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Maximize Your FM Coverage

Paul McLane
Editor in Chief

One of the best things about my job is that it brings me within the professional orbit of so many very smart people. This ebook provides a fresh example of the quality of opinions and expertise to be found in RW's issues and ebooks.

Here, we set out to ask how FM broadcasters can maximize coverage of their over-the-air signals.

We wanted to know what strategies 21st century consulting engineers are using to squeeze the most out of FCC allocations, what role single-frequency networks are playing in today's spectrum strategies, and how RF software can be used to resolve problems or plan upgrades, among other things.

The engineers, consultants and sponsors who answered our questions include Bob Weller, Philipp Schmid, Paul Shulins, Sean Edwards, Frank McCoy, Jeff Detweiler, Gary Luhrman, Doug Vernier, Keith Pelletier, John George and Gary Cavell. My thanks to them for taking time to share their insights.

Radio World's ebook library includes many helpful resources that relate to managing the transmission side of your air chain. Scroll through just the past couple of years at radioworld.com/ebooks and you'll find topics like getting the most out of remote control and management systems; RF site maintenance best practices; virtualization of the air chain; and smart ideas for RF redundancy and reliability.

THIS ISSUE

A station's main channel is usually the most profitable

That may seem obvious, but make sure you've gotten the most out of it, even if exploring more exotic options

Bob Weller is responsible for developing and implementing spectrum policy for the National Association of Broadcasters. Prior to joining NAB, he was chief of technical analysis at the FCC and worked for 14 years as a consulting engineer.


Bob Weller

What legal or technical strategies have stations been using to maximize FM coverage or expand their presence?

Bob Weller: Broadcasters and their engineering consultants are very creative at finding ways to gain listeners. A station's main channel is usually the most profitable and the one that brands the station. So, getting the best possible coverage from the main transmitter is usually the most cost-effective strategy. That could mean ensuring you're getting the most out of your present site and studying alternative transmitter sites to see how they compare. Translators and single-frequency networks can improve coverage but those options are very location-dependent. SFNs can only serve areas within your existing coverage contour, so it's important to be sure that contour is maximized. SFNs can also create self-interference so it's important to do detailed studies and testing.

Translators are less restrictive than SFNs in terms of location, but finding channels for translators is increasingly challenging.

What advice would you give to an FM broadcaster who came to you and asked how they might go about maximizing coverage, expand their signal footprint or maximize existing spectrum?

Weller: The first step is to know where your listeners are. Once you know that, ask whether the station is at the best site to serve them. Then ask whether you can improve at your existing site by increased power or maybe a better tower position.

If not, consider whether there is a better site. A site close to the city center is not always the best choice. Commuters are usually a target audience, and you need to understand where they live and where they work and try to serve as much of that route as possible.

What about strategies to deal with coverage gaps and other signal challenges?

Weller: It's important to know where the coverage problems are geographically, and what those problems are. Are you dealing with a weak signal, interference from another station, multipath distortion? Each of those problems usually requires a different approach. Terrain-obstructed areas are usually the best case for SFNs since the extent of interference is inherently limited. SFNs, a.k.a. boosters, are becoming increasingly sophisticated and can help fill in coverage gaps due to terrain.

Know your competitors. If your station has coverage gaps, your competitors probably do too. So there may be an opportunity for several stations to jointly develop a fill-in site and share costs. Or the fix that a competing station did might be a good choice for your station.

What modeling tools are available to help licensees?

Weller: There are lots of terrain-sensitive propagation

> **Translators are less restrictive than SFNs in terms of location, but finding channels for translators is increasingly challenging.**

modeling tools available today, and most consultants have a go-to favorite. An experienced consulting engineer will understand the limitations of the propagation model and understand what features are important to include (or exclude).

Longley-Rice is a popular model because it's free and because the FCC uses it. Saying "I use Longley-Rice" doesn't really tell you the whole story, though. What terrain database are you using? Are you considering clutter and morphology? How are you handling out-of-range errors? Do you have measured data for the antenna being studied? Are you considering interference from other stations?

All of those things affect the accuracy of the results, and there is no "right" choice for every station.

You mentioned single-frequency networks; what should we know about them?

Weller: SFNs can create self-interference problems if they are not carefully engineered. It doesn't take much time for a listener to become annoyed and tune away, so it's important that you be certain that an SFN isn't creating new problems. Even well-engineered SFNs don't match real-world conditions, so field testing is often an important step prior to committing to an SFN design. An SFN means paying rent at multiple sites, so it's important to test.

Along those lines, how can any broadcaster assure that actual performance lives up to predicted coverage?

Weller: A simple drive test using the car radio is a good starting point to see if the station's coverage matches your expectations. An engineered drive-test with a measurement receiver is the next step that can help confirm actual signal levels are as expected. If there are specific problems such as multipath, specialized equipment can help identify what's causing them and point toward possible solutions. There are consultants who will fly your antenna with a drone aircraft, which is a great way to verify that the installed antenna is working as performed.

HD Radio maximizes the existing FM spectrum

Philipp Schmid on HD Radio SFNs and other strategies

Philipp Schmid, P.Eng., joined Nautel Ltd. in 2005 to develop embedded electronic systems for the deployment of digital radio such as the HD Radio exgine modulator and pre-correction and peak-to-average power reduction for digital signals. In 2019 he was named chief technology officer. He has a bachelor's degree in electrical engineering with an emphasis on computer engineering and a master's in electrical engineering.

Philipp, what's your advice for an FM broadcaster who seeks to maximize coverage or expand their footprint?

Philipp Schmid

Philipp Schmid: FM broadcasters serve the public at large. As a steward of their allocated frequency, it is a station's responsibility to maximize their existing spectrum as a shared public resource. This becomes ever more important as fewer and fewer frequencies are available for new FM radio services.

HD Radio maximizes the existing spectrum. The reduced power of the IBOC carriers minimally impacts the FM host station while the improved robustness of the IBOC carriers work well with an adjacent FM carrier at a much higher power level. IBOC exploits the white space that exists by virtue of well-planned FM allocations as no other analog FM carrier could otherwise be co-allocated on the first-adjacent channel.

What strategies do you see broadcasters using in this vein?

Schmid: The FM radio broadcast service first and foremost serves its listeners and thus naturally wants to increase its potential reach to more listeners. Expanding RF signal coverage is important to reach more listeners, but other options exist like leasing HD side channels on stations in adjacent markets. By converting to HD Radio, a station will maximize their allocated spectrum and perhaps could achieve a reciprocal agreement with a sister station in an adjacent market, in the end providing both markets with greater radio diversity without requiring additional frequency allocations.

How about strategies to resolve signal problems?

Schmid: An increasing challenge in urban areas is shadowing through more and more high-rise buildings potentially creating gaps in coverage that did not exist before. Engineers should always strive to maintaining a clean, well-performing signal. Perhaps single-frequency networks are the answer to fill in these or other coverage gaps.

Are HD Radio single-frequency networks a thing? What should we know about them and how they might be used?

