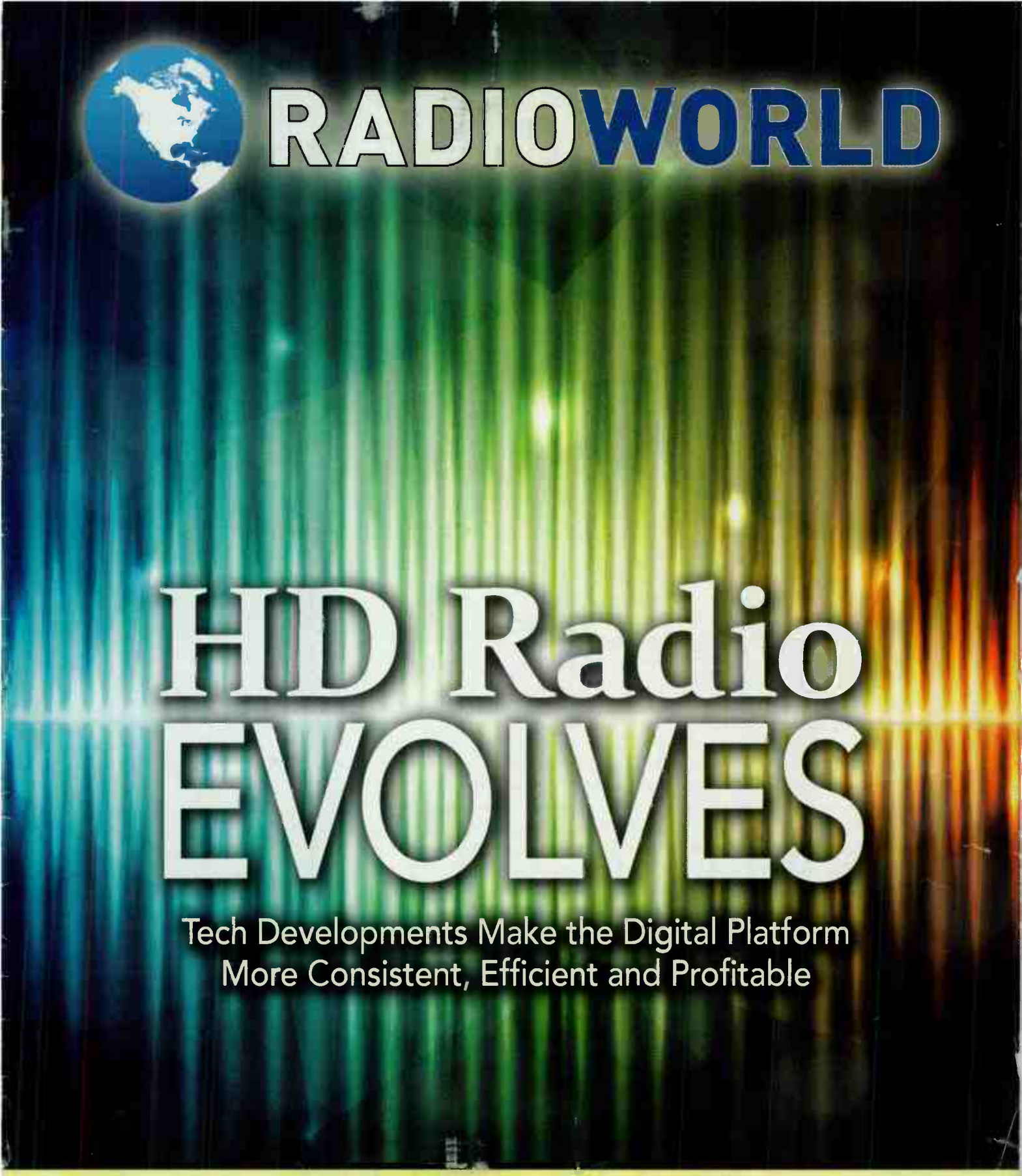

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A Special Supplement to Radio World

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World Radio History

HD Radio Evolves

With HD Radio now part of the FM radio fabric in the United States, developer iBiquity Digital Corp. has focused much of its recent public work on growing the technology's automotive footprint — it's in some 200 vehicle models now — and revenue-specific efforts like helping broadcasters monetize their HD2/HD3 channels with the launch of an HD Radio Ad Network.

But the platform itself continues to evolve, and there are technical developments too that, while less visible, are aimed at making HD Radio more consistent, efficient and profitable. Those are the subject of this special supplement, based on a recent Radio World eBook.

Radio broadcasters have become more aware of the importance of diversity delay analog and digital audio synchronization; and more products are on the market to help. Alan Jurison explores this topic.

Scott Fybush gathers industry reaction to a demo at the spring show of Nautel HD Multiplex, a prototype technology that the company says would enable placement of up to 15 audio streams or stations within 600 kHz of signal bandwidth or up to nine audio streams in 400 kHz of signal bandwidth. What might this portend?

Tom Vernon reports on the creation of a nationwide monitoring network, which iBiquity Digital Corp. says is "focused on improving the quality of HD Radio broadcast operations and the consumer HD Radio Experience."

And the eBook version of this supplement contains a white paper by Phillip Schmid of Nautel, in which he explains that the latest IBOC broadcast systems architecture from iBiquity transforms the Importer, Exporter and Exgine hardware components into software-defined components that can run on any of three iBiquity-supported hardware platforms. That paper provides a history of how the architecture has evolved and the hardware platform choices now available to equipment manufacturers. You can read it in the eBook version of this "HD Radio Evolves" supplement at *www.radioworld.com/ebooks*.

— Paul McLane, Editor in Chief

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World Radio History

Measure Diversity Delay and Correct for It Automatically

Vendors are responding to this important issue with solutions

by **Alan Jurison**

The hybrid digital and analog broadcasting solution deployed in the United States, FM and AM IBOC, more commonly known as HD Radio, allows simultaneous transmission of broadcast radio signals in both the analog and digital domain. A key component is that receivers can immediately acquire the analog signal and then transition (or blend) into the digital signal after it has acquired and buffered. The transition process is called blending.

