. It assumes standard Ethernet technology for the physical and data link layers, but intermediate links do not strictly have to be Ethernet, such as E1/T1 links.

The Internet Protocol (IP) is employed for the network layer. E2X initially only supported the User Datagram Protocol (UDP) as a transport layer protocol, which is a fire-and-forget best-effort protocol that does not guarantee data delivery. UDP can, however, address multiple destinations at once through the use of broadcast or multicast communications and also works on unidirectional STLs. The transmission control protocol (TCP) is in the process of being adopted by the E2X protocol, but at the time of writing is not yet fully supported. TCP does offer guaranteed ordered end-to-end data delivery, but is limited to point-to-point communications and requires a bidirectional link.

UDP is widely used in many E2X deployments, so it is of interest to investigate the associated STL quality requirements. A single bit error on the STL can cause an entire data packet to be dropped, which affects an entire L1 frame in the IBOC data stream causing a 1.48 second audible HD outage. The main HD program may blend back to the analog audio transmission, but secondary programs and data services experience an irrecoverable interruption.

Bit error rate is not an adequate measure for quantifying STL requirements in a networking environment, as many types of packet loss in a network are not directly related to bit errors. However, bit error rate is a convenient measure to assess protocol performance and provides a guideline for an appropriate signal-to-noise ratio on an RF-based STL.

If we define the delivered quality of service (QoS) as the ratio of flawless transmission over the total transmission time, then we can define the allowable mean time between failures (MTBF) as:

$$\text{MTBF} = \frac{\text{error duration}}{1 - \text{QoS}}$$

$$\text{MTBF} = \frac{1.48 \text{ s}}{1 - 0.99999} = 148{,}000 \text{ s}$$

The required bit error rate to sustain this quality of service is then:

$$\text{BER} = \frac{1}{\text{MTBF} \times \text{bit rate}}$$

$$\text{BER} = \frac{1}{148{,}000 \text{ s} \times 115{,}503 \text{ bps}} = 5.85 \times 10^{-11}$$

SEE E2X, PAGE 20

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This means an interruption of service roughly every 41.1 hours in the digital service. The bit error rate can be converted into a packet loss rate of about 4.22×10^{-7}. Ibiquity recommends a maximum packet loss rate of 10^{-5}, which may cause several interruptions every hour (see reference 1).

As shown, the performance requirements on the STL in a UDP type environment are very stringent. We can use either forward error correction (FEC) or automatic repeat requests (ARQ) to effective reduce the required bit error rate.

FEC adds redundant information into the data stream that allows the receiver to reconstruct the original message with corrupted or missing message parts. This technique adds additional bandwidth requirements to the data stream regardless of the actual error rate. Forward error correction works well on the physical link level where many bit errors can be present, but only provides diminishing returns in environments of lower bit error rates.

ARQ, on the other hand, relies on error detection at the receiver and issues a retransmission request back. This only requires additional bandwidth in the case of detected bit errors. This scheme, however, requires a feedback path in order to issue retransmission requests. Even a single retransmission of a bit in error can greatly improve the effective bit error rate.

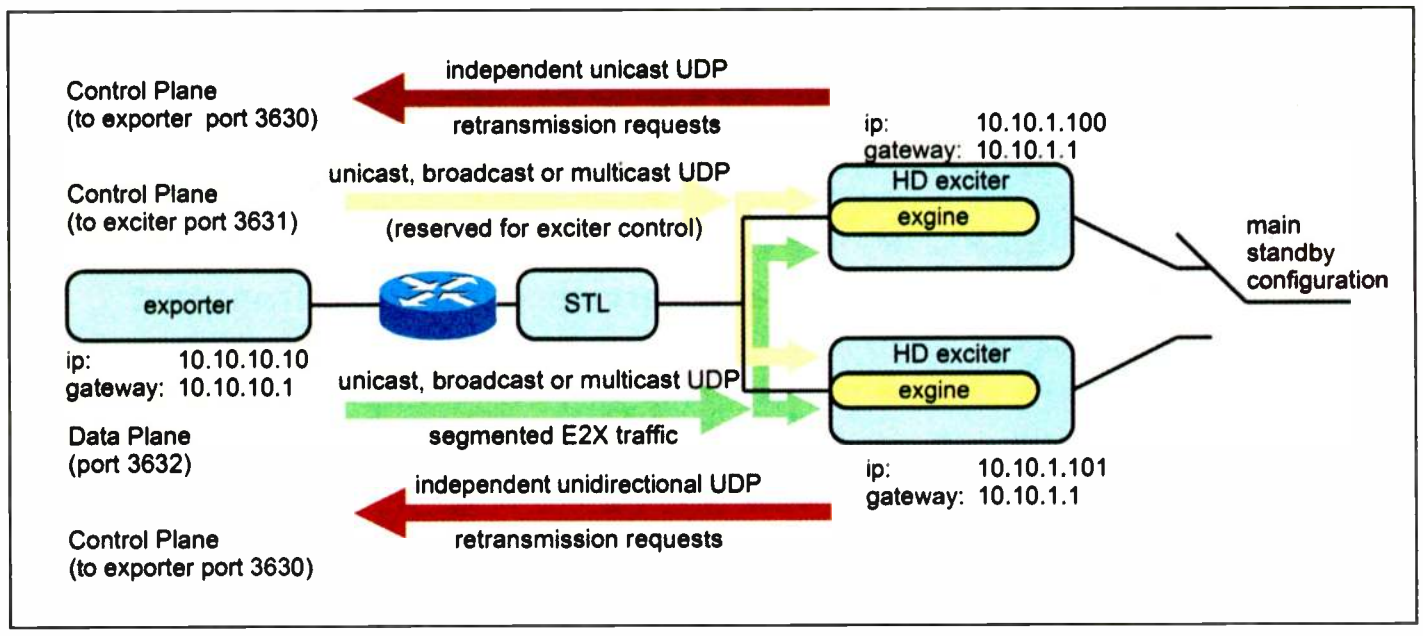

Fig. 4: E2X Transport Protocol for Main Standby Exciter Operation

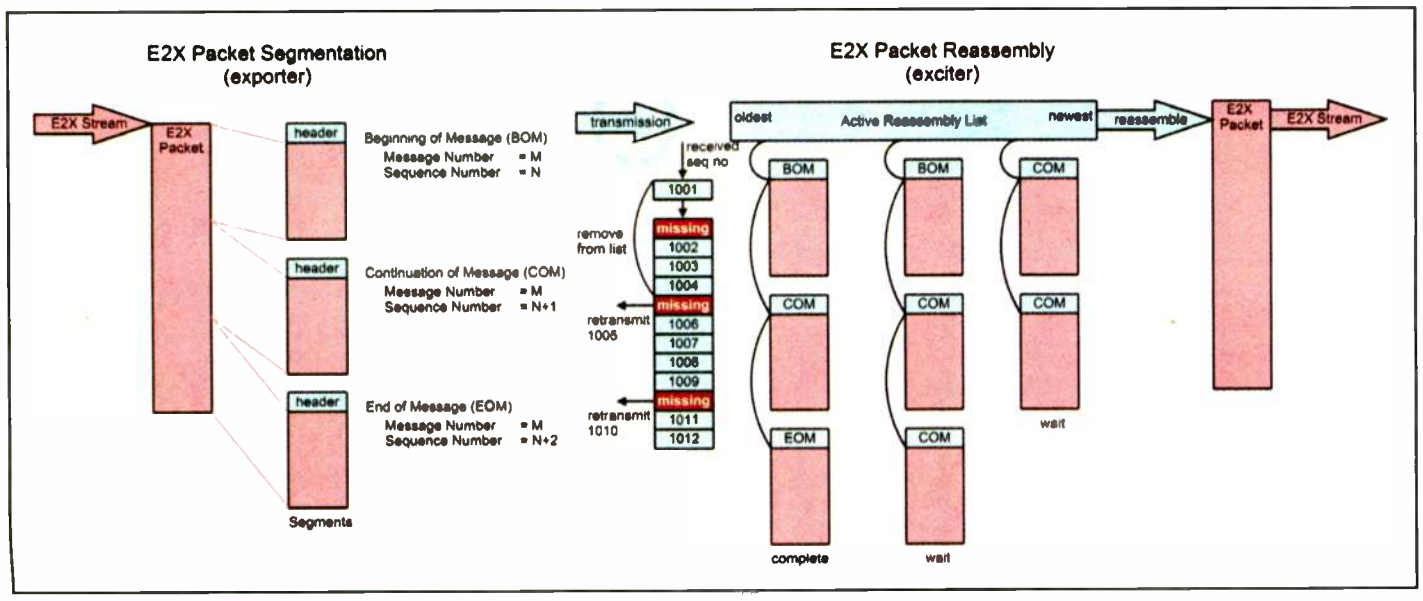

Fig. 5: E2X Packet Segmentation and Reassembly

E2X TRANSPORT REQUIREMENTS

The third-generation radio broadcast architecture is confronted with the challenges of high-performance, real-time data streaming. Good networking practices can ease the presented challenges. However, the problem is that there is no established transport protocol that adequately addresses all the requirements of the E2X protocol.

The E2X protocol poses the following transport requirements:

- Some packet types of the E2X protocol, such as the initial control packet that carries critical system information, require guaranteed delivery reliability in order to start digital modulation.
- E2X data packets only convey meaningful information prior to the time they are intended to be on air. Retransmission requests beyond that time are futile and waste valuable bandwidth resources. A late delivery is essentially a packet discard.
- It is undesirable to retransmit any E2X clock packets, as any retransmission introduces a throughput delay measurement error. Depending on the implementation of the clock recovery circuit, most designs can handle lost clock pulses better than incorrect clock pulses.
- The protocol requires a very high degree of reliability in order to maximize the mean time between HD dropouts. If the transport protocol cannot provide an adequate degree of reliability, then the physical link layer is responsible for reliable data delivery instead.
- Clock packet delivery must not be impacted by the transmission of any other data traffic on the link including E2X data packets.
- Unidirectional and bidirectional STLs must be supported.
- Multiple destinations should be addressable to support multi-exciter configurations, as well as multi- and single-frequency networks.

A NEW E2X TRANSPORT PROTOCOL

Looking at this list of requirements it is apparent that neither TCP nor UDP adequately cover all items on the list. Nautel has implemented a new transport layer protocol that addresses the E2X protocol transport requirements and allows multiple exciters to synchronize to the same Exporter synchronization stream while providing reliable data transfers to each destination.

The proposed E2X transport protocol implementation is layered on top of UDP, as UDP allows broadcast and multicast communication. The protocol is best illustrated by looking at a main/standby exciter configuration across a generic STL, as shown in Fig. 4.

The protocol is broken into a control plane and data plane. The data plane carries the encapsulated and segmented E2X protocol to both exciters. The Exporter can directly communicate with a single exciter using unicast IP, which directly maps a single IP address, such as 10.10.10.100 to a unique MAC address, such as 00:50:C2:59:70:8C.