Schmid: Yes, HD Radio SFNs are absolutely a thing. Since I presented my paper "Single-Frequency Networks for HD Radio" at the 2017 Broadcast Engineering and

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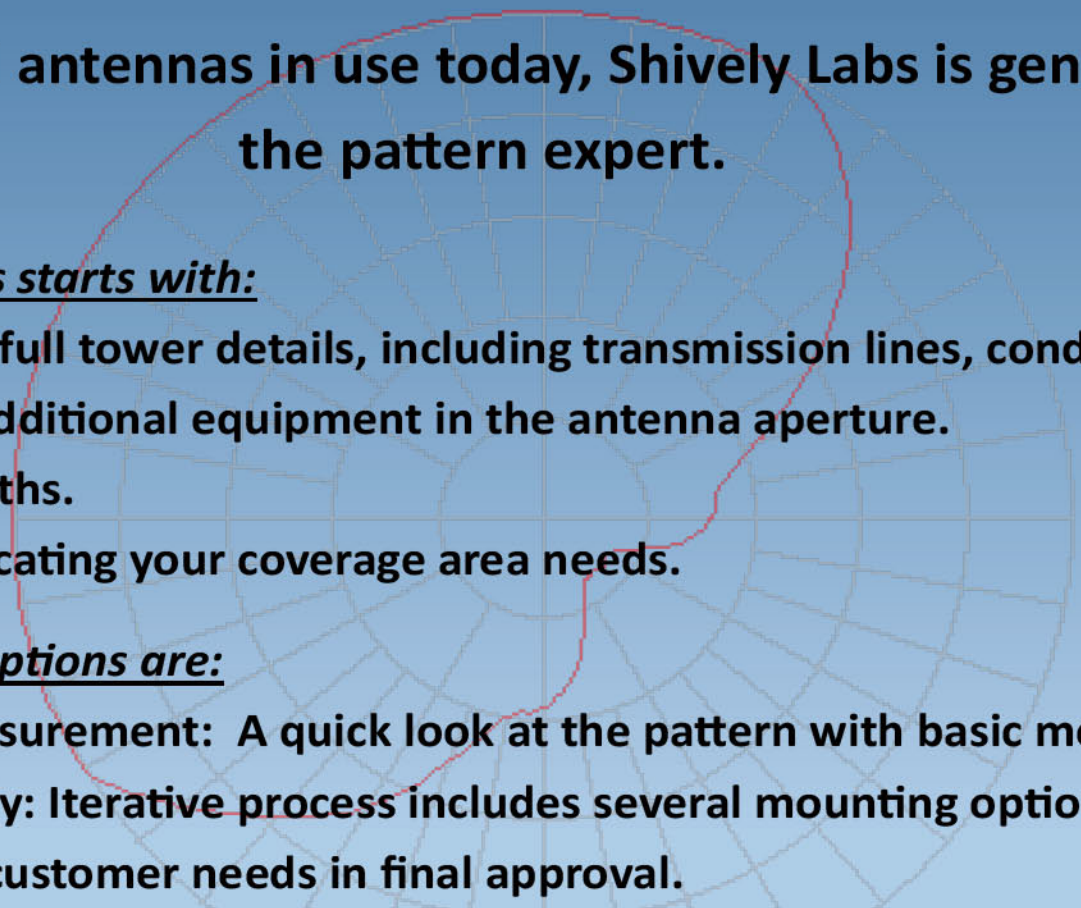

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IT conference in Las Vegas, Nautel has successfully installed several HD Radio SFNs in the United States and Canada. The FM band in urban centers is congested, leaving many stations to either choose a broadcast site outside the urban core or settle for a lower-power signal within the urban core. A weaker signal in the urban core can be greatly affected by new and existing high-rise buildings. SFNs can restore signal coverage out to the protected contour.

How hard are they to set up; what gear and consulting services does the broadcaster need to know about?

Schmid: The OFDM modulation inherent in HD Radio is ideal for SFNs as it rejects multipath interference no matter if it is a building reflection or a second on-channel transmission. On the NAB Show floor we demonstrated the power of HD SFNs on Nautel VS transmitters with synchronization technology in Nautel's exporterPlus and VSHD exciter both synchronized via GPS. We showed that an HD Radio receiver can maintain lock as one transmitter is turned off and a second is turned on, demonstrating a seamless handoff from one coverage region to another.

Coupled with Nautel's IBOC SFN solution, we now offer the Digidia SyncFM and SpanFM, which has been deployed to hundreds of FM highway transmitters in France in a SFN configuration for the analog FM carrier. The two solutions together provide a full SFN solution for hybrid HD Radio.

The challenge in the SFN network planning resides with the analog FM coverage planning, where the services of an experienced consulting engineer is highly recommended. While HD Radio still broadcasts both the analog and digital hybrid simulcast signals, SFN performance in the FM band will be limited by the analog FM. Once we enter an all-digital future of HD Radio, SFNs will become commonplace, just as they are for DAB in Europe.

There's a lot of attention lately to the question of the benefit to FM stations of turning off the stereo.

Schmid: The mono FM signal is far more resilient to a stereo FM signal as it occupies a narrow bandwidth within the FM composite multiplex subject to less noise. This can increase a station's coverage or allow them to maintain similar coverage at a lower transmitter power level. It also has an interesting side effect for SFNs and greatly relaxes coverage requirements for the analog FM. With increasing HD Radio penetration, perhaps the FM carrier becomes more of a backup service. Then going to mono FM may allow stations to more effectively build out SFNs.

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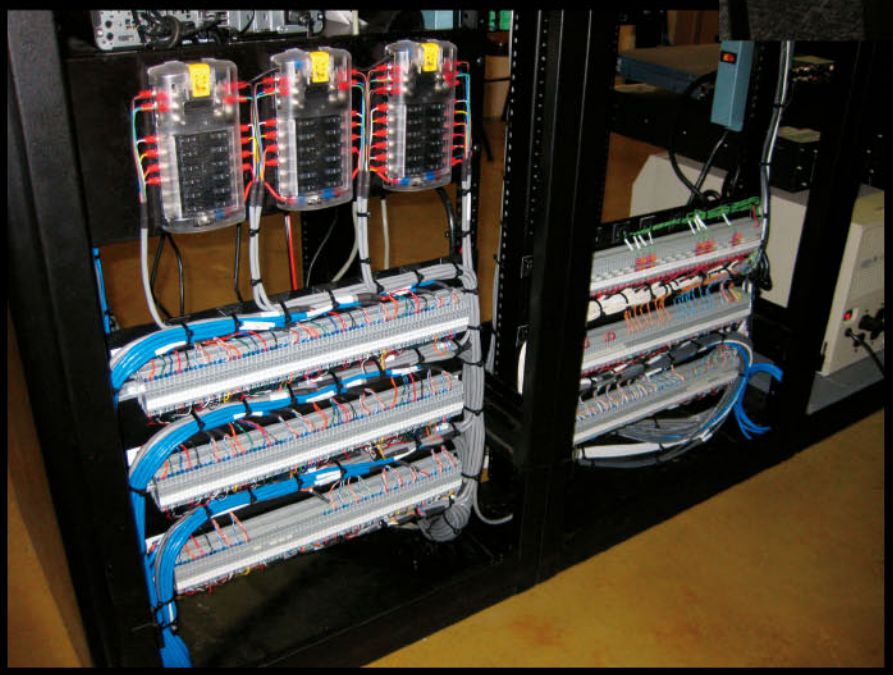

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Paul Shulins

First, be clear about your goals and your target audience

It's all about getting satisfactory millivolts of energy to the receivers you wish to serve

Shulins' Solutions provides monitor, control and protection services for transmission sites and broadcast antennas, as well as drone-based tower inspections and broadcast consulting. President Paul Shulins is a longtime radio chief, licensed Level 2 thermographer and UAS commercial drone pilot.

RW Your turn, Paul. What advice would you give to an FM broadcaster who came to you and asked how they might go about maximizing coverage?

Paul Shulins: One of the most important things to do first is to make sure you understand your target audience. Study population densities and specifically how those populations are distributed relative to your transmitter site. Is your format appealing to a more urban audience, or a more rural audience?

Then you can project existing coverage contours on a map and determine if you are meeting your goals of delivering your product to your intended target. It's all about efficiency and getting satisfactory millivolts of energy to the receivers you wish to serve.

RW What strategies do you see broadcasters putting use in recent years?

Shulins: Traditionally, licensing the station for dual communities has allowed some broadcasters to relocate their transmitter to a geographical site where they can serve two principal communities with city-grade signals. This technique has been used extensively over the last few decades. It sounds big on the air, and actually has technical benefits — kind of a win/win.

RW What other effective approaches help with coverage gaps, obstructions and other challenges?