Imagine your station's most important client in a vehicle with HD Radio hearing their commercial stutter.

In order to have this blend be seamless and transparent to our listeners, we broadcasters have had to employ delays on our analog AM and FM signals to match the digital. This delay is typically called "diversity delay" because the HD Radio transmission system uses a variety of techniques and buffering to add redundancy or diversity to the system for signal robustness.

This robustness and signal processing create significant delays compared to the near-instantaneous analog transmissions, typically anywhere from 6–10 seconds depending on hardware, software and data links in use. At a properly configured AM or FM station broadcasting in HD, there is a device in the analog air chain providing this delay.

In the first and second generation of HD hardware, this delay often was in the same device producing the HD signal. Over time, engineers demanded flexibility in configuration, reduction of hardware costs and fewer points of failure (the first two generations of hardware weren't particularly reliable).

The most common deployment of HD systems came in third-generation and recently introduced fourth-generation hardware, and these systems broke out the functionality of that single device into two, the Exporter and the Exciter. These components communicate over common Ethernet using a system designed by iBiquity called the Exgine platform. The connection between the two is considered the Exporter to Exciter (E2X) link.

As a station-level engineer, ever since I got my hands on an Exgine system (now in its tenth year in production hardware), I was challenged to keep the analog diversity delay perfectly aligned with the digital; and I wasn't alone. But this was the early days; the system was still being worked out, and many many of the major drifting issues were resolved over several software updates.

But precision tools available in the last few years have told us that there is still a long list of items that can cause diversity delay drift on a radio station: incompatible software/firmware loads, improper configuration of the hardware, poor isolation of network traffic and design of the E2X link, location of the Exporter and the Exciter and the latency or jitter on the data link it traverses, component aging and failures … and did you know that if you reboot your Exporter or Exciter, it often will come up with a slightly different delay than it had before the reboot?

A laundry list of items can cause a station's digital transmission timing to change. These, in turn, can cause diversity delay/ blend time alignment problems.

It's impossible to keep your station's diversity delay perfectly aligned through manual means. If you don't have a delay measurement device, it's also nearly impossible to know the precise amount of delay needed on your station. You should seek a way to measure the delay accurately and correct it automatically.

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SPEC

We as an industry really have not been looking at diversity delay measurement with the precision it has demanded. Part of the problem was that we did not have the tools when we launched our HD stations. The initial alignment procedure was to put on a set of headphones and put a receiver in split mode with the analog on the left and the digital on the right, and get them to match. As you might imagine, it takes a "golden ear" to get it perfect. I've determined with precision devices that I'm just awful at it. Or, if I get close, I've wasted half my day trying to get it right.

And let's say you do have that "golden ear"... your UPS on the Exporter just failed, your Exporter rebooted, the delay just changed. Are you able to listen to each of your stations continuously to make that adjustment? The answer is that nobody can do this job manually and stay up on it and provide the precision required to stay in spec.

The official specification is that the analog and digital signals should be at 0 samples, plus or minus 3 samples. So the range is –3 to +3, with the center of 0 being preferred. One sample refers to 1 out of 44,100 samples per second in the 44.1 kHz bitstream.

An extreme amount of precision is required to get this perfect. One sample is 22.7 µsec. Three samples means within 68 µsec. Many broadcast monitoring products show the measurement in seconds and samples. If you've been measuring your diversity delay in seconds from any of these products and been saying things like "...the station is off –0.0001 seconds... close enough," you have been doing it wrong.

I must admit, I was doing it that way for a long time as well. At four digits beyond the decimal point, that is a resolution of 100 µsec. Any reading that is not zero essentially is out of spec. If the station is off by 3 samples, that equates to 68 µsec, rounded to the nearest 100 µsec, you would get 100 µsec or 0.0001 seconds. Four samples is 91 µsec and would round to 0.001. So, you could be in spec or out of spec with that number; there isn't enough resolution. At 2 samples, that will round to 0.000 sec.

Looking at it another way, 0.0001 sec is very close to 4 samples off, but anything between 3 and 6 samples off will round to .0001 seconds.

The best way to avoid these issues is to just focus on the number of samples and stop looking at the time. We need to be focused on samples, not seconds. And when you look at it that way, that level of precision is only available consistently if we automate the process.

WHY DOES IT MATTER?

HD Radio is here to stay and growing rapidly in the only area where volumes of radio receivers are still manufactured: factory installed radios in new automobiles. Ten years ago, the industry wondered when these digital radios would show up. They are here now; your listeners already have them. In 2014, iBiquity reported that 43 percent of new automobiles came with HD Radio, standard. In 2013, that number was 33 percent. This equates to millions of HD radios being sold and used.

Are you able to listen to each of your stations continuously to make that adjustment? The answer is that nobody can do this job manually and stay up on it and provide the precision required to stay in spec.

Each day, more and more of your listeners have HD Radio receivers. Should trends continue for the rest of the decade, it's going to be hard to buy a vehicle without HD Radio in a few years. The digital experience of your radio station is something we should be paying attention to today. Within a few years, an HD Radio will become the primary radio your listeners will use.

If your station is not precisely aligned, all of the time, it makes that transition from analog to digital, or back from digital to analog when the HD fails, sound bad. How bad depends on how far off you are and what type of programming you have.

Stations that are lightly processed or air talk programming seem to be more susceptible to audible problems even with a small offset in samples. On loud, densely processed music stations the effects of being out of spec slightly can get buried in the program density to a point. But keep in mind, even these stations have periods of less density that are important, such as talk-intensive morning shows and commercials.

Imagine your station's most important client in a vehicle with HD Radio hearing their commercial stutter. So every station ultimately is affected by not being "in spec."