To address multiple exciters simultaneously, the Exporter must resort to broadcast mode (without an intermediate router), directed broadcast (through the router) or multicast IP to address only a subset of exciters.

The control plane communication from the exciters back to the Exporter is always unicast directly to the Exporter. In the case of a unidirectional STL, this communication stream will not make it back to the Exporter, so the transport protocol cannot make the assumption that retransmission requests will in fact reach the Exporter.

Some packet types, such as the Exporter's control packet, require guaranteed delivery in order for the exciter to start modulation with correct operating parameters. Allowing exciters to start using locally stored operating parameters can cause a configuration mismatch between Exporter and exciter. Rather than relying on stored parameters, the E2X transport protocol maintains a copy of the most recent control packet and periodically retransmits the control packet to the exciter.

Using this configuration, HD exciters are ready to transmit HD and the digital modulator is not aware whether it is active or in hot-standby mode. The Exporter also is not aware which exciter is currently active. Both exciters independently issue retransmission requests back to the Exporter. If only a single exciter has lost a packet, it will issue a corresponding retransmission request. If both exciters lose a packet, both will issue a retransmission request but the Exporter will only retransmit the same data packet once if requests have been received close enough in time.

Retransmitted packets are delivered to both exciters just like a regular data transmission. An exciter knows based on sequence numbers whether it has already received a packet and will discard duplicate data packets. Retransmission requests are made continuously until the data packet arrives or until the operation times out, accounting for the fact that retransmission requests themselves may be lost.

This approach not only allows for redundancy in the exciters, it also allows the entire data path between Exporter and exciters to be split and made redundant.

E2X SEGMENTATION AND REASSEMBLY

The mechanics of the actual data transfer are shown in Fig. 5. In a real-time data stream, control over the packet's payload size is crucial in order to guarantee a reasonable quality of service. Hence, the arbitrary length E2X packets are broken up into smaller segments with their own header information. Sequencing information in the header allows the segment to be related back to the original E2X packet.

The transmission path across the link may discard individual segments or reorder segments. Any segment that is received is queued in the active reassembly list in accordance with its message number carried in the segment header. Once every segment in a reassembly list is sequential and the list consists of at least one beginning of message (BOM) and end of message (EOM) segment, the reassembly process is complete. The reassembled E2X packet is passed along to the digital modulator for processing.

Every sequence number that is received at the exciter gets entered into an ordered sequence number list. After entering the sequence number, the list is collapsed up to the next missing sequence number or to the end of the list. Now this list can be looked at to determine what sequence numbers to retransmit.

SEGMENT SCHEDULING

Segmenting the E2X data stream does not provide any benefits in and of itself, as UDP does precisely the same function already. What complicates the situation is the fact

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that most STLs operate at a much lower network bandwidth compared to most LAN deployments. Consequently, segmented packets will likely be placed on first-in first-out (FIFO) queues, effectively negating the effect of segmentation unless the STL provides more sophisticated queuing.

Fig. 6, however, presents the queuing structure employed by the Nautel Reliable HD transport protocol. On the Exporter every new E2X packet is segmented right away, and resulting segments are placed on the main queue and each segment is treated independently from thereon.

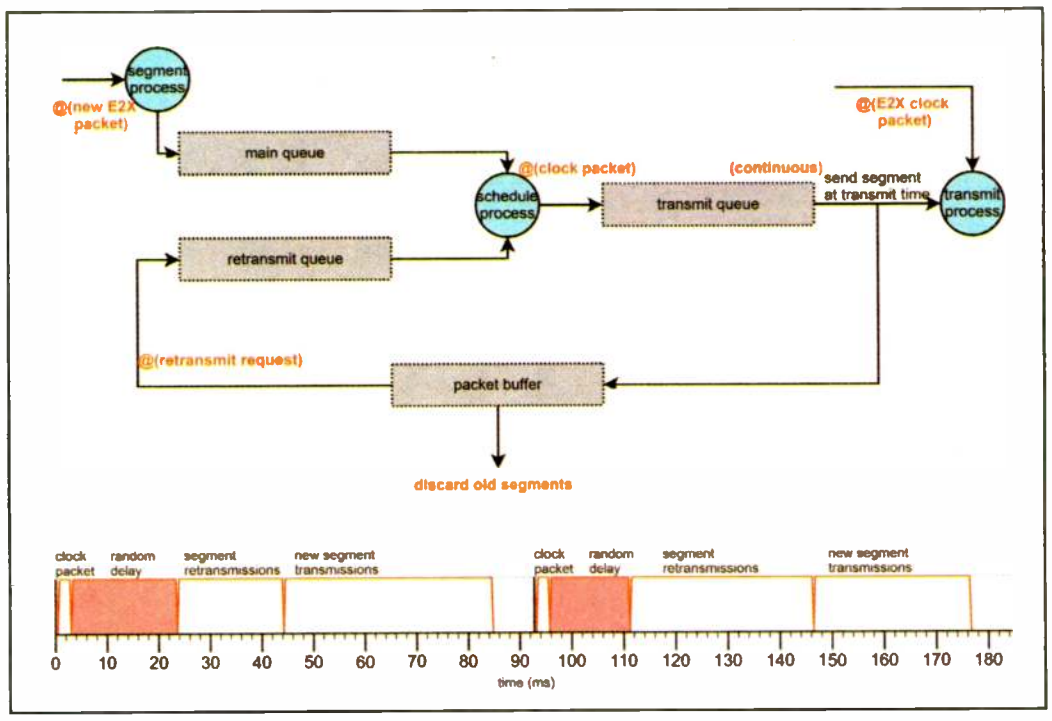

Fig. 6: Transport Protocol Scheduling at the Studio

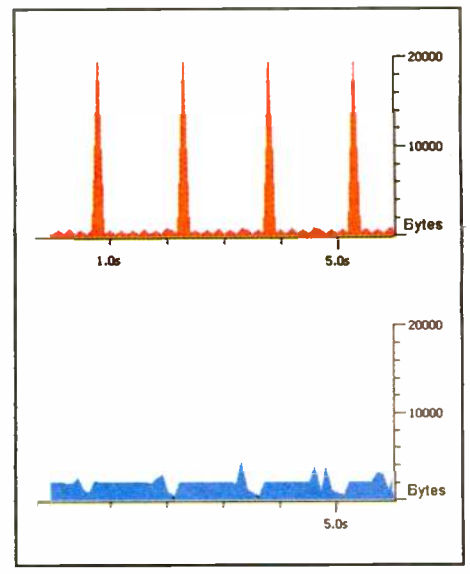

Fig. 7 : E2X Instantaneous Bandwidth (top) and E2X Transport Protocol Bandwidth (bottom)

The reception of a clock packet triggers the scheduling process controlled by two parameters:

1. The main bandwidth parameter sets the bandwidth required to sustain the regular E2X data stream without retransmissions. It determines how many segments may be transmitted in one clock interval and causes any instantaneous bandwidth variations to smooth out.

2. Overall STL bandwidth dedicated to this E2X stream dictates the rate at which segments are dispatched from the Exporter. It also governs how much additional bandwidth is available for retransmissions. The scheduling process places segments from both the main queue and the retransmit queue on to the transmit queue as shown in Fig. 6. However, clock packets bypass the transmit queue and are directly sent to the exciter with a flag set to disabled retransmissions for clock packets.

The scheduler may first insert a random delay where no segments are scheduled. This minimizes the impact of one E2X stream onto another on the same STL, as it allows the two streams to interlock better while minimizing the synchronization impact.

All dispatched segments are placed on the packet buffer until they get too old to be of interest (i.e., greater than the exciter receiver buffer depth). A retransmission request from any destination searches the packet buffer for the given sequence number and places it on the retransmit queue.

Fig. 7 shows a marked improvement in bandwidth utilization compared to standard E2X bandwidth utilization and demonstrates how multiple E2X streams can coexist on the same STL much more easily.

BIT AND BURST ERROR PERFORMANCE

In order to evaluate the effectiveness of this retransmission scheme, random bit errors are intentionally introduced at the segment level. Fig. 8 contrasts the transport protocol's bit error performance with the E2X protocol in UDP mode. The mean time between failures (i.e. HD dropout) is plotted against a channel bit error rate.

The exciter has a configurable receive buffer depth that allows the station operator to choose between increased protocol performance and total signal propagation delay. Two buffer levels of 16 packets (1.48 seconds) and 25 packets (2.32 seconds) are illustrated. With a buffer depth of 16 packets some packets may only be retransmitted once or twice; a buffer depth of 25 packets provides increased reliability due to a

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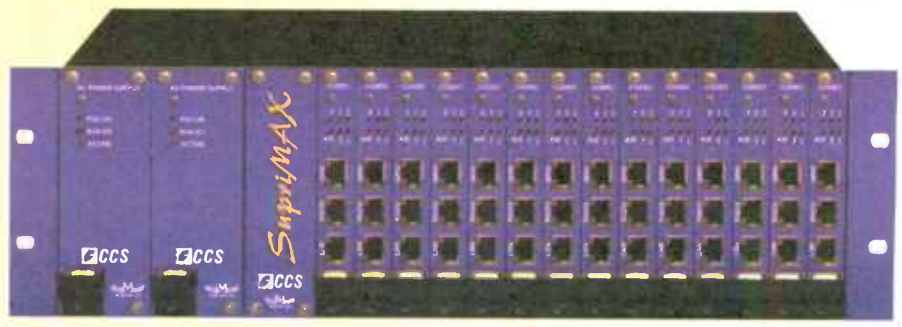

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greater chance of successful retransmission.

The number of retransmissions depends on the throughput delay across the STL and the exciter's receive buffer depth. A station engineer should analyze the effective bit error performance of his STL and select the desired quality of service. This identifies the operating point on this chart. If necessary the exciter's buffer depth can be increased.

High quality RF/T1-based STLs do exist with bit error rates that are sufficient for good quality IBOC transmission. However, the STL itself is not the only source of data loss. Intermediate network equipment can contribute to packet loss due to congestion conditions or other circumstances; most network equipment is not designed to provide extremely high reliability, as in normal network situations the end nodes provide reliable data delivery as part of their transport protocol.

Field results using Moseley Lanlink STLs for HD delivery have shown packet loss rates in excess of 0.7 percent yielding an averaged bit error rate of $1.7E^{-6}$. Using the Nautel Reliable HD transport protocol the mean time between failures has been pushed from 15 seconds to 1.4 days delivering acceptable HD performance in adverse link conditions.