Shulins: Emerging technologies include on-channel boosters and single-frequency networks. Some other strategies include specially designed antennas with directional patterns that in some cases can be licensed to optimize the radiation azimuths to reach target populations in specific areas while allowing broadcasters to utilize more economical or higher elevations sites.

Another technique used is to take advantage of natural terrain to reduce signals in areas that would otherwise result in interference to co-channel neighbors as well as first- and second-adjacent channels.

Can broadcasters boost coverage by switching off their stereo and going to mono?

Shulins: This is a bit of a controversial issue. With HD Radio being more prevalent, this advantage is not as powerful as it was in the past. Additionally, the "red pilot lamp" on older "stereo" components is a relic of the past. So the modern receiver hardly even shows a difference on the display between mono and stereo. Turning off the pilot for spoken voice formats can allow for a bit more energy in the main channel and usually less multipath interference due to the more limited bandwidth mode of the receiver. This comes at the cost of limiting the pleasing stereo effects of jingles and highly produced commercials.

What can be accomplished through tinkering with HD Radio power levels?

Shulins: Broadcasters have options here. At first — circa 2004 — HD Radio levels were authorized at 20 dB below the analog carrier. As an early adopter, I was one of the first to notice that –20 dB would not come close to replicating the analog coverage. Early problems like poor synchronization of the timing of the audio between analog and HD signal lead to blending issues, as the radio often toggled between HD and analog even in traditionally strong signal areas. This was very annoying to listeners, and many car dealers received complaints from customers claiming their new car radios were defective. Fortunately, technology has completely solved the time diversity problem.

Subsequently the FCC authorized a few higher power levels for HD Radio at 14 dB and 10 dB below the analog carrier, and these improvements have resulted in a closer replication of the analog coverage. When selecting a transmitter, it is important to remember that with more power in the carrier (to reach –14 or –10 dB), sizing the power capabilities become critically significant. In these cases more power-generating capability is required.

> **Fortunately, technology has completely solved the time diversity problem.**

Do the calculations to be sure you purchase enough transmitter to accomplish your goals. This includes considering the power requirement penalties when implementing different modes of HD Radio transmission that allow more than 96 kilobits of transmission.

How can a broadcaster assure that actual performance lives up to predictions?

Shulins: There are several recommended methods to help ensure you are getting what you pay for.

First, most antenna manufacturers will, as an option before delivery, run test range measurements on your actual antenna, mounted on a tower that resembles the one you will use to permanently support the antenna.

This gives you physical proof of performance of the antenna you are purchasing. Obviously the physical orientation of the antenna matters with respect to true north, and the installation orientation is critical.

Second, there are three popular methods of verifying antenna performance after installation, including ground-based measurements running radials, traditional helicopter measurements, and the newest technology, using drones with specialized spectrum analyzers attached to efficiently measure and verify radiation patterns.

> **Do the calculations to be sure you purchase enough transmitter to accomplish your goals. This includes considering the power requirement penalties when implementing different modes of HD Radio transmission that allow more than 96 kilobits of transmission.**

Understand how the antenna, mounts and tower interact

Sean Edwards highlights this unique and complex relationship, which he calls the single most important aspect of signal propagation

Sean Edwards discovered his love of RF working in U.S. Navy electronics. He joined Shively Labs as senior RF field technician, overseeing the installation, testing and verification of thousands of antenna and combiner systems; that led to assignments in test and development, then product design, introducing new antennas and filters. Today he is director of Shively's RF Engineering group.

Sean how would you advise an FM broadcaster who wants to maximize coverage?

Sean Edwards: Well, any such discussion should be predicated upon the answers to two other questions: "What are you licensed to provide?" and "What are you trying to achieve?"

Sean Edwards

Once those primary hurdles are cleared, we will normally recommend a Pattern Review, an analysis that allows our technicians to better understand the relationship between the antenna, its mounts and the support structure itself. This unique and complex relationship is the single most important aspect of signal propagation, but by closely analyzing all the components, it becomes possible to discover specific changes that can significantly affect the station's radiated signal.

Sometimes those changes might be a simple adjustment to the mounting configuration, while other times it might require looking at a different radiator entirely.

As an antenna manufacturer, what less-familiar approaches do you think readers should know about?

Edwards: It's easy to look at antenna radiator selection as being entirely based upon power handling, as that's how they're most easily categorized. But every antenna model radiates somewhat differently than every other one — sometimes only slightly so, sometimes dramatically. Those differences can be exacerbated by mounting and the support structure. Furthermore, some models are easier to "control" than others; and other models are simply better at achieving a specific aspect of signal propagation. So the rated power handling — and cost — of an antenna can sometimes seem like "overkill" for a station, but those parameters may not be driving the selection as much as the physics of that radiator's design interacting with its mounting design and the tower situation to provide the desired pattern result.

What strategies are available to fill gaps and deal with obstructions and other signal challenges?

Edwards: Talk to your consulting engineer, as they stay current on the rules and regulations governing the "big picture" aspects of these issues. Boosters and translators are usually in the mix; both can be useful tools. Boosters can often fill in an area that is terrain blocked, and other times, an entirely new translator has been deployed to increase coverage, including HD signals.

Can you discuss the basic relationship among number of bays, TPO and coverage?

Edwards: This has been a subject of lively debate for decades. Basically, as you increase the number of radiating elements, you increase the "gain" of the antenna, so the TPO can be reduced while maintaining the same ERP, which is great on the bottom line. But there are certain situations when a high-gain array could actually create problems with coverage due to the inherent nulls produced, often mitigated by adding null fill, or the narrow width of its main beam "shooting over" close-in areas, usually fixed by adding some beam tilt. So reviewing both the azimuthal and the elevation patterns generated by an array, then overlaying those data to the target signal area, is always recommended.

Another adage says, "Gain is great for distance, but raw power is better for getting into concrete and glass," meaning that they felt a high-gain, low-TPO array will work the best for covering a large geographic area, but that a low-gain, high-TPO array will better penetrate in a close-in, urban market.

You mentioned beam tilt. What should a buyer know about electronic and mechanical beam tilt effects on coverage and RFR on building rooftops?

Edwards: Rooftop RFR is both complex and important. Towns and cities are rarely static, and the skylines of our urban areas change constantly. A broadcaster with a rooftop antenna array is dealing not only with their own coverage issues — close-in coverage, building penetration, etc. — but also with other nearby buildings, as well, so it's another great example of the importance of looking at both the azimuthal and elevation patterns of the array.

First, imagine the radiated signal as a flat disc; if you "tilt" that signal/disc mechanically, you're lowering one side of it, which therefore raises the opposite side. If you tilt it electronically — manipulating the relative phasing between antenna radiators — you will lower it in all directions, equally, bending the signal like a taut umbrella.

Both approaches have advantages and disadvantages, depending upon the unique situation of the site and coverage requirements.

Another common approach to RFR is to modify the bay-to-bay spacing of the array's radiators, which doesn't "tilt" the signal, instead dramatically reducing the amount of downward radiation. Another less-commonly known approach is polynomial feeding, progressively shifting the amplitude and phase of each radiator to eliminate all side lobes to eliminate RFR.

How can a broadcaster assure that actual performance lives up to the predicted coverage?

Edwards: Many approaches can help verify results, from field strength measurements, to simply driving the predicted coverage area. But one of the most important things the broadcaster can do is to verify that the antenna is mounted EXACTLY as the manufacturer recommends, then to ensure that nothing else is allowed to be mounted within one wavelength — about 10 feet — of the antenna's aperture.

> **"By closely analyzing all the components, it becomes possible to discover specific changes that can significantly affect the station's radiated signal."**

We saw rapid growth in translators over 20 years, even apart from the AM revitalization initiative. Are translator-based strategies still important?

Edwards: Consultants play a vital role in evaluating the benefits of a station deploying a translator. Many times, these translators can help carry the main signal to outlying areas; other times, a new translator can be fit into a small area between existing stations. The antennas needed for these situations can be very different and may require very specific directional patterns.