World Radio History

Diversity Delay

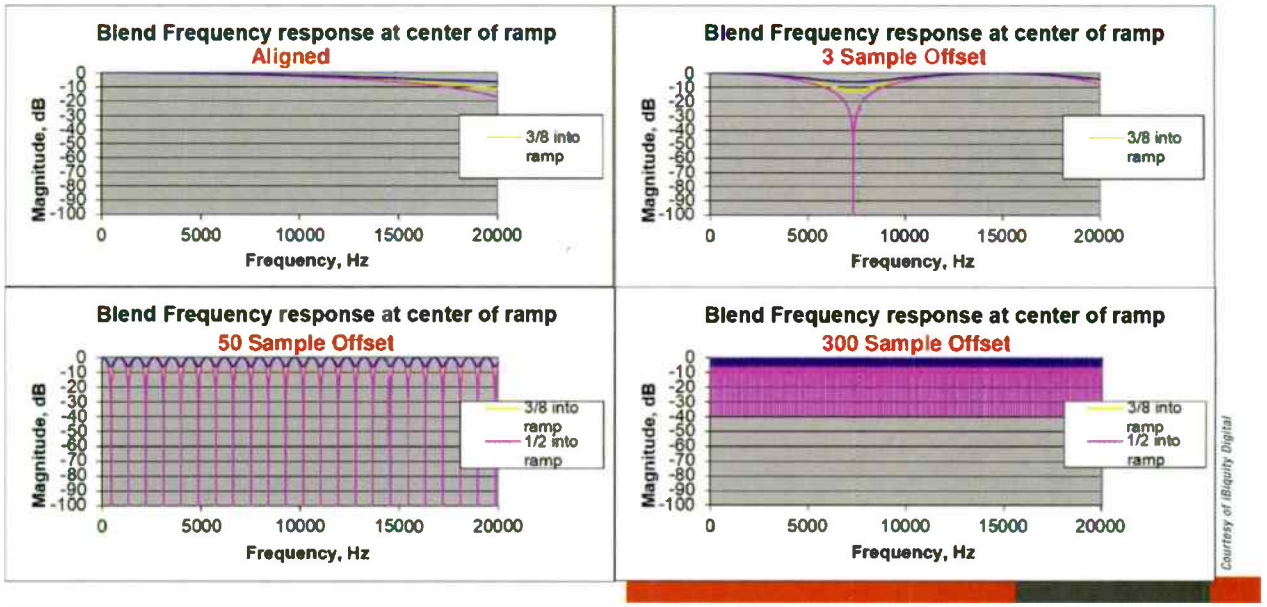


Fig. 1: Audible effects on blending at various sample offsets

IBiquity has done research, and you can get various audible blending effects depending on how many samples you are off. Fig. 1 shows the effect of different sample offsets and the impact on the audio. During a blend, any misalignment >5 ms (approx. 200–300 audio samples) will be perceptible to a listener as an echo or skipping effect. The two audio sources will sound distinct. Even small misalignments (< 200 samples) will produce a filtering effect during a blend. It will sound like one audio source, but will have a "hollow" sound due to a comb filtering effect. The effect is not noticeable if the misalignment is less than 3 samples.

Some people may think, "Well, the radio blends once 8 seconds after it tunes to the station, so it skips once; why does it matter that much?" Perhaps they think of the blend as an initial acquisition; then you keep digital forever. But that isn't always the case. Receivers of all types lose digital lock at some point. We could go into an exhaustive investigation of those situations, but that's a topic in itself.

The easiest way to think about this is in the car. Perhaps you think of the blend as if someone is driving out of your market. They have coverage, and at some point on the highway, they lose digital lock, it blends to analog, and eventually as you go out further and further, the signal is gone. But that's not the typical experience of your listeners. Most of your listeners do not leave the market and stations' signal coverage each day.

Think about your station's 60 dBu contour, which is where most –20 dBc stations tend to start to lose digital lock. If you live and work in that area, you can experience constant drifting in and out of digital. You can run into situations where the radio is blending quite a bit.

CAR COMPANIES CARE

Diversity delay blending issues are the number one complaint from auto manufacturers. IBiquity has told the industry that for years, their number one complaint about HD Radio is time alignment. I can independently vouch for this. I work closely with many automotive companies, and I've had emails, phone calls and idle conversations at lunch about this problem with their engineers. I have been in vehicles with these engineers where they hear stations skip and ask me to help fix it. The problem is, those stations typically belong to other companies, so it takes time to research who owns that station and to contact their engineering staff to have them make a manual adjustment.

GM temporarily removed HD in some vehicle models to help fine tune their implementation to address consumer feedback about HD Radio blending. It turns out that their customers (and our listeners) have been com-

World Radio History

plaining to them about this for a long time. But instead of calling up the radio station to complain about it, the customer takes the car back to the dealer and thinks there is a problem with the radio. Listeners are not (and should not be) educated enough on this issue to think to contact the radio station about this annoyance. This customer feedback is not unique to GM vehicles.

Automotive designers are sensitive to this problem, and it is my experience that 99 percent of the problems come back to issues on the broadcast side. We need to fix this with automated monitoring and correction.

WHAT CAN YOU DO ABOUT IT?

For years, broadcast engineers have been working with iBiquity and transmitter hardware manufacturers to resolve this problem. We have made progress, and addressed some of the most common problems that cause drift. But as I transitioned from a traditional broadcast engineer to an HD Radio implementation specialist, I have discovered there are just too many variables beyond the control of all parties involved; there really needed to be a push for automated diversity delay measurement and corrective systems. I and other colleagues have been asking for products and solutions in this area, and we've seen the industry respond in the last few years. This year at April's NAB Show in Las Vegas, we saw a large collection of solutions being introduced to the marketplace.

Below, we've created a roundup of products that can help you monitor and manage diversity delay. Note that we have not personally tested each solution, and the list should not be construed as a product review or endorsement. Also, this is an evolving space. Some vendors are working on integration efforts with other products; and there may be other offerings available. Check with each vendor about pricing and delivery schedules for products or software you are considering.