Bit errors are a good way of characterizing the effectiveness of this protocol, but uniform random bit errors are almost an ideal error distribution, if they happen infrequently enough. In reality, bit errors are not uniformly distributed and usually occur due to an interference condition or fading. So it makes sense to investigate the maximum amount of time the exciter can maintain a steady data stream and replenish the data due to a complete STL interruption and associated packet loss. The following table outlines the burst tolerance of the protocol with respect to a configured receive-buffer depth:

Buffer Depth (packets)	Buffer Depth	Maximum Error Burst	Max Aggressor Traffic (300 kbps)
16	1.48 s	200 ms	7.3 kB
25	2.32 s	600 ms	22.0 kB
35	3.2 s	1300 ms	47.6 kB
50	4.64 s	2100 ms	76.9 kB
75	6.96 s	3700 ms	135.5 kB

The leading reason for an STL interruption may not be the RF path at all. Instead the STL may experience a congestion condition due to other traffic, which could lead to packet loss. The last column shows the rate at which aggressor traffic can cause a corresponding STL interruption given an effective throughput rate of 300 kbps. Aggressor traffic can be effectively managed using a priority-based quality of service (QoS) approach. By configuring the IP Type of Service (ToS) field, the protocol allows the HD traffic to assume a higher priority than other traffic on STLs that provide QoS support.

APP EXAMPLE: DUAL STATION TOPOLOGY

This topology is ideal for multiple HD stations that are co-located at the same studio and transmitter site. It demonstrates how multiple STL paths can be combined on the same network and is shown in Fig. 9.

Two links with sufficient forward error correction to allow a reasonable quality of service, such as the Moseley Starlink, are chosen to carry the HD traffic to the transmitter site. These links have enough bandwidth to carry two HD streams simultaneously. Therefore, each link can serve as a backup STL to the other link.

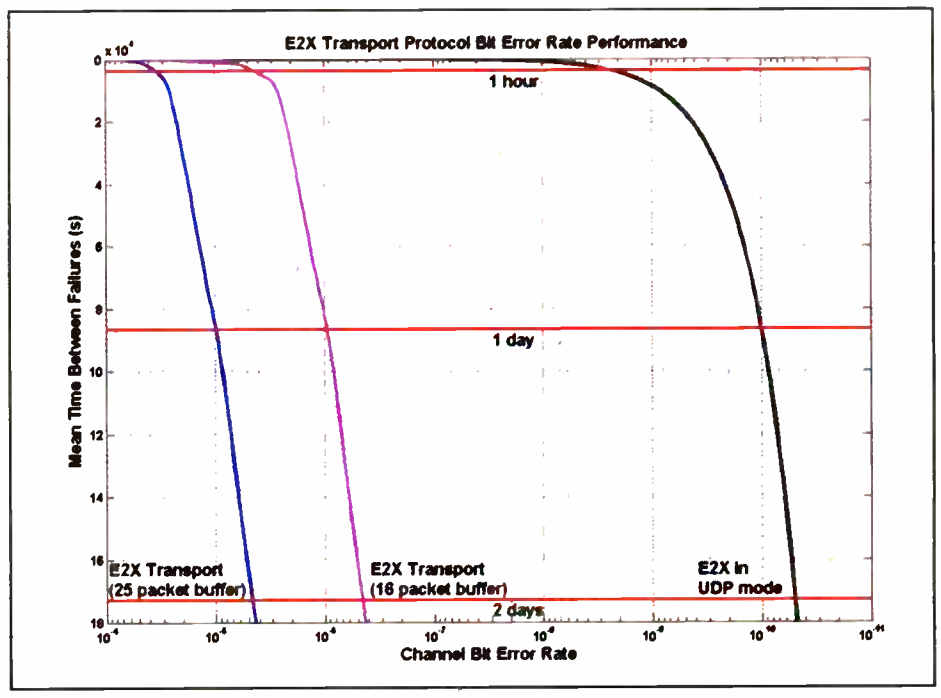

Fig. 8: Bit Error Performance

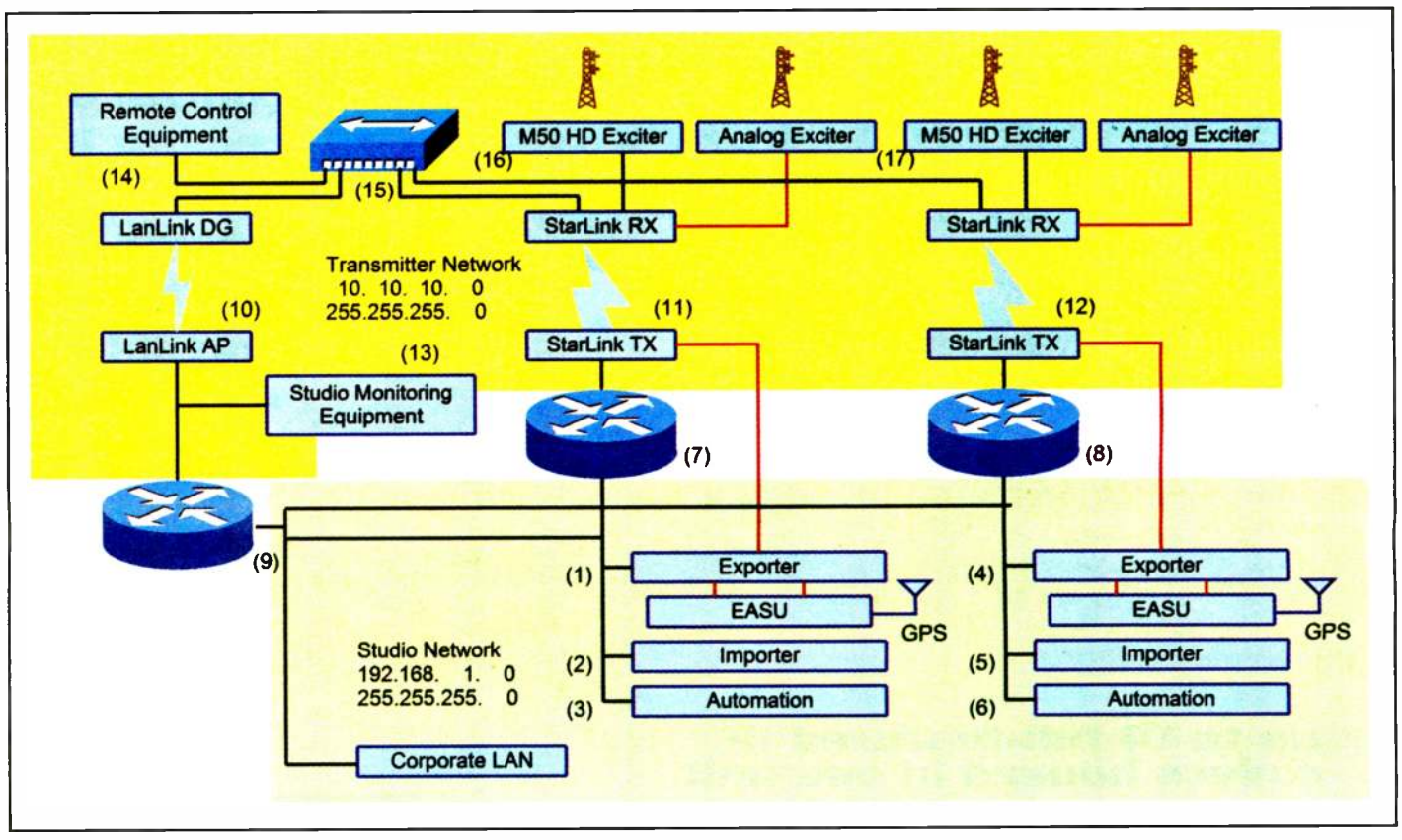

Fig. 9: Dual Station Topology

Because the E2X transport protocol is structured in such a way as to minimize impact on the other data stream, the presence or non-presence of the other data stream only affects the average clock packet throughput delay by about 4 ms, an amount that can easily be adjusted to match the analog diversity delay. In conjunction with this protocol and a dedicated link, the StarLink provides clock packet jitter less than 1 ms, allowing the exciter to synchronize to an error less than 0.1 ppm. Therefore, no GPS-locked synchronizer is required at the transmitter site to attain IBOC synchronization.

The network is broken into two distinct subnets: the studio subnet and the transmitter subnet. This is necessary in order to isolate the three parallel paths between the two sites.

Ethernet topology intrinsically does not like to be configured in closed-loop systems, as it could lead to unnecessary packet forwarding. Spanning tree protocols implemented in many Ethernet devices will intentionally sever Ethernet links if they detect multiple paths between two locations. By placing Layer 3 routers between the two subnets, not only are the subnets isolated but we also can prevent any unnecessary network traffic, such as broadcast traffic, from traversing the link.

The forward links are unidirectional by nature, but the exciters for both stations can share the same bidirectional Moseley Lanlink STL for retransmission requests. A host at the studio can select which path to take to the transmitter site by pointing its gateway setting to the appropriate router connected to the desired STL path. Only the Exporter points its gateway to the StarLink routers; the Importer or other studio equipment would use the LanLink router to access the exciter or other control equipment.

The exciters, on the other hand, point to the Lanlink router as their gateway in order to reach the Exporter for retransmission requests or serve control and status information.

This topology has many advantages:

- Redundant HD forward path allows the Exporter to select which link to use by simply reconfiguring its gateway. It can be demonstrated that this switch can be made quickly enough that with retransmissions enabled no on-air data loss occurs allowing STLs to be serviced and maintained.
- The reverse path can be shared by multiple stations reducing infrastructure costs.
- The Lanlink STL is not on the critical HD path, allowing it to be shared with other network applications without the use of quality of service queuing.
- Unlike TCP/IP, the E2X transport protocol is not dependent on the reverse path. For TCP/IP, a failure (including congestion) in the reverse path would terminate the forward connection as well. The E2X transport protocol loses the ability to retransmit data while continuing operation.
- Using directed broadcast, each station can have a standby HD exciter, provided that the studio side switch can prevent the broadcast stream from traversing the bidirectional Lanlink STL back to the studio.
- Link monitoring can be included in the E2X transport protocol with support for automatic link switch-over on link failure.

CONCLUSION

The proposed E2X transport protocol provides drastic improvements over current E2X deployments, reducing bandwidth and bit error rate requirements on the studio-to-transmitter link while allowing for Ethernet-based synchronization. It provides additional flexibility in the layout of STLs by allowing multiple streams to be run across the same STL. By implementing a feedback path back to the studio, automatic repeat requests can be used to greatly improve quality of service.

Various multiple exciter configurations can be implemented, such as main/standby exciters and multi-frequency networks, by incorporating this protocol into the radio system broadcast architecture.

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3 Freeman, R. L., 1997, "Radio System Design for Telecommunications," 2nd ed. New York: John Wiley & Sons

This article was adapted from a paper presented at the NAB2007 Broadcast Engineering Conference. ■

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Wildfires a Challenge, Even With Preparation

Are You Truly Ready for Emergency Situations When Contact With Regular Civilization Is Lost?

Way back in late 1776, in a dark hour while Gen. Washington and the Continental Army were on the run back into Pennsylvania from Gen. Howe and the British army, Thomas Paine wrote an aptly titled work, "The Crisis." It included a quote that would become famous: "These are the times that try men's souls."