The FCC now allows computer modeling of directional FM antennas. It will save money for manufacturers, but will it also have meaningful impact on how broadcasters and consultants design RF systems and signal footprints?

Edwards: Computer modeling is definitely a powerful tool for manufacturers, but to call it a "money-saver" is a bit misleading, and that is not that the reason it was desired. Like so many computer advances, it allows many more permutations to be examined, and this is an absolute benefit to the manufacturer and broadcaster alike. Still, the costs involved in the software and licensing, as well as training and staffing to leverage all the advantages it offers, are significant. Manufacturers must continue to ensure precise attention to detail to guarantee all interfaces between the antenna and tower structures are accounted for, accurate and designed properly. It is a wonderful tool for the entire industry, but not a miraculous silver bullet.

Don't ignore options to upgrade in class

Frank McCoy has a warning about a scenario that you could easily overlook

Frank McCoy is retiring from his role as chief engineer for the Salem Media properties in Chicago, legendary directional AM stations WIND and WYLL. He has worked there since 2010, overseeing the technical assets of three transmitter sites and a studio complex. He also worked for ABC, Gannett, Skywave Inc., Capstar Broadcasting Partners and American Media Services. He does consulting work and is the managing member for an LLC that owns several FM translators.

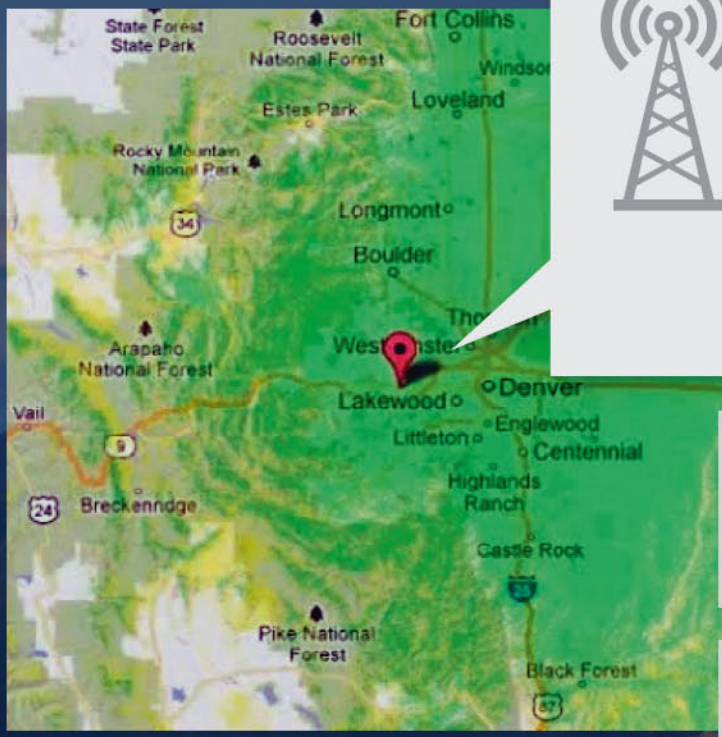

Frank McCoy

Frank how can broadcasters maximize coverage of their FM over-the-air signals?

Frank McCoy: Coverage is basically limited by co-channel and first-adjacent-channel interference. FM HD is well into the guard band between co- and first-adjacent, more or less by design. An all-HD world might employ error correction-type schemes to sort out this kind of interference. Analog FM detectors of the discriminator kind just decode what they pick out of the air, so there's no fixing that.

On the other hand, the FM band interference rules for second- and third-adjacent channels are completely pointless. They came, in part I suppose, from similar rules for AM at the time. Early analog tuned FM receivers had AFC, a feedback-driven system for maintaining receiver tuning and compensating for drift. Strong adjacent-channel signals would capture the AFC and made listening to distant signals difficult. Plus in those days, FM meant "Forget Money," so there just wasn't that much demand for FM allocations. Aside from dividing the

> **"Most licensees — and that includes most corporate group engineers — have little understanding of the three-dimensional chess game that is allocations."**



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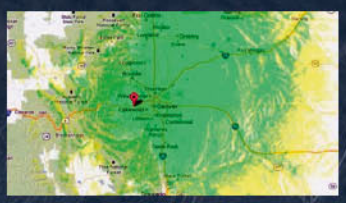

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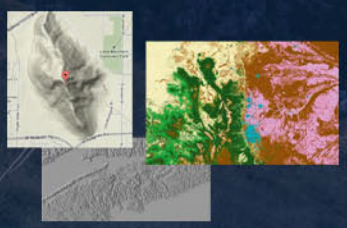

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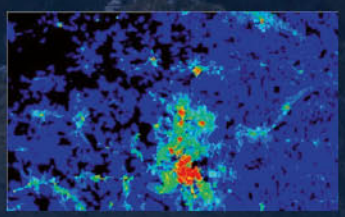

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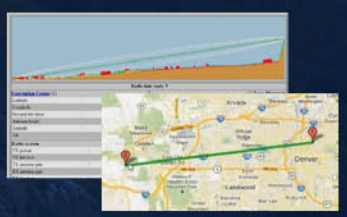

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> **There are people like me looking to claim spectrum for paying clients, and all is fair within the FCC rules. You have been warned.**

FM revenue pie — likely to be resisted by the incumbent players — there is no reason the number of FM outlets couldn't double using existing analog methodology. A ceramic 10.7 MHz IF filter costs a quarter. An FM receiver with a cascade of these will experience no ill effects from a strong signal 200 kHz (first adjacent) away. Contrast this with the inductor-capacitor IF "cans" of the era that included AFC. Radios are way better. Allocations should recognize the improvement.

What strategies are 21st century consulting engineers deploying to squeeze the most out of FCC allocations?

McCoy: Some clever ideas have gotten engineers and licensees in trouble. A Texas group advertised their signal for sale and included a coverage contour map that looked very asymmetric for what should have been an omnidirectional facility. Turns out they'd researched on the antenna range what distance the antenna needed to be from the tower in order to maximize the signal towards the population center. Their rimshot had some extra juice —nearly 6 dB worth if memory serves — in one direction. A competing broadcaster pointed this out to the FCC and included the sales literature with the description of the coverage and the "how it was done." The FCC staff put an end to that cleverness by imposing an overall power reduction, nixing the gain they'd created with exotic engineering.

When consultants look at a station's signal footprint today, what techniques are they using to improve it? What options might they recommend?

McCoy: Most licensees — and that includes most corporate group engineers — have little understanding of the three-dimensional chess game that is allocations. The FCC has constrained much of this work with two rulemakings in the past decade.

The first was the change from notice, counterproposal and comment-type processes for significant changes to the FM table of allocations. Now city changes and interrelated channel changes are handled as applications, entitled to first-come-first-served processing. While streamlining, this also limits most rearrangements to four or fewer participating stations.

The second significant change was the Rural Radio rulemaking that sought to limit moves of stations from outlying areas into more urbanized places. This had the effect of limiting new entrants and new voices in populous areas. The jury is still out on the public benefit of that one, but it was applauded by the community of existing broadcasters in those same larger markets.

One piece of advice, learned from heartbreaks I've personally witnessed and caused: If your FM station has an option to upgrade in class and you don't file it, perhaps because you don't really want to budget for the upgrade, or whatever reason, you are a prime target for those looking for upgrades for others. Nightmare scenario? Some other licensee, likely a smaller player in your market, forces a channel swap, then takes first your frequency and then the upgrade you dilly-dallied over. You get shifted somewhere else on the band. Talk about a business model disrupting experience!

But read your license. The FCC specifically excludes any exclusive right to operate on a particular frequency. There are people like me looking to claim spectrum for paying clients, and all is fair within the FCC rules. You have been warned.

What about translator plays, rimshots and other time-tested techniques, what role do they play in 2022?