TWO IMPLEMENTATION STRATEGIES TO CONSIDER

Create a two-piece system. Consider pairing a monitoring receiver that can measure the diversity delay offset and send a correction offset to a device that is active in the analog air chain (an audio processor, delay unit or exporter). If you have some of these products already, this could make a lot of sense for your station. By upgrading firmware on your devices, you can possibly put together two pieces of hardware to come up with an automated hardware solution.

Single-box solution. Some stations may choose to implement devices that measure and correct the diversity delay in a single device. This is especially handy for stations that do not have products below already in their air chain, or for companies looking for standardization of delay solutions from station to station. The devices below can be inserted into either your analog or digital air chain to make delay adjustments and have an integrated receiver to make the measurements of delay offset. You can use a simple antenna on these units, or wire off an RF sample (in FM+HD installations) with the appropriate amount of attenuation and the device. Many engineers I have spoken with are most comfortable about having these right before the HD Exporter, so that any adjustments it is making to delay are limited to just the HD broadcasts and the analog plant remains exactly the same as it does today. In that use case, you increase the existing diversity delay in your analog chain to a larger number than you need today; then these devices will make up the difference on the digital chain. The advantage of going in this direction is that the devices can then correct digital level and give you level alignment between analog FM and HD. The disadvantage to it being in the digital chain is that it would not work for any station that has to eliminate all delay for live programming and enter what is commonly referred to as "ballgame mode." Luckily, the products are easily configured to work in either chain.

Some solutions may be a better fit for your station than others. There are many factors to evaluate, including repurposing equipment you already have, overall system costs and your level of comfort with the devices. As mentioned, this is a rapidly developing space. If you adopt now — and I suggest that you do — you might need to provide feedback and observations to the manufacturers to refine the code and products. The industry is going to learn a lot about this issue in the next few years now that we have tools to measure and correct for this delay automatically.

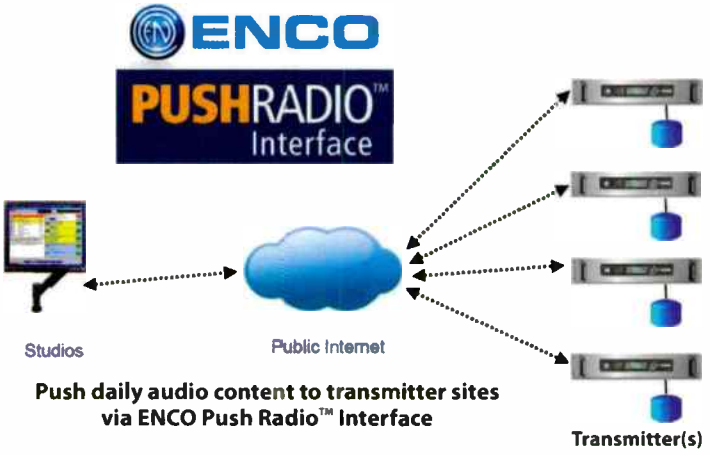
Belar

The FMHD-1 broadcast monitor receiver performs a variety of HD Radio-related measurements, and it can measure diversity delay continuously. Not only is this helpful when trying to manually align a station, the correction offset can be sent to a variety of devices in this list, such as products from GatesAir, Nautel, Omnia, Orban, 25-Seven and Wheatstone below. Currently, the FMHD-1 works on a single-station basis; however a future software update is being considered to have the device scan multiple station presents and send correction codes to multiple stations devices.

World Radio History

Automate Your HD Channels with DAD

Looking for a powerful radio automation system that gives you flexibility and scalability to grow with you in the future?
DAD by ENCO may be your answer. Not only is DAD considered the most reliable automation system available today, it was built with scalability in mind. Adding HD channels with DAD is easy. In fact, a single instance of DAD (Digital Audio Delivery) can run 16 independent playlists simultaneously. DAD gives you the flexibility to share content, run different commercial breaks for different feeds, and even push daily playlists directly to transmitters to stay on the air during STL outages.



Push daily audio content to transmitter sites via ENCO Push Radio™ Interface

Broadcasters are always looking for ways to get more for their money and a scalable radio automation package like DAD will prove well worth the investment.

Key Benefits

USER FRIENDLY:
Award winning Presenter interface for live assist Playout. Fast paced changes easily made on the fly. Customizable module based architecture.

CENTRALIZED CONTENT:
Share content across multiple stations. Easily break away for local commercials, liners and jingles and rejoin seamlessly.

EASY INTEGRATION:
Seamlessly integrate into any environment. DAD interfaces with all kinds of broadcast hardware and software.

AUTOMATIC CONTENT INGESTION:
Download content on demand or schedule and convert on the fly.

AUTOMATIC PLAYLIST CREATION:
Automatically create playlists out of music and commercial logs. Re-export traffic and without having to re-merge the logs.

CONTENT DISTRIBUTION:
Rule based content distribution to push or pull content between sites, studios, and devices.

FLEXIBLE COMMANDS:
Integral programming language allows for construction of commands and macros to operate the system more efficiently.

REAL-TIME LOG:
Real time log changes in any studio at any time. No need to reload the current hour or current day's log.

WORLD CLASS SERVICE:
ENCO's responsive client support is second to none and available 24x7x365.

DAD Flexes To Your Needs

No two DAD installations are alike. In fact, many sites use DAD in completely different ways. That's just one of the major benefits of using DAD; it's incredibly flexible to meet the ongoing demands of today's broadcasters. No longer will you be constrained by the automation system sitting at the core of your operation. Let DAD free you up to create radio how you want with the resources you have on hand.

REMOTE VOICE TRACKING:
Voicetrack into your playlists from anywhere in the world via Web Browser, iPad, or Windows PC. No VPN required.

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nautel GVSeries THE Choice for HD Radio® Digital AM & FM

Meet the new GV Series, the culmination of years of Nautel digital/analog transmission innovation.

Nautel's field-proven, high-power FM architecture is mated with advanced RF technologies, the award-winning AUI and a new Spectrum/Efficiency Optimizer to set a new standard for digital performance, efficiency, serviceability and unmatched functionality.