The title and words come to mind as I ponder recent events and the subsequent "dark hours" for one of my radio stations in wildfire-scorched Southern California.

Indeed we have seen some crises and trying times of late.

I live in the west, in Colorado, where we are no strangers to wildfires. There have been times in recent years when even metro Denver has been smoke-choked and ash has fallen like snow. And yet some of what occurs when a wildfire sweeps through an area did not really occur to me until it happened to us in California.

In mid-May of this year, a wildfire swept through the area around one of our transmitter sites, that of KBRT(AM) in Avalon. The transmitter site is on Santa Catalina Island.

This wasn't a forest fire; it was more of a brush fire with scrub brush, grass, weeds, sage and a few trees providing the fuel. As such, the fire moved quickly. And we were prepared for it … or so we thought.

TELCO GONE

Our chief engineer had done a great job of maintaining adequate fire breaks around all our structures, maintaining the fire hose and sprinkler system at the transmitter building and even conducting fire drills.

Because of that, our transmitter plant suffered only one fire casualty: a single fence post that burned. This actually happened a couple of days after the fire swept through; evidently an ember had landed atop the post and smoldered all that time.

As the remaining brush in our antenna field lay charred and smoking, the rest of the place was fine — buildings, tuning houses, fences and all; see Fig. 1. But this station in the No. 2 U.S. market was off the air, dead in the water, without power but with a perfectly functional generator sitting idle.

According to Edison, some 60+ utility poles burned. The three transformers feeding our site ended up in the dirt on the hill above our transmitter building; see Fig. 2. But while the power was out, power was not the immediate problem. As I mentioned, we had a working generator. The issue was the STL.

Because of the distance and path involved, we had ditched our unreliable 950 MHz over-the-air STL system years ago in favor of a T1-based system with ISDN backup. The problem post-fire was that the trunk line feeding our site was in the dirt with its jacket melted (and probably its copper pairs as well). That pretty well killed the T1, ISDN and POTS service to the site.

"Surely you must have planned for a cable severance," you say; and you would be right. Our company has a Ku-band satellite network with six uplinks and with downlinks all over the place. There is an uplink at the studio and a downlink at this particular transmitter site, but this is where Murphy came in.

Photos by Bill Agresta

Fig. 1: The KBRT antenna field immediately after the fire moved through. Note that aggressive fire breaks left the antenna system intact.

After the fire, we had not one but two bad LNBs that did not immediately present themselves as such. Solving an equation with multiple variables is exponentially more difficult than solving one with a single variable. Add to this all the post-fire confusion and other difficulties of just getting into the fire area and you've got a recipe for being off the air for a while.

NAMING NAMES

Radio engineers are by and large a great bunch of folks.

Our sales teams may compete on the streets and our PDs may be engaged in an epic battle for listeners, but when one of our stations gets into trouble because of an equipment failure, a tower collapse or a natural disaster, it is the engineers who come to the rescue. In this case it was three individuals from outside our company whom I want to recognize by name.

Joel Saxburg is a well-recognized name in Southern California engineering circles. He is an experienced and capable local consulting engineer with a great spirit, always willing to help and lend his expertise. He was invaluable in our post-fire recovery efforts.

Burt Weiner is another outstanding Southern California freelancer who came to our rescue. Burt was scheduled to head to Hong Kong a couple of days after the fire; on the eve of that long trip he was at our site helping our chief engineer put Humpty Dumpty back together again. He was able to keep to his trip schedule, too.

KFI Chief Engineer Tony Dinkel is no stranger to catastrophe. In December of 2004, a plane crashed into KFI's tower, putting the structure in the dirt. After the fire, Tony didn't hesitate to come to our rescue. It was his expertise that got the downlink running, working by the glow of halogen stand lights powered by a portable 3 kW gasoline-fueled generator; we only fire up the "big boy" during normal daytime broadcast hours to conserve fuel.

It was because of the selfless efforts of these three plus those of our own chief engineer and operations manager that we got back on the air as quickly as we did.

Chief Engineer Bill Agresta was at the time working with three cracked ribs, an injury suffered in a collision with a front-end loader when the fire was sweeping through our site. He also was working with a nasty case of poison oak, the result of oil-laden smoke covering every bit of exposed skin.

Fig. 2: KBRT's Edison transformers are in the dirt following the supporting pole's collapse in the fire.

Thank God he wore a respirator while fighting the fire or things could have been much, much worse. Bill has been "camping out" at the transmitter site since the fire.

KBRT Operations Manager Todd Stickler came to the site with several days' programming on CD and "ran the board" locally at the transmitter site while the others worked to get the STL running. His efforts saved us a day off the air and the lost revenue that would have come with it. He also replaced the burned fence post, restoring the integrity of the tower base fence to maintain FCC compliance.

With the world's longest STL path working perfectly, the challenge became one of communications and power. Our generator was working fine, but getting it fueled regularly quickly became a problem. And with the cell site serving the area around the transmitter site out of service (and with all the telco lines to our site down for the count), just communicating with Bill was a challenge.

Bill, serving as full-time "transmitter duty operator" while operating the transmitter in local control, couldn't really leave the site. He did find one spot on the property, on top of a knoll above the transmitter building where if he stood in just the right spot with his head turned just so, he got some cell service. But that was of little value if someone was trying to get in touch with him.

As I write this, our station is still operating on its satellite STL and on generator power, but the bottom line is that we are on the air, thanks in large part to those special individuals who worked so hard in very difficult conditions to make it so.

That's what being part of the radio engineering community is, and always has been, all about. Joel, Burt, Tony, Bill and Todd, great job!

IMPOSSIBLE D-A SOLVED, PART I

I recently wrote about an interesting but difficult problem I was dealing with in Colorado that involved construction cranes off the end of the KLDC(AM) daytime directional array ("Check Out the Numbers on Those Pesky PCNs," June 13).

This represented, on a relatively small scale, the "worst case" for a directional array: a constantly changing, non-detunable reradiator in the main lobe. At the end of the column, I noted that my intention was to augment the pattern to restore it to full power, and that's exactly what I did.

The first part of May, I made a little drive up to Sturgis, S.D., home to co-channel 25 kW daytimer KBHB(AM), the primary daytime protection for our Colorado station

SEE FIRE, PAGE 28

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Fire

CONTINUED FROM PAGE 26

(and what a great station; KBHB is a full-service station that brands itself as, "Five State Farm Radio!").

The direct path from KBHB back to Denver runs down the spine of the Black Hills (right past Mt. Rushmore, in fact), hills that are composed mostly of granite.

Having made a lot of mountain conductivity measurements over the years, I suspected that we would find the conductivity down that radial path was much lower than the FCC's M3 conductivity maps predicted (M3 showed 8 and 15 mS/m for that area). I made measurements out to about 100 km, right to the south end of the Black Hills, and sure enough, when plotted and analyzed, the conductivity on that path showed to be 1.5 mS/m, between 5 and 10 percent of what the FCC map showed it to be. See the chart in Fig. 3.

As you can imagine, that lower conductivity has a dramatic effect on AM propagation and contour distances. Plotting the KBHB contours based on the measured conductivity, suddenly there was a ton of room between the KBHB contours and KLDC's. That allowed me to augment the KLDC pattern.

Our Denver engineering crew then hit the road with field strength meters, running a combination full and partial proof on KLDC (full on the augmented radials, partial on all others). I then put the exhibits together and filed the augmentation and license applications concurrently along with an STA request to get KLDC back to full power.

We now await FCC action on these applications. Stay tuned for the exciting conclusion of this project in the next issue of RW-EE (I hope).

IMPOSSIBLE D-A SOLVED, PART II

Antenna systems remain perhaps the biggest challenge to AM HD Radio. With a required bandwidth of over 30 kHz in the hybrid mode, the challenge is significant, representing over 5 percent of the operating frequency at the low end of the band.

While non-directional antennas are challenge enough, directional arrays are particularly difficult. In addition to the impedance slope of each radiating element, each network in the system has its own peculiar slope. In conjugate at the common point, the load seen by the transmitter power amplifier — where the rubber meets the road, so to speak — can be well outside the load specifications set by Ibiquity Digital Corp.

In many cases, there are things one can do to improve the situation somewhat. In the case of sharply sloped radiating element impedance curves, it may be possible to improve the situation using a "pre-match." Slope-correction is another technique that occasionally can be used to good effect in tight bandwidth situations. Certainly maintaining a proper impedance match at every node in the system carrying a significant amount of power is a good place to start, as unwanted reactances tend to be bandwidth killers.

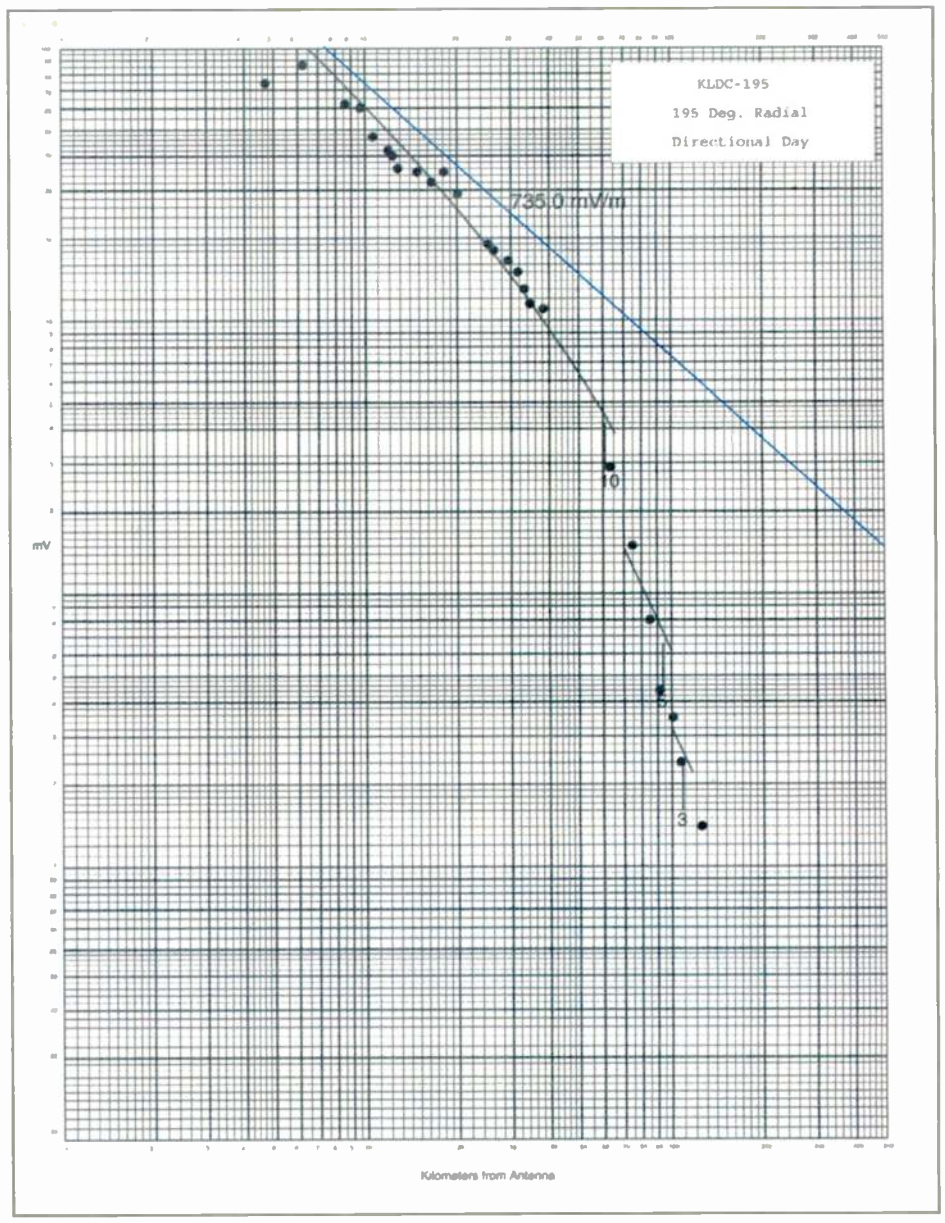

Fig. 3: Field strength measurements are graphically analyzed to determine the actual conductivity along a radial path.