McCoy: Translators simply prove that the interference rules are entirely overkill, based on receiver technology from 1960. Rimshots invariably are on second- or third-adjacent channels.

If the FCC is looking for a solution for AM broadcasters, whose spectrum is hopelessly polluted by uncontrolled switching power supplies and industrial-scale interference hash, rimshots are probably it. But not as they are now. Instead, subject to waivers of the kind afforded to translator moves where there is an AM primary station, move those rimshots into markets those same AMs now serve. Then sunset the AM licenses. Again, recognize that receivers are better for the 60 years of design progress.

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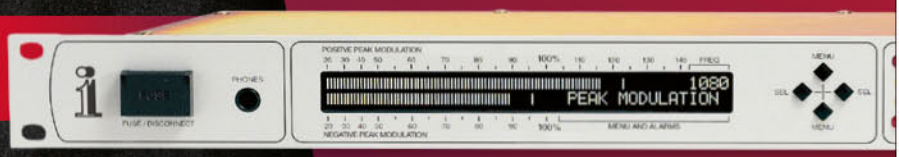

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For HD Radio, use the maximum authorized power

Jeff Detweiler talks about other best practices to get the most from your digital IBOC FM

As senior director of broadcast technology at Xperi, Jeff Detweiler directs broadcast product development and the introduction and launch of its HD Radio brand of in-band on-channel technology to stations. Earlier he worked for Radio Systems, QEI Corp., Allied Broadcast Equipment, Lake Erie Radio and Nassau Broadcasting.

HD Radio raises its own particular questions, Jeff. What advice would you offer?

Jeff Detweiler: When it comes to maximizing HD Radio digital coverage, broadcasters should consider operating with the maximum authorized digital power.

Initial station conversions in 2002 limited digital power limited to 1% of the analog ERP. In 2010 the Federal Communications Commission Media Bureau adopted an order establishing procedures to permit FM stations to voluntarily increase hybrid digital power, or ERP, levels unilaterally to –14 dBc. A licensee desiring digital power in excess of –14 dBc is currently required to calculate the station's analog F(50,10) field strength at all points on the protected 60 dBu F(50,50) contour of potentially affected first-adjacent stations.

FCC Docket No. 99-325 contains the relevant information to calculate your station's maximum authorized digital power.

Jeff Detweiler

What coverage improvement strategies do you see being put in use?

Detweiler: Many broadcasters who have adopted HD Radio technology are taking advantage of the FCC regulation allowing digital multicast channels to feed FM translators. Doing so allows the station to have another analog channel in addition to the digital multicast signal. Xperi has also observed stations leasing another broadcaster's multicast channel to feed a translator. Station phone apps allow broadcasters to reach cellular-connected listeners, and HD single-frequency networks improve digital coverage in terrain-challenged markets.

A recent addition to radio's arsenal is DTS AutoStage, a hybrid radio solution that combines IP-connected metadata enhancements with the over-the-air broadcast. The IP-delivered content affords a rich metadata-enhanced listening experience as well as "service following" when driving beyond the station's primary coverage area.

Are there particular strategies to solve gaps and other signal challenges?

Detweiler: Orthogonal Frequency Division Multiplex, or OFDM, signals used in the HD Radio digital transmission are excellent at overcoming multipath distortion. The spectral redundancy of the upper and lower sidebands all but eliminates outages caused by channel fading. Synchronous OFDM boosters (SFN) allow for nearly seamless HD Radio coverage. For broadcast markets that have significant terrain obstruction, as found on the west coast of the U.S., single-frequency networks and synchronous boosters afford considerable coverage improvements.

What legal options for improving footprint might a consultant recommend?

Detweiler: We've always recommended that radio stations discuss their licensing and technical strategy with their communications attorney. Some of the tools available to increase coverage may include mutual interference agreements and directional antenna optimization for move-ins.

Are strategies being deployed these days to locate translators in major markets to repeat rimshot signals?

Detweiler: Broadcast groups who own both in-market stations and rimshots have used their HD multicast channels to broadcast the rimshot stations' programming. These new multicast channels offer great coverage and also may serve to feed translators.

You mentioned SFNs. Are they worth it?

Detweiler: Yes, SFNs are valuable, and many implementations have demonstrated increase in digital coverage. An SFN may be the only way to serve underserved markets that have been obscured by terrain. However, single-frequency networks are potentially challenging as they require sophisticated signal delivery networks and require more care and feeding than conventional FM signals.

HD Radio single-frequency networks have been employed in locations that have sufficient terrain shielding to minimize OFDM inter-symbol interference in the signal overlap regions. While OFDM is more tolerant of any misalignment from main to booster, the analog alignment needs still dominate. Unless we are proposing all-digital boosters, the needs of the analog signal still dominate the system synchronization design.

What can be accomplished through increasing HD Radio power levels?

Detweiler: Operation of HD Radio at 10% of the analog signal ERP affords coverage equal to or better than analog. However, there are situations where the equipment was purchased prior to the 2010 digital power increase and –10 dBc operation may only be attainable with additional cost. Moreover, if a digital power increase would put coverage beyond the population areas, it would be difficult to justify the expense outside of increased building penetration. Regardless, testing the coverage at incremental digital power levels between –14 dBc and –10 dBc would afford the station the ability to determine the exact point of diminishing return.

And what about changing HD Radio modes, in regard to transmitter TPO capabilities?

Detweiler: When sizing a transmitter for HD Radio operation, the appropriate headroom must be determined for the service mode — MP1, MP3, MP11, and so forth. As the digital power is increased above –14 dBc, the total integrated power also increases. For example, Mode MP1 at –10 dBc will have digital carriers at 10% of the analog power. If MP11 mode is transmitted, the extended partition logical channels are additive. The integrated power of the primary and extended partitions now represents 14% of the analog power. All of the carrier partitions (P1 and P3) are transmitted at the same amplitude, but the total integrated power increases proportionately.

Can a station improve coverage through RBDS/RDS injection levels?

Detweiler: Raising the injection level of the RBDS (RDS) subcarrier increases the signal-to-noise ratio. This improved SNR makes it easier for receivers to decode it error-free, in challenging reception environments such as multipath, co-channel interference and low signal levels. For stations that operate with the HD Radio extended partitions enabled, care should be exercised with increasing RBDS injection beyond 6% as intermodulation with 19 kHz pilot will degrade the enhanced carrier performance.

Can FMs boost coverage by going mono?

Detweiler: It is generally accepted that broadcasting an FM stereo signal results in a 23 dB penalty to the signal-to-noise ratio over an analog monaural FM. This is due to the increase in the noise floor over the subcarrier range of 23 kHz to 53 kHz as compared with the monaural SNR 0 Hz–15 kHz. This has a significant impact to the recovered SNR of the analog FM. For formats compatible with monaural programs like news, talk and sports, this offers substantial analog performance benefit at the edge of coverage, but will offer no improvement for digital.

How much impact does antenna design have on coverage and efficiency?

Detweiler: The beamwidth of the antenna is determined by both the number of bays as well as the spacing of the elements. An antenna with greater beamwidth produces fewer nulls in the elevation pattern of the antenna focusing more of the signal in the formed beam. A halfwave-spaced design will reduce the depth of these nulls as well as reduce radiation at 90 degrees to the beam. These halfwave designs are considered desirable to reduce downward radiation when located on the roof of populated buildings.

Last, what other developments can play a role in getting the best coverage?

Detweiler: Innovations in modeling and design software have improved system performance and made master antenna and combiner systems more cost-effective than ever before. Drone verification of relative field strength is essential to validate proper installation on the tower structure. These optimized master antenna sites afford improved coverage for all participating stations.

Processors and mod monitors play an important role too

Luhrman of Inovonics discusses the role of these products in maximizing performance

Inovonics manufactures processors and modulation monitors, among other products. Sales & Marketing Manager Gary Luhrman started in radio at KSJS(FM) at San Jose State University and says he has been "a serial radio fan" ever since.