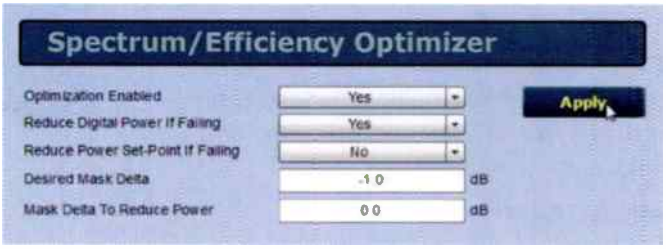
Learn more at **nautel.com/GV**

Highest Hybrid IBOC Efficiency

With the GV Series Nautel has charted new ground for digital transmission efficiency. Traditionally, digital hybrid modes have displayed much lower efficiency compared to analog-only broadcasting. The GV addresses the need for analog/digital hybrid efficiency as well.

New HD Spectrum/Efficiency Optimizer

A new Spectrum/Efficiency Optimizer dynamically optimizes digital transmission parameters to achieve optimum spectral performance and efficiency. Digital efficiencies have improved by up to 15%. High digital efficiency can result in tens of thousands of dollars savings over the life of your transmitter.



70% at -20 dB | **57%** at -14 dB | **52%** at -10 dB

Nautel 1st to Deliver MER HD Radio Instrumentation

Nautel's award-winning AUI enables real-time measurement of MER including the ability to diagnose issues such as interference with the MP3 carriers near the analog signal due to FM analog signal over-modulation. Measurements follow the new NRSC standards and require no external equipment.

Learn more at **nautel.com/MER**

Try Nautel's Exclusive NPR HD Radio Calculator

npr labs

Calculate a proposed IBOC power increase using Nautel's exclusive Asymmetrical IBOC Sideband Elevated Power Calculator from NPR Labs®.

Try the NPR HD Radio Calculator at **rftoolkit.net**

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World Radio History

HD PowerBoost™ GEN4

Nautel's award-winning HD PowerBoost GEN4 is a revolutionary technology that increases HD Radio power output while increasing efficiency, and addresses the FCC HD injection level increase ruling. It uses an intelligent peak to average power ratio (PAPR) technique to squeeze more hybrid power from any given transmitter and increase hybrid-mode efficiency.

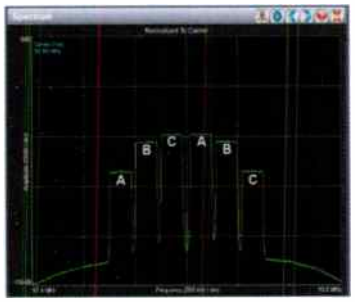
Learn more at **nautel.com/HDPowerboost**

More IBOC Power at Any Nameplate Level

Nautel's GV Series offers more IBOC power than any other transmitters available today. In a single cabinet, Nautel GV transmitters can provide up to 36 kW of analog power with a -14 dB injection level and up to 26 kW with -10 dB injection. In fact they can even make their nameplate power at -16 dB. (e.g. a GV30 can make a full 30 kW of analog power with digital carriers at -16 dB).

Pushing HD Radio Transmission Boundaries

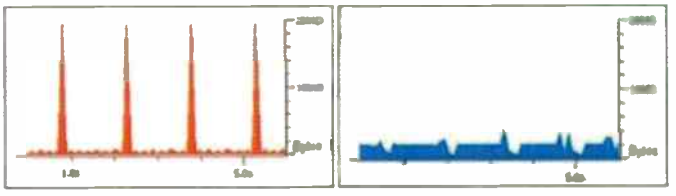
HD Multiplex



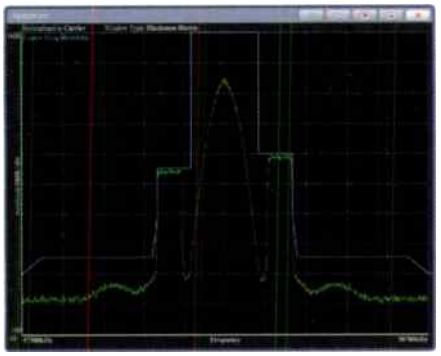
This new experimental technology is a spectrally efficient and energy efficient means to implement all-digital radio utilizing a multiplexed implementation of iBiquity's Gen4 HD Radio™ transmission technology. It enables the placement of up to 15 audio streams or stations within 600 kHz of signal bandwidth or up to 9 audio streams in 400 kHz of signal bandwidth. Learn more at **nautel.com/HDMultiplex**

HD Reliable Transport

This software solution helps eliminate IBOC audio drop-outs. It is applicable to every HD Radio deployment and allows various multiple exciter configurations to be implemented, such as main standby exciters, multi frequency networks, single frequency networks and satellite distribution applications.



BEFORE AFTER



Asymmetrical Sidebands

If interference issues prevent the use of increased IBOC injection levels on both sidebands, broadcasters can use Nautel's award-winning asymmetrical HD Radio transmission capability to increase only one sideband while leaving the other at levels that do not cause interference with adjacent stations, and still achieve maximum coverage of their digital signal.

Learn more at **nautel.com/AS**

nautel

World Radio History

Broadcast Electronics

The XPi10 esp HD Radio Exporter has a built-in diversity delay alignment feature. If you provide the Exporter with audio of the analog and digital from a receiver running in split mode through the unbalanced audio inputs, when configured, it will measure and maintain diversity delay. Note that the station must be configured to have the analog diversity delay fully provided by the exporter for this feature to be useful.

DaySequerra

The M4DDC is a single-box solution that can do the measurement and delay adjustment in a single box. It inserts in your AES stream of either the analog or digital air chain and can make the corrections necessary for time alignment, level alignment and phase reversal correction. It has a Web GUI and can alarm via GPIO, SMTP (email alarms), and also has an SNMP interface. The GUI also does data collection and can show you how the device is working overtime. This is an FM-only device; an AM version with slight hardware variations is expected later this year.