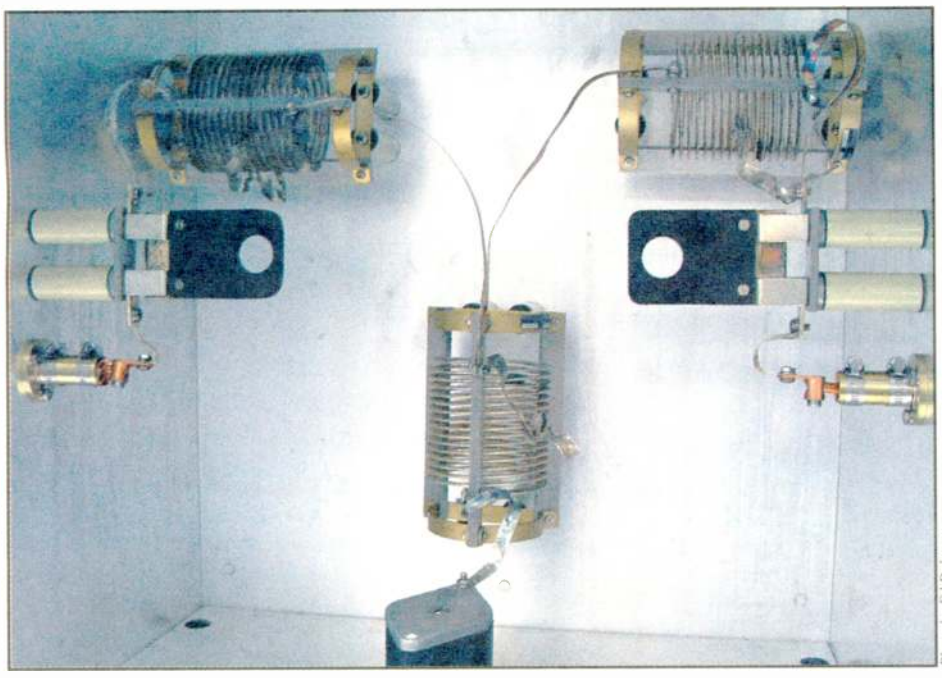

Photo by Ed Dulaney

Fig. 4: A phase shift or 'line stretcher' network was built up and inserted between the main transmitter and phasor input.

But there are some situations where despite one's best efforts, the VSWR bandwidth of the antenna system is less than desirable. In the case of some directional antenna systems, the issue is one of array geometry. Driving point impedances shift rapidly with frequency, and slope correction is ineffective because it tends to cause the impedance plot to loop back over itself, an "IBOC killer" if there ever was one.

The obvious solution, to redesign the array, often isn't an option because of the allocation picture, available land, grandfathered status, overlaps and other factors. So we give up, right?

Not necessarily, although it may come to that in some cases. I recently dealt with such an antenna system, one that on the surface would seem to be a good candidate for HD Radio. The station was KLZ(AM), one of the old-guard regionals on 560 kHz.

The station employs a wide-spaced two-tower DA that produces a broadside north-south "peanut" pattern. The towers are 91 electrical degrees tall, large cross-section towers that have a very favorable impedance slope. The bandwidth-optimized phasing and coupling system was built and installed in 2000.

SEE FIRE, PAGE 30

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iPhone: Worth the Wait

It Offers Indisputably Cool Functions and Aesthetics, But the Second-Gen Model Likely Will Cut Price, Bugs

Have you bought your iPhone yet? The panting over the most hyped smart phone on the planet will subside but one thing is for sure. It is indeed a very cool personal electronic pocket servant that has mesmerized Apple lovers, students, geeks and even broadcasters.

In many important ways, the iPhone introduces a new look and feel that will undoubtedly be mimicked in competitors' products.

Cell phones and PDAs are indispensable tools for today's broadcast engineer, so this topic deserves some ink — especially for those who also do IT support and set these devices up for other staff members. By now, you have undoubtedly had to deal with employees who want to use them at work, complete with MS Exchange e-mail and desktop PC synch.

If you're happy with your present cell phone, PDA and iPod, you've probably chosen to ignore the iPhone hysteria. After all, there are tons of other ways to spend $600.

Early adopters who just can't wait for the latest gadget have been more than willing to spring for one.

I usually wait for prices to drop and for the bugs to get flushed out before succumbing to new high-tech gadgets. But I must confess, the iPhone almost seduced me like no other so-called smart phone in its class. Clearly, iPhone is in a class all by itself. And I'm not even a big Apple guy, although I've enjoyed handling Digidesign and other audio editing Mac boxes over the years.

I decided to wait before punishing my own plastic and instead was able to play extensively with an iPhone that a fellow broadcast buddy waited in line three hours to buy. I'm going to resist listing and describing all of its features and functions. That would only get lost in the blizzard of press already heaped on the iPhone. You've heard about most of them anyway.

There is simply no denying that Apple has produced a striking handheld entertainment-communication device that delivers an entirely new electronic handheld experience. In addition to its splendid Web browsing and wonderful display, it adapts to human habits and limitations and gives users what they want with minimal effort.

The iPhone differs from other smart phones in that there is no keyboard or number pad. Everything is seen and executed via touchscreen.

WORKING THE iPHONE

There are a few striking differences compared to other smart phones you need to know about. It has no keyboard or number pad. Everything is seen and executed via a full-color touch screen.

Even though this phone is palm-sized, the 3.5 inch display area is huge. Icons, letters and numbers on the virtual screen are larger and easier to see than any competitor's buttons. If you've gotten adept at two-thumb Blackberry manipulation, you should be able to adapt to the iPhone screen with a little practice, although losing the tactile feel of depressing a button will be a problem for many.

The graphics are dazzling and smooth as silk. Scrolling through Web pages with your fingertip is amazing.

Despite the superb quality of the display, Web browsing for me seemed a bit sluggish on the iPhone compared to my Verizon BlackBerry. Obviously there are a myriad of variables that can affect it, especially the speed of the local carrier's bandwidth and whether you use the AT&T Edge network or WiFi. Browsing on the Edge used to be like surfing on molasses, but it has rapidly gotten speedier for the iPhone rollout.

Browsing Web sites with lots of Flash and Java look a bit strange, as neither is supported in iPhone just yet. I was able to make it lock up on several occasions while Web surfing and bouncing in and out of phone calls and contact lookups.

Radio, like any other business, is going to be hard-pressed to accommodate the tight integration with iTunes and use the iPhone as a legitimate business tool.

The first generation of any PDA always has bugs, so I'm hoping and expecting this will all improve.

Of all the smart phones and PDAs I've used and test-driven, the iPhone is by far the most intuitive and easy to navigate. With a Home button to get you back to the major function choices, it's impossible to get lost. The browser zoom function really helps to see the fine print on crowded Web sites.

Steve Jobs and his cronies obviously spent a huge effort getting the GUI as good as it is in this first-generation release.

The coolest iPhone feature for me is the GPS-based Google Local display dialed into real-time traffic. A pocket nav-package shows you where you'll encounter traffic congestion up ahead. Other smart phones can do this, but not on such an impressive easy-to-read display.

A close second is iPhone's ability to train

SEE iPHONE, PAGE 32

Fire

CONTINUED FROM PAGE 28

Sounds like a slam-dunk, doesn't it? But it was anything but.

The issue is those driving point impedance slopes. Because of array geometry, they are steep. When we first did the digital conversion, we tried so much stuff that we briefly considered changing the call sign to "WTET" for "We've Tried Every Thing." Ahem.

Slope correction improved the spot +/-15 kHz VSWR values, but we could not make the HD-R system work. The network analyzer showed us why: that looped impedance plot thing. At the end of the day, after all the tricks had been tried, the best we could achieve was a 2.1:1 more-or-less symmetrical VSWR at +/-15 kHz. No way HD-R is going to work with that, right?

I wasn't ready to give up, though. Our crack engineering staff quite literally "breadboarded" up a line-stretcher network on a piece of plywood and attached it to the wall behind the transmitter (see Fig. 4). This network was inserted between the main transmitter and the phasor input.

They then experimented with different values of phase shift, starting with a load cusp orientation close to what the transmitter manufacturer recommended, looking for something resembling acceptable HD Radio performance. They eventually found it. The experimental network was then made permanent and enclosed in a steel cabinet.

There is one thing I learned in this process and want to convey to you: cusp orientation and symmetry are critical in cases of less than optimum VSWR bandwidth. As little as 10 degrees made all the difference.

After the optimization, KLZ worked very well in the digital world. En route to those South Dakota conductivity measurements, I listened to KLZ in digital well into Wyoming, more than 170 miles from the KLZ site. At the point where the digital began cutting out, the carrier field strength was below 1 mV/m. I'd say that the digital performance was adequate.

REAL-TIME TOOLS NEEDED

But some time later, we began hearing digital "chirps" in the demodulated digital audio, chirps that weren't present in the analog audio, a clear sign that there was a problem with the digital path. As it turned out, in the process of maintaining the pattern through normal, seasonal phasor adjustments, that optimum cusp and symmetry was lost.

It wasn't much, just a few degrees, but it was enough to degrade the digital performance. It didn't take much to set it right, either, but doing so required us to get out the network analyzer, directional couplers, pads and all the cables, taking the station off the air for a few minutes to make the adjustments.