Gary Luhrman

From your perspective as a manufacturer, are there techniques or product options that FM broadcasters should know about?

Gary Luhrman: Inovonics does not manufacture the obvious influencers for broadcasting coverage such as transmitters or antennas. Our products can best support broadcasters to maximize their coverage through our FM processors to ensure clean audio quality, coupled with our monitoring products such as our 531N FM Modulation Monitor that allows broadcasters to measure their off-air signal. By accurately measuring the off-air FM signal, engineers can optimize their FM transmissions to improve coverage.

I will add that Inovonics manufactures a number of products for remote monitoring that allow engineers to know in real time what is going on at their remote FM transmitter sites.

What are some effective strategies to fill in coverage gaps, obstructions and other signal challenges?

Luhrman: FM translator sites are a traditional and effective way to fill coverage gaps. The challenge can be how to get the program signal to the FM translator sites.

Inovonics has a number of options with our AARON Translator Receivers for FM and HD Radio reception. These are basically very sensitive and selective receivers to pick up the original FM programming and output an MPX signal to the translator transmitter. Sometimes an HD Radio digital channel is stronger than the FM signal at the translator site. In this case, broadcasters can opt to use the HD Radio channel as a program source for the translator.

What other strategies do you see broadcasters putting in use to maximize their presence?

Luhrman: Adding RDS messaging and HD Radio transmissions really increase broadcasters' presence on car radio displays, which is where most radio listening takes place. RDS adds station branding through text messaging and HD Radio adds digital graphics to the radio screen with station logos and the artist experience.

Again, strategies include adding FM translators to areas with weak coverage. I recently learned about a creative application using the Starlink satellite network to successfully feed an IP program stream to the FM translator in a very remote area with no internet.

HD Radio gives broadcasters the opportunity to add HD channels to increase their programing choices and serve specialized audiences in the area, such as ethnic groups in native languages.

So translator-based strategies are still relevant.

Luhrman: They are still a viable way to increase FM coverage. At Inovonics, we still have a steady flow of sales with our AARON FM Translator receivers. Nevertheless, I believe broadcasters are now employing other means to provide programing to their translators such as IP streaming for a primary program or backup program sources.

What's your take on the question of boosting FM coverage by going mono?

Luhrman: Switching off the stereo signal makes sense in formats where stereo separation is less important, such as talk radio for news, sports or religious programing. Transmitting in mono can improve coverage with less interference for a stronger signal. There are fewer controls to deal with, and matters such as phase and balance are eliminated.


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Pelletier: Consider the entire system

That includes the antenna, RF filter/combiner, transmission line and HVAC

Keith Pelletier was appointed president of Dielectric in 2022. He earned his BS in electrical engineering from the University of Maine and holds a patent for increased isolation in FM interleaved arrays.

Keith, if a broadcaster asked how they could improve or expand their signal footprint what would you tell them?

Keith Pelletier: One method for maximizing the footprint for best signal strength is to utilize an optimizer, similar to the Artificial Intelligence Optimizer created by Dielectric. The AIO process verifies that hundreds of solutions are generated in a short amount of time, ensuring that the user gets the best performance possible.

Traditional ways of maximizing signal within the DMA began with a physical antenna range. Once the general pattern requirements were met, typically no more measurements were made, which in most cases means the solution was not fully optimized. Using AIO technology you will never wonder whether it was the best possible solution.

Keith Pelletier

What other strategies do you see FM broadcasters putting to use?

Pelletier: Power increases are one strategy that broadcasters are looking at to maximize their presence. In addition, tower site moves may yield better signal coverage in the DMA due to the new location and/or tower size, with fewer limits in certain directions.

The use of HD signals and streaming are also strategies being used, as listeners no longer have to be in the DMA to listen to their favorite radio station.

To address signal challenges, all options should be considered, including but not limited to antenna selection; offsetting bays; the use of parasitics; multiple panels; translators; electrical and mechanical tilts; antenna size vs. TPO; and AIO technology.

What RF design tools, software, mapping or other options are available to help licensees?

Pelletier: The technology advancements over the past few decades are astounding, and strengthened when combined with knowledgeable RF engineers. Licensees benefit from the tools and speed to market, including but not limited to new antenna designs, pattern analysis and advanced combiner systems.

Once a design or new analysis is thought of, advancements in software allow these to come to market quickly. Just a decade ago it would require a lot more validation time, manufacturing prototypes and making physical changes to the model. Dielectric is at the forefront of this technology, and we expect that NAB 2023 will see another major breakthrough.

How much impact does antenna design have on coverage and efficiency?

Pelletier: It's ideal to look at the system level. The RF filter or combiner need to balance the size of the filter, the cost and overall system footprint. The size has a direct correlation with the loss of the filter; the smaller the filter, the less efficient it becomes, and there is more of

> **The broadcaster should be looking at results from the manufacturer to confirm the projected losses in each component as well as meeting the proposed VSWR.**

a heat load to consider when addressing HVAC for your transmitter building.

The transmission line size going up the tower also needs to be considered: Larger line is more efficient but it increases the wind load on the tower. The antenna design is all about maximizing the customer's coverage. Dielectric uses Artificial Intelligence Optimization with a full-scale 3D electromagnetic program. The results are accurate and produced quickly.

Also consider the VSWR performance of all components in the chain. The better the system VSWR, the more efficient your system will be. The broadcaster should look at results from the manufacturer to confirm the projected losses in each component as well as meeting the proposed VSWR.

The broadcaster should look at multiple scenarios and feel confident the best results were achieved before finalizing the antenna design.

How can a broadcaster assure that actual performance lives up to the predicted coverage?

Pelletier: The customer should first order a pattern study even if it's an omnidirectional pattern. Get all the tower information to your antenna supplier, including the cable conduits, transmission lines, elevator cables, elevator sheeves, guy wire lugs, etc. at the antenna location. Precise detail regarding the tower is critical to put into the model.

Second, the technology advancement of drones taking RF measurements on azimuth and elevation patterns is astounding. The broadcaster can order a fly-around and get the results quickly based on the antenna performance in the field.

Dielectric has done numerous elevation pattern analyses on antennas and the validation and correlation of the design versus the actual results match up very well. The drones will catch if the orientation is incorrect at install, the tower information supplied was inaccurate, and if the antenna was installed on the wrong leg.

Dielectric's new FM pylon antenna is a notable recent introduction.

Pelletier: The design is a game-changer in technology and will change the RF landscape. It has advantages in both windload and icing conditions over the traditional ring-style antennas. As a full-band device, it allows broadcasters to multi-cast from this antenna. When used with new groundbreaking technology on combiners, this device will produce a system design optimized for efficiency, adaptability, flexibility and future growth.

What's the basic relationship among the number of antenna bays, TPO and coverage?

Pelletier: The fewer bays, the wider the beam is on the elevation pattern, which requires more TPO. Most consultants will favor — within reason — more TPO over more bays, as the wider beam keeps the signal strength higher the closer you get to the tower. For example, an eight-bay antenna will require 3 dB less TPO than a four-layer antenna. The consultant at times may be working with a TPO based on a current transmitter or what the customer is purchasing, so that will dictate the antenna gain. In some scenarios they also can size the transmitter, and when they do, they will favor fewer antenna bays, i.e. lower gain.

What should a buyer know about electronic and mechanical beam tilt effects on coverage and RFR on building rooftops?

Pelletier: When designing for a rooftop install it's important to understand the elevation pattern details, which are typically from 75 to 90 degrees below the horizon. To achieve low downward radiation, they should look at reduced bay spacings to yield a lower grading lobe on the building rooftop. With today's technology a full-scale 3D electromagnetic virtual model can be analyzed while adjusting the bay spacings, phasing and amplitudes for each antenna element.