The M4.2 TimeLock broadcast monitor receiver makes a variety of HD Radio-related measurements; this product can measure diversity delay continuously, helpful for aligning stations manually. In addition, it supports automatic diversity delay correction with the GatesAir HDE-200 Exporter and the Orban processors mentioned below. Future support for Nautel, Omnia and Wheatstone products below is planned.

GatesAir

The HDE-200 Exporter can receive correction outputs from both the Belar FMHD-1 and the DaySequerra M4.2 TimeLock. Note that the station must be configured to have the analog diversity delay fully provided by the exporter for this feature to be useful.

Inovonics

The JUSTIN 808 is a solution that can do the measurement and delay adjustment in a single box. It inserts in your AES stream of either the analog or digital air chain and can make the corrections necessary for time alignment, level alignment and phase reversal correction. It has a Web GUI and can alarm via GPIO, SMTP (email alarms), and also has an SNMP interface. The GUI also does data collection and can show you how the device is working overtime. This is an FM-only device.

Nautel

The Exporter Plus can receive correction outputs from both the Belar FMHD-1 and the DaySequerra M4.2 TimeLock. Note that the station must be configured to have the analog diversity delay fully provided by the exporter for this feature to be useful.

Omnia

Omnia 7, Omnia 9 audio processors can work in conjunction with the Belar FMHD-1 to automatically adjust the analog diversity delay, with future support for the DaySequerra M4.2 TimeLock planned.

Orban

The Orban 8600, 8600S, 8500, 8500S, 5700 and 5500 audio processors can work in conjunction with both the Belar FMHD-1 and the DaySequerra M4.2. Orban notes that even the non-HD versions of these processors make diversity delay available for stations running separate analog FM and HD processors.

25-Seven

Precision Delay can be inserted in the analog air chain to achieve diversity delay and supports automatic correction adjustments from both the Belar FMHD-1 and the Worldcast/Audemat Golden Eagle HD.

Wheatstone

AirAuraX3, FM531HD, FM-55, and AM-55 audio processors can work in conjunction with the Belar FMHD-1 with future support for the DaySequerra M4.2 TimeLock expected but not available yet at time of publication.

Worldcast/Audemat

Golden Eagle HD is a broadcast monitor receiver that performs a variety of FM and HD Radio related measurements, including diversity delay. It can work with the 25-Seven Precision Delay for automatic diversity delay correction. Also, it can be configured to monitor diversity delay alignment and send alerts if alignment (or other parameters) are out of specification. All alignment measurements are available via SNMP for use by third party equipment. ■

Thanks to Harvey Chalmers and Jeff Detweiler of iBiquity for providing insights on their research.

Alan Jurison is a senior operations engineer for iHeartMedia's Engineering and Systems Integration Group. He also chairs the NRSC RDS Usage Working Group (RUWG). He holds several SBE certifications including CPBE, CBNE, AMD and DRB. His opinions are not necessarily those of iHeartMedia, the NRSC or Radio World.

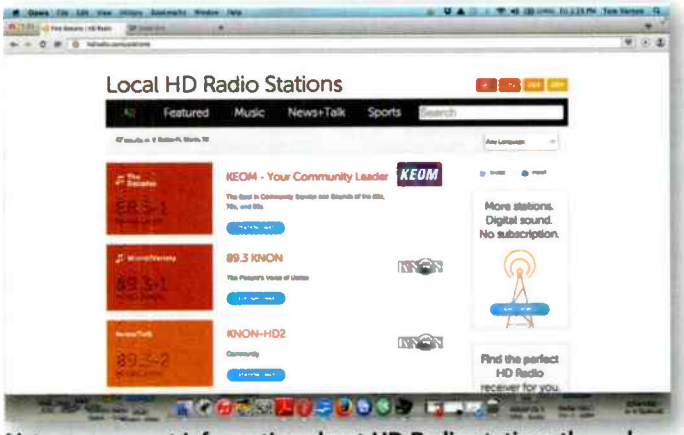
World Radio History

Creating the HD Radio Monitoring Network

It's intended to provide more technical insight and enhance the experience for listeners

by **Tom Vernon**

At the NAB Show in April, iBiquity Digital announced the development of a monitoring network for HD Radio stations. The project has been completed in the top 10 radio markets, as well as Detroit (market 12) and Las Vegas (32). Plans are underway to have the network operational in the top 50 markets by the end of the year. DaySequerra and MediaMonitors collaborated with iBiquity on the project.



Listeners can get information about HD Radio stations through the website HDRadio.com or via the HD Radio Guide app on mobile devices.

Senior Vice President Joe D'Angelo identified two driving forces behind the creation of a monitoring network.

"First, we wanted to get a better technical insight of the HD Radio landscape for ourselves. We have scaled up to 2,300 licensed stations with over 3,000 programs and data services. There are also about 25 million HD Radio car radios. This project has a huge potential to provide useful information for iBiquity, as well as give feedback to stations," he said.

"Second, we wanted to enhance the HD Radio experience for our listeners, and provide a tool for them to find the format they want to listen to. Listeners can find out about stations through the HD Radio Guide app or at HDRadio.com. Both services use a database of station information, including call signs, frequencies and formats. The monitoring network is a way to keep that information current."

PARAMETERS

By way of example, D'Angelo said the monitoring sites briefly scan each station's data channel. If the program type doesn't match what is on the guide, the guide is updated. Right now there is a human step in between to validate the changes, but the process is expected to be automated soon.

Jeff Detweiler, executive director, broadcast engineering for iBiquity Digital, said the low-level technical capabilities of the system are comprehensive.

"We can monitor about 140 parameters for each station's HD Radio signal. We normally check 20 on a regular basis. If we note a problem, or one is reported by listeners, we can do a more detailed analysis, and reach out to the station's engineer."

The DaySequerra MAM2 monitors analog AM/FM signals as well as HD Radio and EAS. Users can view the public parameters of all HD Radio signals in addition to the public and private parameters of their own stations via an iBiquity-issued broadcast token.