The lesson here, and this is something I discussed at length with other engineers and transmitter manufacturers at NAB2007, is that station engineers need a means of observing the load plot in real time. Arrays do drift and we must adjust them back to the proper parameters to maintain FCC compliance. This will have some effect on load orientation and symmetry, but there is no way those who do not have network analyzers handy are going to call up the consultant every time the pattern drifts.

So how about it Nautel, BE and Harris? Most of the information needed for load analysis is already present in the digital carriers. You just need to retrieve and analyze it, providing us with a Smith chart display in a Web interface. If HD Radio is here to stay, and I believe it is, this is a tool we must have.

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

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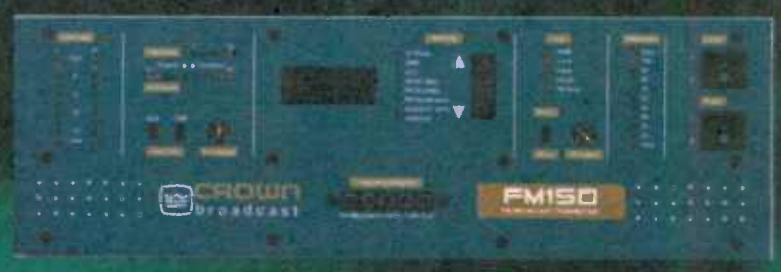

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iPhone

CONTINUED FROM PAGE 30

itself to its user's needs, habits and intentions. Apple has pushed the neural intelligence of their smart phone technology farther than most all the others so far. If you are working on a document or doing a Web search, iPhone will know about the names, words and phrases you frequently use and will auto-complete them for you and correct misspellings on the fly.

ALMOST EVERYTHING YOU NEED

Like most other smart phones, the iPhone gives you the usual functions you'd expect. Telephone, music, Internet, e-mail and a 2 megapixel camera all are in there.

One glaring MIA feature for many, however, is the absence of video games, at least as of July. And there are a number of other critical limitations, caveats and disappointments for the business user. Through the eyes and fingers of a radio engineer, let's check those out.

The base phone with 8 GB of storage lists for $600. That's not very big for those with big iTunes collections. Software is extra and it's Apple-proprietary. In its quest to control everything it sells, only Apple provides iPhone software and its updates. Users have no other open-source choices just yet.

The Free Software Foundation has been suspicious of Apple for years regarding its use of General Public License-based elements in the Apple proprietary platforms like OSX and the Safari Web browser. Some observers think Apple may be violating GPL licensing if it releases iPhone software that includes GPL-based features.

Steve Jobs has been asked about third-party software at lot. So far he says that safeguarding the iPhone's security and making it less prone to crashing requires restricting non-Apple software apps. But he knows the market is pushing hard for this so he's been hinting that Apple will be working carefully towards allowing at least some kinds of third-party software into the iPhone's space going forward. If he's not really being truthful about that now, the market likely will force him in that direction.

iPHONE AT WORK

When you buy an iPhone, you don't sign the usual two-year contract and activate the account with a phone call. All iPhone registering, activation and software updating are handled via the Apple iTunes.com Web portal.

Apple appears so convinced that iPods and iTunes are now so mainstream that it's challenging all consumers to embrace the paradigm change.

Most business and corporate IT policies do not now support or even allow personal iTune loading or storage on company-owned equipment. It's going to be difficult for a while for iPhone owners to be able to use them as effectively as they would like in the workplace.

For radio, iTunes presents an opportunity but also a challenge to accommodate and support using it on the station PCs and LAN. In some cases there may be legal issues. iTunes is a fine resource for purchasing music online to augment record libraries where CDs and high-quality linear recordings cannot be found elsewhere. While the vast majority of iTunes customers are personal users, many radio station employees have iTunes accounts and buy music for both personal and station use.

Radio stations pay licensing royalties for the privilege of playing copyrighted music over the air, so playing a song purchased on iTunes.com is the same as buying it anywhere else. Using iTunes at work usually raises issues with IT support staff who are concerned about the bandwidth and storage resources iTunes can consume.

Except for programming folks who need iTunes access for show prep and music directors who may need it for record library support, allowing rank-and-file staff to install and use iTunes on company-owned PCs often is restricted or discouraged if not prohibited.

Be careful using copyrighted music in commercial production, however. There are often legal restrictions in the fine print covering that arena. Radio company owners and their lawyers almost universally insist that their stations and employees recognize and honor music copyright laws and licensing agreements. After all, we expect others to respect our copyrighted program distribution and rebroadcast rights. We went through all of this before with Kazaa and Napster.

WHERE ARE MY OFFICE APPS?

Microsoft Office claims 95 percent of the business office software applications market. The tiny leftovers are shared between Corel WordPerfect and Apple's relatively new iWorks package.

I usually wait for prices to drop and for the bugs to get flushed out before succumbing to new high-tech gadgets. But I must confess the iPhone almost seduced me like no other so-called smart phone in its class.

While you can produce and open simple DOC and XLS files on iPhone, you won't be able to show Excel tables or PowerPoint presentations. Apple obviously wants you to buy iWorks with its equivalent programs rather than offer full support for its eternal adversary.

Many observers feel this is a huge non-starter for most business-class customers looking at iPhone. Surely Jobs doesn't think iWorks is going to seriously challenge the dominance of MS Office at the business enterprise level.

Beyond multimedia editing, Apple has not been able to dent the business market in its 30 years of trying. They've never made a real commitment to developing much of anything for enterprise applications. I highly doubt any new detour to the business world will be traveling through an iTunes portal.

WHAT ABOUT E-MAIL?

Another problem limiting the use of the iPhone at work is e-mail integration.

Almost every station or IT engineer has been asked by their GM, PDs and AEs to help them get new or updated BlackBerries set up and running with Outlook. Hours can often be wasted working through the sometimes-quirky setup requirements to make everything synch up and talk.

Are you ready to take on the iPhone? So far, Apple has not recommended any enterprise solutions for iPhone e-mail like the ubiquitous MS Exchange service. It works fine with the Pop3 and IMAP e-mail platforms but making the iPhone fully compatible with Exchange is a work in progress.

Just before the June 29 unveiling, MS had to scramble to issue a patch to fix a nasty bug so the iPhone could hopefully work and fully synch with Exchange 2007. The iPhone will not be able to handle corporate Exchange e-mail for Outlook clients, for those stuck on older server platforms. It's been rumored Apple will license ActiveSynch, a product that allows Outlook to connect directly with Exchange servers, bypassing the intermediate link to Exchange like BlackBerry uses.

Except for Apple shops, it's going to be a while before most businesses tackle the challenge of adding personally owned iPhones to their IT support services. Radio, like any other business, is going to be hard-pressed to accommodate the tight integration with iTunes and use the iPhone as a legitimate business tool. Fortunately, for a while at least, you should have relief from this additional burden.

DISTRESSING PHONE CALLS

At the unveiling in June, Jobs proclaimed the iPhone to be an incredibly great cell phone, the best iPod ever and a fine pocket Internet browser.

Two out of three isn't bad, Steve; but frankly, the quality of the phone function is almost abysmal.

Compared to any good G3 phone, caller quality on iPhone sounds muffled and weak. The speakerphone is not nearly loud or clear enough and callers at the other end reported my voice to sound heavily compressed and rather tinny. Plus there were noticeable amounts of that annoying GSM digital buzz bleeding into its own speaker. And where was the anticipated voice-activated dialing feature? Another disappointment.

Apple has a long way to go to make cell phone performance measure up and be fully competitive in generation two of iPhone — especially considering the price they are charging.

Let's face it, Apple has never been very good getting their first-generation

SEE iPHONE, PAGE 37

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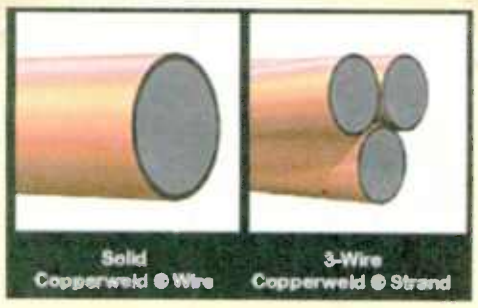

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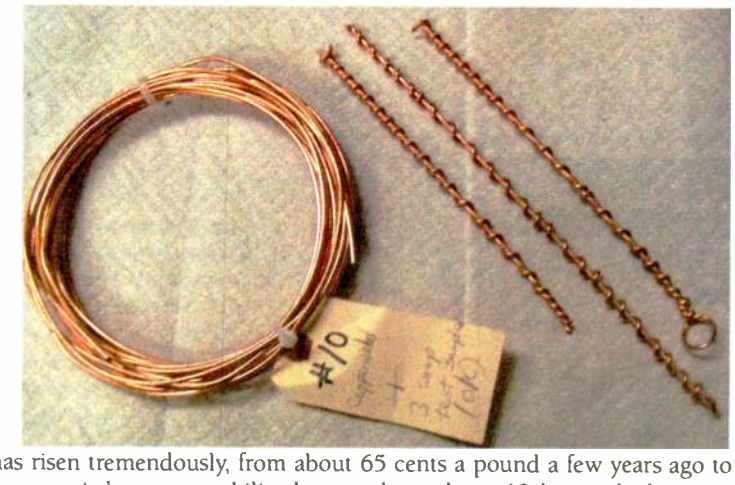
Copper Thieves No Match For Copperweld Wire

Nott Ltd. has been approved by Copperweld Bimetallics LLC to distribute Copperweld grounding wire, which the company says has been used by the electric utility industry for many years and now comes to broadcasting.

Standard Copperweld wire is not annealed, making it springy to deal with. However, Nott says, its ground wire is annealed and handles like pure copper wire. It also can be silver soldered like pure copper. Tests indicate that erosion may occur at the ends of buried wires, but will go no more than two wire diameters into the metal. In the case of #10 wire, this is less than 1/4 inch.



Nott Ltd. notes that the price of copper has risen tremendously, from about 65 cents a pound a few years ago to more than $4 last year; it has now stabilized somewhere above $3 but with the price changing frequently. Copperweld ground wire costs less than pure copper wire and has little scrap value.

"Copper thieves are looking for copper in all forms, including AM ground systems," said Ron Nott. "Copperweld tells me that copper thieves often carry magnets with them, so when they put the magnet onto your radial wire it will stick and they won't bother it. While maybe not all of them carry magnets, the first time they try to sell it as copper scrap, the dealer will turn them down because it's mostly steel and has little scrap value.

"Recall that RF current travels only on the outer surface of a wire due to skin effect, so most of your current will be flowing in the copper skin," he said. "So Copperweld ground wire is just as good as pure copper. Note in the pictures that bending it into a sharp radius does not cause the copper skin to crack. Wrap it as tight as you like, then silver-solder it."

For information, call Nott Ltd. in New Mexico at (800) 443-0966 or visit www.nottltd.com.