The results of the elevation characteristics using this technology are proven to be accurate based on RFR field measurements. Studies have shown that comparing elevation pattern results to factory measurements, as well as drone studies, have verified the accuracy of these measurements. As far as the beam tilts, both mechanically and electrically, an analysis of the actual design can be analyzed quickly. When varying the tilts, the customer can finalize the preferred design and an analysis can be done on impact to RFR. The key to low RFR is the element design and reduced bay spacing to eliminate the grading lobe directly below the antenna.

When planning any antenna project, it pays to adopt a team approach

Involve your owner/manager, OM and PD, not just your technical suppliers

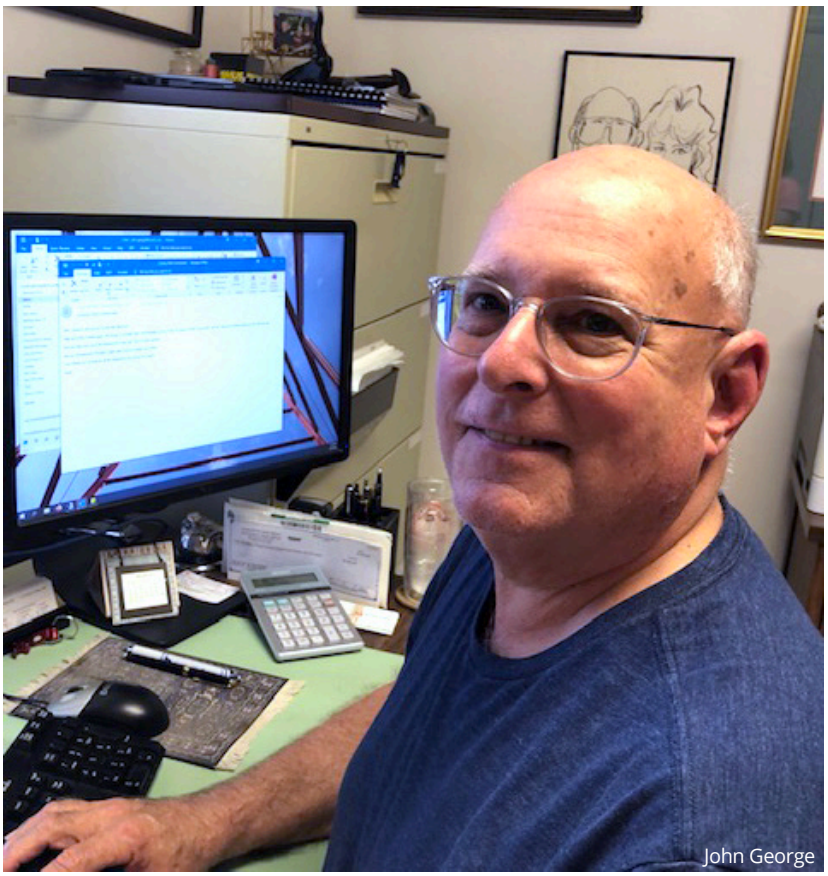
John George has worked in broadcasting for more than 50 years, starting as a DJ, then moving into sales, technical services and station ownership. Today he is president of Broadtech Services and RF Specialties South. He is a member of the Association of Federal Communications Consulting Engineers, the IEEE Broadcast Technology Society and the Society of Broadcast Engineers.

John what's your advice for our readers seeking coverage improvements?

John George: The first step would be to speak with a qualified consulting engineer to determine if the allocation would allow signal improvement. There are still a number of stations that have not totally maxed out their signal, though it's much harder in largely populated areas. An increase in antenna height might be possible, a slight change in location in relationship to the primary population area, or sometimes consideration of changing a directional signal to non-direction can provide improvement to coverage. You should consider having your consultant review incoming interference with co-channels and adjacent channels. Many times this can provide eye-opening results.

Creative use of HD channels has helped many stations. Especially in large markets where an owner may have multiple signals, the use of an HD channel along with a translator can help add to coverage. A good study of the allocation table may allow some shuffling of frequencies for signal improvement but this is getting harder to do due to the FM band congestion.

Single-frequency networks with specially synchronized boosters have possible promise but there is much controversy as to whether this is viable. Of course a number of stations have used boosters with success over the years. You have to carefully study where the interference band will fall, especially in a large population area. You could easily end up with interference over a well-traveled highway or in other important area. Boosters have been used in mountainous areas with success, but are more challenging in flat or hilly areas.



John George

How about strategies to fix coverage gaps, obstructions and other signal challenges?

George: A consideration of transmitter site location is important to review with a qualified consultant. It may be possible to reduce power in some cases and move closer to a population area. A move from one side of a market to another, especially if there is an increase in elevation, can sometimes bring improvement.

The possibility of combining signals with another station may be valuable in getting a better market position.

It's not only important to consider terrain, but to review obstructions such as high-rise buildings in metro areas. It's easy for buildings to block coverage into important areas.

Another consideration is location of existing stations. Blanketing interference can cause many coverage issues for close-spaced stations, especially "rimshots."

Special consideration should be given to locations of translators. Many of the translator sites are on rooftops and multi-purpose towers that can cause interference to a station. Consider moving a translator that is causing

interference if this is feasible.

How much impact does antenna design have on coverage and efficiency?

George: Any antenna project should be approached carefully as a team project — you should have at a minimum your technical consultant, antenna manufacturer, the tower company and/or installer together on the project. Of course, you want your owner/manager, and you should consider the operations manager and/or program director a part of the planning.

Many times, management will come to you and say they want to improve the signal but provide little or no information. They just want more coverage. It becomes our task to determine why the station needs better coverage. Is it a signal problem in the population area to be served? Is it a building penetration issue in a downtown area that only recently became an issue or just old, outdated equipment?

If your signal has issues that recently came to light, maybe a new translator in a particular area was turned on and is causing interference only in that locale.

If your antenna is old, replacement could be in order. When was the last time the antenna was thoroughly inspected by a qualified tower crew? A drone inspection would be handy for an initial observation.

Lightning damage over the years can cause issues. If your antenna is side-mounted on a tower with multiple users, check the transmission lines that may pass behind your antenna. If the number and size of lines has increased, this can affect the coverage.

Another area to review is other antennas that may be in the aperture of your antenna. I have seen two-way antennas appear overnight and cause multiple issues, especially if the FM antenna is directional.

Once you have gathered your facts on why you need a replacement, it is time to call your consultant and determine if a move is in order or just a replacement antenna. There is excellent software available that most consultants utilize. Probe 5 by V-Soft Communications is one such package. If you don't have a consultant, ask other engineers for recommendations. The Association of Federal Communications Consulting Engineers is a great source of qualified consultants.

Next, based on your consultant's recommendations, contact an antenna manufacturer and discuss your needs with them. The manufacturer will assist you with determining which antenna will work best for your requirements.

Many times, the consultant will determine which antenna will work best, based on years of experience with the different manufacturers.

Keep in mind that the design of your tower can affect your pattern, so have drawings available or have your tower company map the tower so this information is available. This is where the consultant, manufacturer and tower company work hand in hand to provide the best results.

Also consider having the manufacturer do a pattern study to determine the expected coverage once the antenna is mounted on the tower. A slight change in mounting can provide meaningful results.

Keep in mind that just hanging an antenna on a tower will provide results, but they may not be the results you want.

The FCC now allows computer modeling of directional FM antennas. It will save money for manufacturers, but will it also have meaningful impact on how broadcasters and consultants design RF systems and signal footprints?

George: I'm not really certain that computer modeling will save that much money for the manufacturers. The cost of the software utilized is very expensive to license and there is training that has to be considered.

The advantage of computer modeling is providing results that are very close to full-scale and quarter-scale outdoor ranges. These ranges can be limited by weather and other factors.