After about a month of observing the technical parameters of HD Radio stations, Detweiler said the overall picture is "very good." While on the phone with Radio World, he makes a quick check of the dashboard

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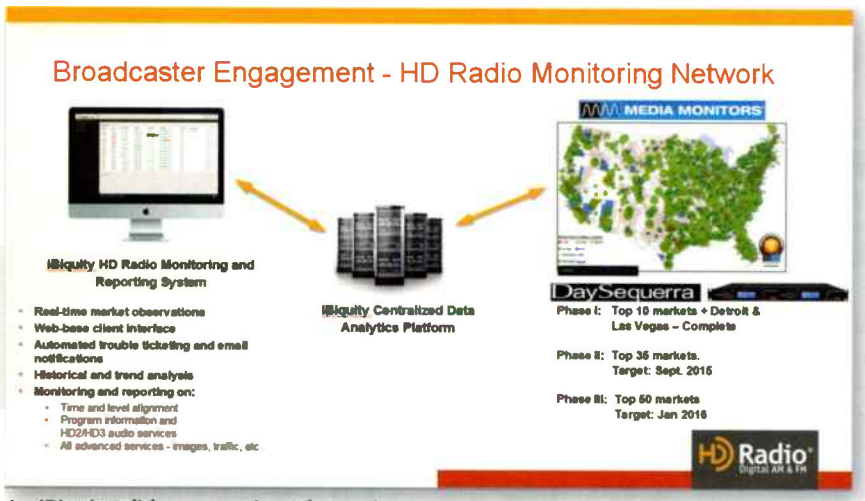
for New York and observes that of the 23 HD Radio stations, all but two are green; those two have minor problems with level alignment, he said.

"Moving forward, we expect to see continuous improvement in the technical performance of HD Radio, as there is ongoing feedback from the monitoring network to iBiquity and on to the stations," he said.

D'Angelo emphasized that the network "is not a substitute for a station's due diligence in monitoring and maintaining their HD Radio parameters. They should think of it as a second form of validation."



An iBiquity slide summarizes the project.

The monitoring system is transparent to HD Radio stations; there is nothing station engineers need to do, except respond to calls from iBiquity if there is a problem. But D'Angelo said stations can take a step to help: "We maintain a database of contacts at each of the stations. Obviously, people move around. If stations can update their contact list when there are personnel changes, that would be very useful." He said the easiest way is via email to *quality@ibiquity.com*.

Although the rollout of Phase One is ongoing, iBiquity is planning for what comes next. "We want to be monitoring HD Radio stations in the top 75 markets or beyond by the end of 2016," said D'Angelo. He adds that the next year will also include adding the top seven or eight markets in Canada, as well as Mexico.

Under discussion is a plan to share technical data gathered from the monitoring network with equipment manufacturers. "We may be able to spot a small problem before it goes critical," says D'Angelo. "Putting the manufacturers in the loop may lead to fewer unnecessary service calls and more expedited repairs."

IN THE FIELD

All of the monitoring sites are equipped with DaySequerra MAM2 monitors. DaySequerra President David Day said the origin of the device is an interesting story.

"Initially, we were approached by one of the broadcast groups through iBiquity to develop an update for our Market Area Monitor that we fielded years ago with Arbitron. Shortly thereafter, iBiquity asked us to expand the project scope and develop a version that could monitor virtually every attribute of an HD Radio signal. The MAM2 was in development for over 2-1/2 years."

He said the MAM2 monitors are able to scan all analog AM/FM and HD Radio broadcasts in a market, and that the MAM2 software is customized for each customer.

"Every HD Radio signal has some parameters that are public, and some that are proprietary or unique to a group owner. Using an iBiquity-issued broadcast token, MAM2 users are able to view both the public and proprietary parameters of their own stations, but only the public parameters on other stations in the market," said Day. The monitors built for iBiquity Digital are able to monitor all parameters on all stations including EAS messages. Each MAM2 takes up half of one rack width.

Once the monitoring devices have been manufactured, they must be installed and maintained at the monitoring sites; that's where Media Monitors comes in to the picture.

Media Monitors is a subsidiary of broadcast software company RCS. President/CEO Philippe Generali said iBiquity Digital's decision to partner with his company was due in part to the infrastructure that Media Monitors has in place.

"We have monitoring sites in about 160 markets, so it's fairly easy to add the iBiquity monitors in our equipment racks." The sites are chosen for IT access, backup AC power, backup air conditioning, and of course excellent reception of all broadcast signals in the market. Most are in central downtown locations.

Generali said the rollout of the iBiquity monitoring sites is on schedule. "We expect to have the top 25 markets complete by the end of the summer, and the entire project done by the end of the year." ■

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HD Multiplex Scheme Brings Promise, Obstacles

Demo at the spring show grabs attention; its long-term implications are to be seen