OnAir 3000 Updated With Modules for 5.1

Studer says software version 2.2 for its OnAir 3000 series adds features and functionality to the production and on-air console such as optional modules for handling 5.1 signals that allow control of a 5.1 input signal from a single fader. Stereo downmixing tools also are included, along with surround control and monitoring through the Touch 'n' Action interface.

The D21m I/O system for the OnAir 3000 also supports the recently debuted SDI and Dolby E cards, the latter of which allows the console to decode eight audio channels from a Dolby E stream for processing within the desk.

OnAir 3000 5.1 Channel Screen

The new software supports the connection of the SCore Live DSP system, which brings more DSP power to the OnAir 3000 and increases the I/O capability of the desk to 1,728 x 1,728, with external control of the router control possible. More redundancy options are available with the SCore Live.

The Reverse Contribution Overview page on the main screen allows the operator to see which channels are contributing to an output bus by a switch function. Management tools included Advanced Central Error Logging and a System Viewer.

Other additions include limiters on the Aux and N-X busses; an N-X bus mode called N-1 and full return functions for clean feeds; a Conference MPX option and configurable output routing preset keys for monitoring source selectors, transmission control, studio sharing, direct outputs and talkback to DJ only.

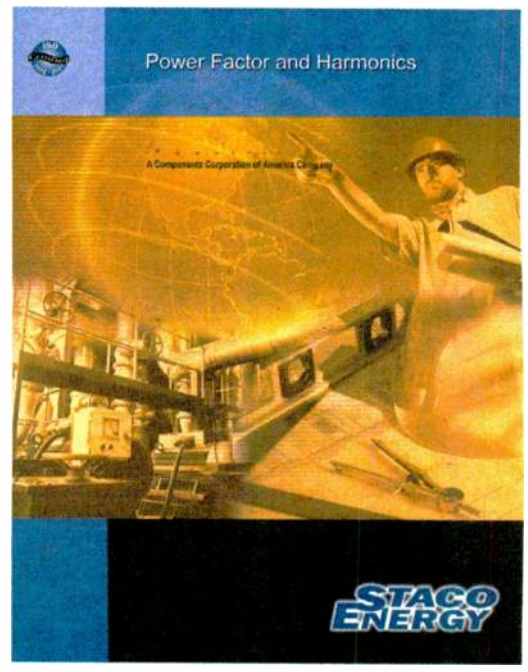
The company also released a 42-fader version of its Vista 5 console, which also adds more channels and multiple operator control.

An additional bay of 10 input faders allows an operator to control 42 input channels simultaneously and permits two-man operation of the desk. This input bay is situated to the right of the output/master section, and can be "isolated" from global adjustments made on the left side of the desk using the Lock mode.

For more information, including pricing, contact Studer USA/Harman Pro North America in California at (866) 406-2349 or visit www.studer.ch.

Staco Guide Explains Poor Power Factor

A guide to power factor and harmonics is available from Staco Energy Products. The color 42-page catalog serves as a primer for understanding the causes of poor power factor and harmonics, how these problems are manifest in various facilities and how they can be corrected.



Highlights include illustrations; examples, such as ROI and payback periods; checklists; selection guides; and reference tables. The company says it is suitable for readers of any knowledge level. Copies may be ordered at the Staco Web site.

Staco says the most common symptom of poor power factor (or inefficient use of supplied power) is higher utility bills — whether companies are invoiced on a kVA or kW basis. It says load types that can cause poor power factor include induction motors, electric furnaces, machining, stamping, welding, variable frequency drives, fluorescent lights with magnetic ballasts and computer controlled equipment.

For more information, contact Staco Energy Products at (866) 266-1191 or visit www.stacoenergy.com.

Deuce 722 Boasts Versatile Toolset

Symetrix is shipping the Deuce 722, the second product in its Integrator series. The company says it solves everyday processing problems for integrators, calling it a "'Swiss Army' DSP."

The Deuce 722 is built upon the Symetrix 322 DSP engine and the 9022 before it. Its toolset can be applied to live sound management, voice processing for public address, headphone processing and line sweetening for broadcast. Symetrix says the 722 also tames wildly varying digital media assets and assistive listening processing.

Highlights include two inputs and two outputs (on XLR connectors); microphone preamplification, featuring a THAT front-end with +48 V phantom power; compression; split-band compression; downward expansion; gating; de-essing; AGC; and ambient noise compensation.

Additionally, a process known as the volume "Clamp" helps protect the sound system from overzealous DJs and sound mixers.

The Deuce 722 carries an MSRP of $849.

For more information, contact Symetrix at (425) 778-7728 or visit www.symetrixaudio.com.

Soundcraft Vi4 Suitable for Remote Broadcasts

Soundcraft extended its Vi6 series of digital live sound consoles with the Vi4, which offers the functionality and facilities of the Vi6 but in a smaller, more compact footprint suitable for remote broadcasts.

It provides access to 48 inputs on 24 faders, with a total of 27 output busses available for use as masters, groups, auxes or matrices. Other features of the Vi6 include the Vistonics II touchscreen user interface and Soundcraft FaderGlow fader function display.

Also available on the Vi4 is the Processing Card option, which adds eight assignable Lexicon effects sections, together with 30-band BSS Audio graphic equalizers available on each output.

The Soundcraft Vi4 retails for $75,000.

For more information, contact Soundcraft USA/Harman Pro North America at (818) 920-3212 or visit www.soundcraft.com.

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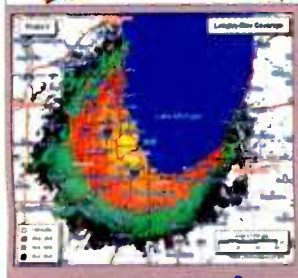

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KUNC Improves Coverage Toward Denver

Colorado noncom KUNC(FM) switched on a new transmitter site on Buckhorn Mountain in July.

Chief Engineer Larry Selzle described the new coverage as phenomenal.

"KUNC now has terrific coverage through the Denver metro area" — something it has sought for two decades, though it does not plan to market itself as a Denver, station he said. The Class C1 station is licensed to Greeley.

"With the FM band filled and a co-channel located in Colorado Springs, we could not move further south," he said. "We even investigated buying a station to cover the Denver area. A small public radio station like KUNC could not afford that option.

"Vic Michael, the site owner, presented us with a proposal two years ago that looked very attractive. After discussing this with the entire management team, we worked up the cost of the project and took it to the board of directors. They approved it."

The CP was granted in 2006; construction began in January and program tests in late June. Full-time service started in late July.

"While KUNC could be heard in the metro area from the former transmitter site, coverage was weak and spotty in many areas," he said. "Quite a few commuters travel from the Greeley/Fort Collins/Loveland area to Denver and now they can enjoy KUNC for their entire commute." He estimates the change adds 800,000 potential listeners to the coverage area.

Selzle said the new site is the one from which KJAC at 105.5 and KXWA at 89.7 broadcast. "Both of these stations bill themselves as Denver stations, even though the site is 50 miles from the metro area," he said. Educational Media Foundation station KLHV at 88.3 also has a small Class A there.

"The Buckhorn site has many other users, including a number of two-way users, both private and government; cell phone; micro-wave relay," he said.

A view of the antenna bays (lower left) waiting to go up the tower.

The radio stations are in a large two-story structure that used to be an AT&T microwave facility. KUNC is using Nautel analog and Harris digital transmitters and a Shively 6810 six-bay, half-wave-spaced antenna.

The old site was about 20 miles north of Greeley, west of the town of Pierce. Regent Broadcasting owns the site and still operates two stations from there. KUNC will keep its old Continental transmitter there and license it as an aux site for the remainder of its lease with Regent.

Assisting Selzle on the construction of this project were Ron Crob and Cliff Mekkelson.

Tell RW about your facility upgrade or project at rwee@imaspub.com.

Long Tail

CONTINUED FROM PAGE 38

choices is always better.

In a study at Columbia and Stanford Universities, researchers found that when faced with too many choices, consumers are less likely to buy a product than when faced with a limited number of choices.

When presented with a table that contained six types of jam, 30 percent of the customers purchased one, but when faced with 24 types, only 3 percent made a decision to buy one. And with too many choices, customers were less satisfied with what they selected.

As choices grow, the corresponding psychological burden also grows; liberation is replaced with debilitation. A human limitation replaces a technical constraint.

As the battle of head and tail continues, terrestrial broadcasting should focus on the new equilibrium, however it will evolve. The head will never return to its kingly status of 1950s, and the tail will never conquer the world. Technology unleashed a genie that has no intention of returning to the bottle.

Historically, neither listeners nor commercial organizations had the problem of managing the tail. That is no longer true. Technology changed the rules because manufacturing, storage and distribution no longer have an intrinsic cost.

Terrestrial broadcasters have the opportunity to reposition their added value within the context of this new equilibrium. A combination of terrestrial broadcasting, Web streaming and e-mail lists are likely to be part of the new balance between head and tail.

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

iPhone

CONTINUED FROM PAGE 32

offerings all that polished or perfected out of the box. Great ideas take time to mature before they can be transformed into great products.

Short battery life and a battery that is not field-replaceable are further negatives. You'd think Apple would have learned from the mistakes of others in this regard. That big, bright display may be beautiful, but it also is power-hungry.

One last obvious oversight in iPhone is the missing FM radio tuner.

Maybe it's too unrealistic for a radio guy to expect Apple with its iPod and iTunes juggernaut to pay any attention to the need for a radio in a super smart phone. Yet others like Nokia and Samsung are doing it. Our industry needs to keep the heat turned up on the Cellular Telecommunications Industry Association to make an integrated radio a basic feature in all smart phones, especially as the HD rollout matures.

THE NEXT MOVE

Despite all the foregoing disappointments, the wonderful new iPod and Web-browsing experience of the iPhone are big winners.

Certainly the best features of iPhone will be quickly imitated in competing cell phone offerings very soon. If Apple is good at anything, it's great at pushing the envelope to squeeze out totally new and clever ways of doing familiar and common tasks.

PC Magazine ran a piece in June on how those of you with a hard case of iPhone-envy can make your present cell phone work more like the iPhone with various software enhancements; see *www.pcmag.com* and type "iPhone envy" into the Search engine. Suggestions include how to get iTunes and iSynch integration, and replace your browser with Opera-Light, a Safari-like experience.

The PC Magazine article also offers links to "Google Local for Mobile" for GPS mapping, "Mobilcast" for handling podcasts and "SimulScribe" to convey visual voicemail. However no other smart phone just yet has the equivalent look and feel of the iPhones's 3.5 inch touchscreen.

After reading my musings here and mulling it over a bit further, I think I've decided to wait a lot longer before reconsidering the purchase of an iPhone.

In the beginning I admit I was very impressed and almost seduced. It was like meeting a gorgeous new female employee at the office: An exciting and breath-taking experience in the beginning, but after the first encounter and some in-depth conversation, there's too much about her that doesn't measure up.

Best to follow the corporate HR policy on this one and don't mix business with pleasure.