by **Scott Fybush**

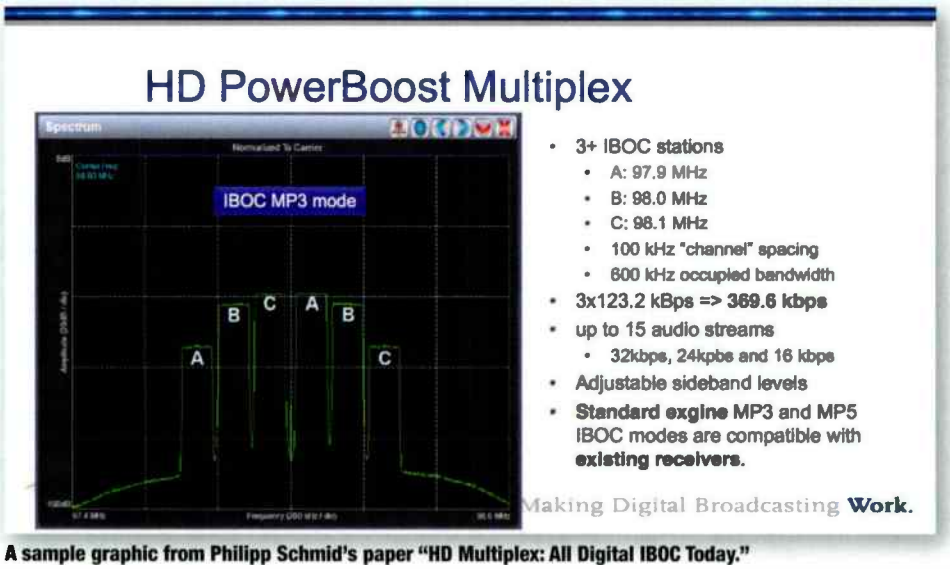
For broadcasters willing to dream big about a potentially disruptive change to the entire layout of the FM dial, Nautel's announcement of an experimental "HD Multiplex" technology at the NAB Show in April comes with the possibility of lower transmission cost and space for many more audio streams in any given market. The road from experiment to adopted technology could be a rocky one, though, especially on crowded U.S. radio dials.

"It is still very, very early on," says Nautel research engineer Philipp Schmid of the HD Multiplex system, which was envisioned just a few months before making its debut in Las Vegas.

At its core, the multiplex system starts with the digital carriers that currently sit on either side of an FM station's analog signal. While iBiquity's HD Radio system has long included at least the concept of an all-digital mode in which additional lower-level digital carriers would fill the 200 kHz hole where a station's analog signal now lives, "that hasn't really been implemented anywhere," Schmid says. "Now you can transmit HD without analog and it works, but it leaves that big gap in the middle."

Nautel is proposing to fill that gap by straddling it with additional digital carriers just like those used in the present hybrid digital/analog system. As it demonstrated in a test on the floor of the NAB Show, the Nautel multiplex system could stack three alternating sets of digital carriers across 600 kHz of spectrum in a way that most HD Radio receivers now on the market can receive. That could create room for as many as 15 streams of audio, which would appear on the radio as multiplex channels attached to three consecutive frequencies (say, 98.5, 98.6 and 98.7 MHz).

"The whole concept is very flexible," Schmid says.



A sample graphic from Philipp Schmid's paper "HD Multiplex: All Digital IBOC Today."

Unlike the European DAB systems or others that need specific carriers, Nautel's system can at least theoretically be expanded or contracted, functioning within as little as 400 kHz or, conceivably, adding still more alternating sets of HD multiplexes that could take up 800 kHz or even more, with correspondingly larger numbers of channels available.

"NEW GROUND"

"They're kind of breaking new ground here working with all-digital FM," says David Layer, senior director

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for advanced engineering at NAB. Layer says Nautel's proposed system is "unconventional" but intriguing, especially in the way it promises significant power savings.

"Normally a broadcaster would use three transmitters to provide three stations," he says, "but they've rigged software to do all three." Because HD Radio's digital carriers already operate at much lower power levels than the analog signal they sandwich, a multiplex of purely digital carriers would also operate at lower power with correspondingly lower power bills.

Inventing the technology is one thing, but getting it approved by regulators and finding a market for it may be a bigger challenge.

"The first thing you have to recognize is that all-digital FM is not currently recognized by the FCC," Layer says. "It would take a lot of work to get this to the point where it's something the FCC would even consider."

The multiplex system could stack three alternating sets of digital carriers across 600 kHz of spectrum in a way that most HD Radio receivers now on the market can receive.

Another informed observer is Milford Smith, vice president for radio engineering at Greater Media and chairman of the National Radio Systems Committee.

"I believe it would be a considerable challenge to fit this additional spectral occupancy into the existing tightly-packed FM spectrum. Full-power stations, many new LPFMs and many new translators have all made the FM band a very busy place," Smith said.

Nautel's Schmid says much of the interest in a multiplexed HD Radio system is coming from outside the U.S. "In Europe, HD Multiplex could become an in-band alternative to DAB, leaving Band III available for DVB." In Mexico, regulators are pushing to clear the AM band but have been thwarted in bigger markets by a lack of space on the FM dial. "So we have some broadcasters interested in trying all-digital IBOC there."

At least for now, most U.S. broadcasters aren't terribly interested in following those leads.

"I do not believe there would be a lot of real-world use of the concept in the near future, even if the potential allocation/interference issues could be solved," Smith says. "We still see very few FM broadcasters going beyond HD2 implementations now and fewer still able to appreciably monetize those multicast channels. I just don't know what one could do with all those additional channels that would make business sense circa 2015."

Schmid says one potential use in smaller markets might be allowing a single broadcaster (or several working together) to bring in niche formats that might not otherwise be feasible in their areas.

"Now that you have 15 audio streams, you could have 15 different genres with crowdsourced content. Each individual listener would have greater input into the playlist, and you could potentially have a big jukebox service."

Schmid also points to another announcement from the NAB Show, the HD Radio Ad Network that's already looking to place Radio Disney content on HD Radio subchannels in the top 60 markets.

But making the leap involved in turning off an FM analog signal is still a huge jump for most U.S. broadcasters.

"HD Radio penetration would have to be 90 percent or more before any broadcaster would likely even consider turning off the analog service," Smith says. "And even assuming that deployment could be possible and digital receivers were ubiquitous, I doubt if most FM broadcasters would be enamored with the idea of exponentially increasing the number of potentially competing signals."

Schmid says the proof will be in the testing, which is being planned both in the lab and, he hopes, under experimental licenses at stations willing to help demonstrate the system under real-world conditions.

"We do have stations stepping up and saying if you want to test, we've got an application for you," he said.

Whether this eventually becomes an industry standard or just an interesting technological footnote, NAB's Layer says he's pleased to see Nautel and other companies testing the limits of radio technology.

"I applaud Nautel for doing something this innovative," he says. "This is exactly the kind of activity you want to see with a technology like HD Radio. You want to see them doing things with the technology that even the developer didn't envision." ■

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