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

Comment on this or any article. E-mail rwee@imaspub.com. ■

—Next Issue of Radio World: September 1, 2007
Radio World Engineering Extra: October 17, 2007—

For address changes, send current and new address to Radio World a month in advance at P.O. Box 1214, Falls Church, VA 22041. Unsolicited manuscripts are welcomed for review: send to the attention of the appropriate editor.

by Barry Blesser

The Long Tail Wags Broadcasters

Radio Must Embrace the Best of New Distribution Technologies to Synthesize a Future

In my previous column ("A Tall Tale of the Long Tail," June 13), I discussed how modern technology now enables businesses to focus on niche products (the tail of the popularity distribution curve) rather than being preoccupied only with blockbusters (the head of the curve).

While the long tail is becoming universal, it is particularly relevant to the radio industry, which traditionally focused on the head. Using a wide variety of delivery options, audio enthusiasts now select choices that are only of limited interest within the larger culture. Eventually, listening tastes become a collection of individual niche interests: customized preferences.

What changed during the last few years? A song track still has to be composed, performed, recorded, edited, produced, packaged, stored, distributed and then discovered by those with an interest in its unique properties. But if all of these stages become commodities, at a trivial cost, markets can profitably service the tail of the popularity distribution.

SCARCITY VS. COMMODITY

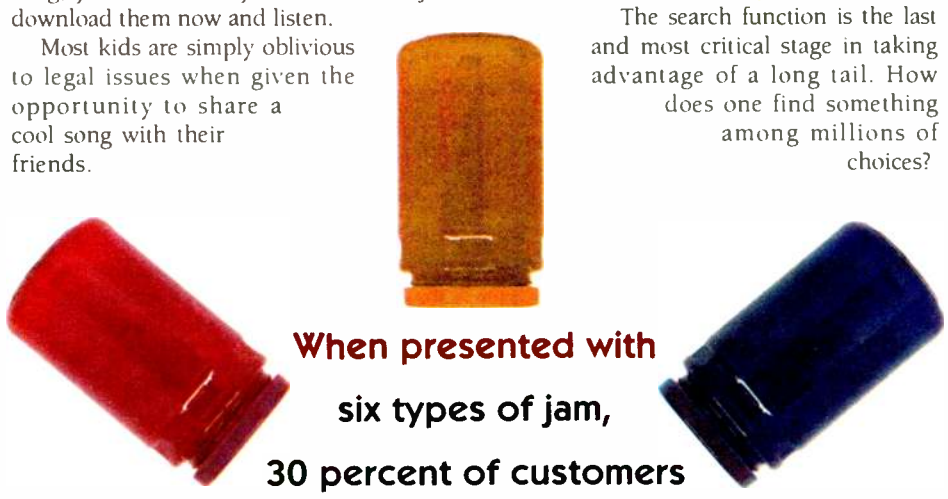
There are thousands of talented musicians who would love to quit their day job.

A personal computer becomes a recording studio for anyone with modest skill, time and resources, so production costs are minimal. Distribution over the Internet is essentially free, and search engines allow us to find even the most obscure objects. The entire chain now has no intrinsic cost. Even if the average song quality is relatively low, there are likely to be many gems in a pool of 10 million tracks.

Although the RIAA has asserted that kids steal music using the Internet to avoid paying for copyrighted media, many of these kids are motivated by the desire to participate in the long tail.

When visiting a friend's Web site, a teenager hears some cool song. The desire to add it to his collection is irresistible: he wants to be cool too, and he wants it now. Sharing files satisfies a need for immediate gratification. Kids post their favorite music on their Web sites, which become personalized versions of Google. If you like this song, you will like my other choices, just download them now and listen.

Most kids are simply oblivious to legal issues when given the opportunity to share a cool song with their friends.



When presented with six types of jam, 30 percent of customers purchased one. Faced with 24 types, 3 percent purchased one.

What's the lesson?

Except for popular songs from famous artists, nobody can distinguish between a song that is being freely distributed and one that is under strict copyright.

For example, when my son, who wants to publicize his singing talent, posts a song that he created, its legal status is unknowable by anyone who visits his site.

The dramatic shift in the balance between scarcity and commodity changed the context for everyone. Craigslist.com has replaced the newspaper's function of classified ads with a no-cost way of buying or selling goods and services. Netflix provides access to millions of obscure movies. Blogs become customized newspapers. Every day a new service or object is added to the unstoppable advance of long tail niches.

The search function is the last and most critical stage in taking advantage of a long tail. How does one find something among millions of choices?

When I discuss the ideas from an obscure book in my *Last Word* articles, I am providing the search function: finding and applying ideas that you might not otherwise have found among thousands of publications.

Similarly, broadcast programmers would do well to think about their balance between two distinctly difference types of services: (a) finding unusual songs in the long tail, and (b) saturating the airwaves with blockbusters from the head.

LESS IS MORE

Traditional terrestrial radio has been locked into distribution scarcity that prevents participation in the tail. The number of possible frequency channels is very limited. Satellite radio addresses this with an increase in channels, and even HD Radio might make a dent. But ultimately, the Internet will be king because it has more potential capacity than any of the alternatives.

It can "narrowcast" to 10 listeners in the tail at little cost. If narrowcasting ever becomes truly portable, and if the Internet remains free, it will become an even more aggressive competitor.

The only viable path for broadcasters is to embrace those technologies that combine the best features of the head and tail. Can broadcasters take advantage of the fact that for every revolution there is a counterbalancing reaction? A return to the "good old days" is not possible, but broadcasters can follow the universal dynamic of change: thesis, antithesis, synthesis.

Why is a synthesis inevitable? First, consider some related questions.

What social forces make listeners aware of what they want? Do they have the time and energy to look for the perfect song, shirt, dinner or vacation? Programming an iPod takes work even if every song was available at no cost. There might be new music genres that would appeal to many listeners if they had the time to find them.

When teenagers want clothing that matches the norms of their elite subculture, they are allowing someone else to determine their taste. With the freedom of the long tail comes the burden of managing your tastes. The reactive force is simply the burden of always exercising the freedom to have exactly what you want.

Chris Anderson, who publicized these concepts in "The Long Tail: Why the Future of Business Is Selling Less of More," mentions a self-limiting process for those who are faced with a long tail, which he calls the Paradox of Choice. The conventional wisdom is that having more

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Networked / Independent

This D-75N Console is BOTH

OUR DIGITAL D-75N is a full-featured standalone mixing console that can also be seamlessly integrated into the AUDIOARTS DISTRIBUTED NETWORK along with other D-75N consoles. Designed specifically for the broadcast industry, the D-75N is intended for on-air and production applications that demand a lot of function and performance. It's got all the features you need: four stereo program busses, dual caller Superphone module, line selector modules, control room and studio modules, plus additional accessory positions.

The D-75N gives you the benefits of both standalone and networked architectures—the console has both independent faders for "local sources" and six networked faders capable of accessing designated sources and mixes throughout your system. Single CAT-5 cables connect all studios to your central rackroom, eliminating the need for costly multi-pair wiring between rooms and making installation and expansion fast and easy.

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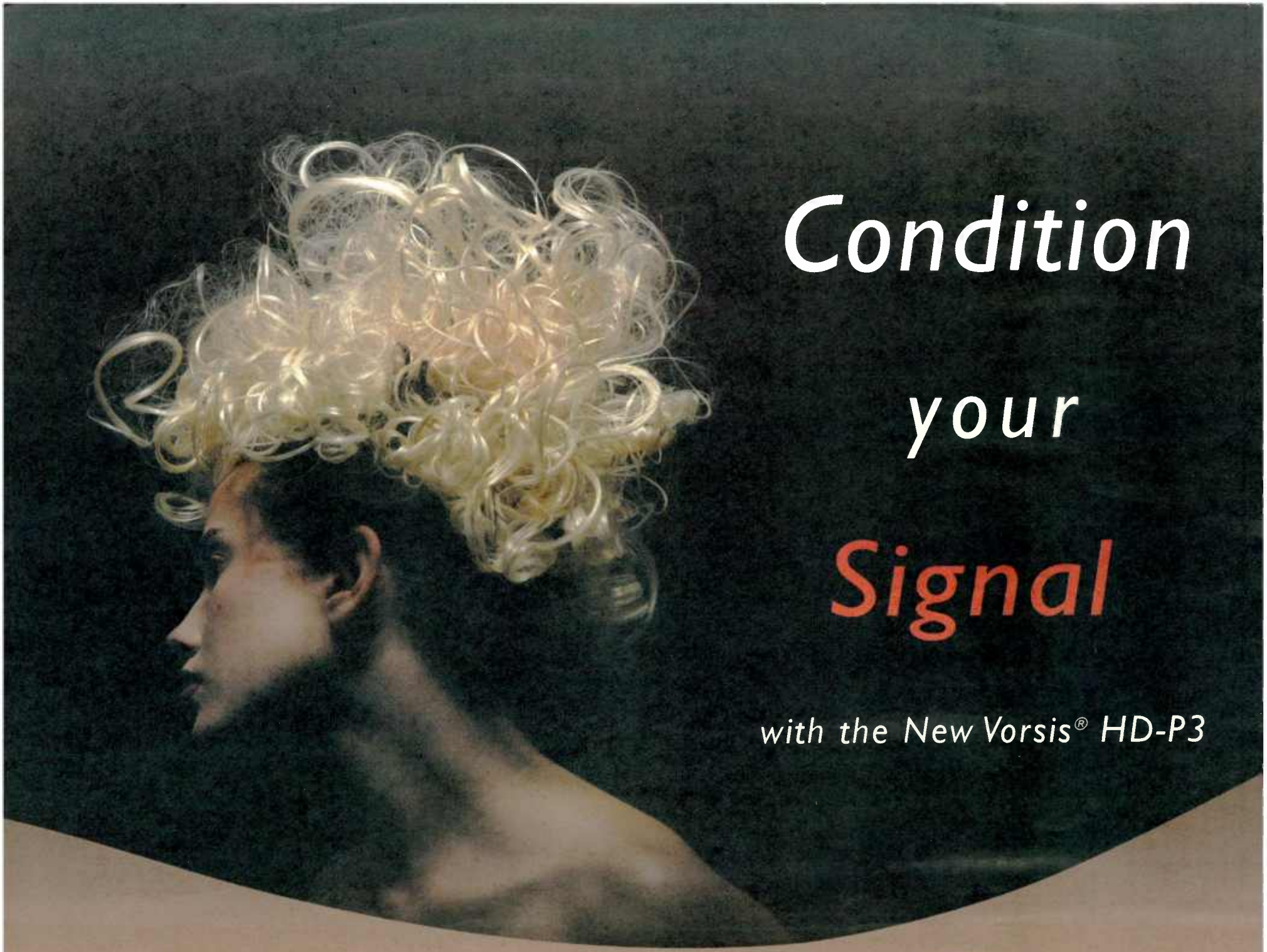

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