In the initial months that computer modeling has been available, several of the manufacturers are charging the customers close to the price of range testing. One manufacturer is providing a "review" of patterns previously done on their range for much less that the original study. This allows a comparison of the original pattern with a comparison of the computer study. By doing this, it is possible to model the antenna in less time and possibly provide improved coverage for the customer. Results are promising, but for the time being, the FCC is asking for data from both a range study and computer modeling to ensure reliable results.

The computer modeling should provide a much easier method to determine improvements can be done for a station without going through the process of a complete range study.

"Results are promising, but for the time being, the FCC is asking for data from both a range study and computer modeling to ensure reliable results."

To get to the end of your project successfully, start at the beginning

Cavell: Jumping to a quick answer often leads to not solving the real problem

Gary Cavell, president of technology consultants Cavell, Mertz & Associates, has been in the broadcasting industry for more than 47 years. He is a member of SBE, Life Member of IEEE and SMPTE, and past president of the IEEE BTS. He was editor in chief of the 11th edition of the NAB Engineering Handbook and is a certified Master Thermographer. He is a recipient of the NAB Radio Engineering Achievement Award and the IEEE BTS Cohen Award for Outstanding Broadcast Engineering.


Gary Cavell

Thanks for answering our questions, Gary. What legal and/or technical strategies have you seen FM broadcasters putting to use in recent years to maximize their coverage or expand their presence?

Gary Cavell: Although somewhat "traditional" seeming, FM class changes, shifts to adjacent frequencies, principal community changes and even new allotment proposals are strategies still being successfully used to more favorably situate transmitting sites to vantage points that provide improved coverage reach into communities of interest. Quite often, and perhaps paradoxically, a class reduction can offer an opportunity to move a station closer to a desired community or a better signal path into a desired area.

What advice would you give to a broadcaster who asks about maximizing coverage?

Cavell: Before rendering any advice or proposing a solution, I find it helpful to ask a series of questions to better understand what the broadcaster is looking for, and what they are REALLY looking for.

For example: What do they perceive to be their present coverage? What do they feel is lacking, where is the audience residing/commuting? In what environment is their target audience listening in (car, office, home)?

Have they done any coverage studies or "population served" analysis to determine where their core audience (and advertisers) reside? What audience is the format targeting — and do you know where they would likely be listening? Are they planning a format change?

Have they had any reception or interference complaints from listeners, sales staff, advertisers … and if so, what kind of complaints and from where?

Once you and the station owner have an understanding of where they are and where they really need to go, I can start working on possible solutions that may better address the real need. Jumping into a quick answer for the articulated question often leads to not solving the real problem. And frankly, sometimes there is simply nothing that can be done for them.

What strategies are available to fill in coverage gaps and fix other signal challenges?

Cavell: Before delving into possible solutions, make sure you understand the nature of the problem, unless it is painfully obvious.

Look at the geometry of the transmitting location versus the location of the areas of concern, along with the transmitting antenna height. Is there intervening terrain, foliage or cultural features like buildings that may impact a clear view into the community?

Then use reception prediction tools starting with optical shadowing studies, and Longley-Rice received signal studies. Be sure to crank in the program's "land use / land cover" options. Also, know that the default receiving antenna height is typically 30 feet above ground. I prefer to use a more realistic antenna height of 6 feet above ground.

Once I create a Longley-Rice coverage map based upon the theoretical predicted levels and realistic receiving antenna heights, I ask the station owner to look at the map and tell me how this lines up with their actual reception experience and regions where there are perceived problems.

I also separately look at predicted INCOMING potentially interfering signals to see if the areas where coverage issues exist are really interference driven — which may dictate the use of a different approach for resolution.

Finally, look at the locations of other stations transmitter sites within the "poor reception" areas. Is the problem localized brute force overload or receiver-induced intermodulation interference?

All of these factors can figure into how the problem can be addressed. It is at that point that we then start looking at relocation, on-channel booster feasibility, fill-in translators, use of HD channels on other stations, and the like.

How can a broadcaster assure that actual performance lives up to the predicted coverage?

Cavell: It's impossible to provide absolute assurance of performance, since there are so many variables to the transmission/reception equation, many of which are beyond the station's control. I feel that the best that we can do is to provide relative comparative information based upon the best available methods recognized and accepted by our industry.

Before contemplating any changes, I traditionally recommend creating a Longley-Rice coverage map based upon the existing facility; theoretical signal levels for various levels of performance like urban vs. rural; expected building attenuation factors; and realistic receiving antenna heights and terrain factors. I then ask the station owner to look at the map (and preferably driving around with it) and tell me how this lines up with their actual reception experience and regions where there are perceived problems.

This establishes the "before" coverage conditions against a possible solution generated in an "after" coverage map — provided that the station owner "calibrates" their mind (and ear) using the "before" map. All of this assumes that the existing (and newly constructed) antenna and transmitting system is operating properly and as designed … otherwise the comparison will be flawed.

Another means is to do an actual before vs. after "in the field" measurement of the signal using scientifically based methods such as those set forth in the FCC's rules — mobile ground-based measurements using the decades-old techniques and analysis means — or some of the newer automated signal analysis boxes using car-top receiving antennas. Both methods are subject to localized influences and errors that affect accuracy, with the "traditional" "FCC method" likely being the most defendable. While tedious and potentially expensive, this is perhaps the best method of scientifically assessing existing coverage and comparing it to the post-installation solution.

The newest tool being used is the use of drone-based antenna pattern measurements, which is a technique we had a hand in developing. Where feasible, these are useful for verifying whether an existing antenna is having performance issues or is operating differently than intended, or to compare an "as-installed" antenna's pattern to a replaced antenna's pattern (pre- and post-construction checks), or that the as-installed antenna reproduces a vendor's published azimuth and elevation patterns.

While the drone-based technique is usable in determining antenna pattern performance, antenna performance is but one part of the complex propagation / signal reception equation. As such, this alone should not be considered to be the sole indicator of ultimate reception in a station's service area.

> **Sometimes the technical solution offered by the consultant can only work if a rule or policy can be waived or interpreted differently.**

Attorneys and engineering consultants both may be involved in a coverage project. How does that work?

Cavell: From my experience, it really needs to be a collaborative effort, and should draw upon the strengths of both disciplines. The consultant generally has the "lead" initially, but then it usually quickly shifts to the lawyer as options start jelling. The consultant looks for technical solutions within the rules and offers alternative approaches for consideration under various possible options.

Where there are FCC rule and policy implications, the legal team plays a key role. Sometimes the technical solution offered by the consultant can only work if a rule or policy can be waived or interpreted differently.

For example, the legal team provides guidance in the case of relocations and "move-ins" that may run afoul of the FCC's "Rural Radio rule," checking whether service area gain and loss concerns involving Section 307(b) of the Communications Act may be a factor — the consultant usually provides the gain loss studies for the lawyers — "multiple-ownership" rule complications occasioned by shifts in coverage, and other rule waivers such as the Mattoon waiver.

"Why aren't we reaching our target listening area?"

Powerful software tools and databases help stations fix issues and plan upgrades

V-Soft Communications provides RF software used in researching and preparing applications to the FCC. The company also consults and creates custom Longley-Rice and FCC coverage maps, interference analysis studies, population and demographic studies and frequency searches. Doug Vernier is an owner and principal engineer.

What's an example of how your products might be used?

Doug Vernier: Let's say your station gets a call from someone who says they can't pick you up, yet you look at their location and it's right in your 60 or 54 dBu contour. You can get a really good idea about the issue from your desk. You might see an area that winds like a river's stream that, in fact, is the river's depressed elevation. When you look at it with Longley-Rice, you can tell exactly what the signals should be at those locations.

Our software is a starting place to help explore what's wrong: "Based on our understanding of this antenna and our coverage as shown in the FCC database, we ought to be serving this area, but we're not."

What common coverage issues are stations dealing with?

Vernier: If you haven't optimized your antenna to deliver signal to your major locations, I certainly recommend that you do so. Or if you have a directional antenna, talk to the manufacturer and get the actual "as-built" pattern rather than the theoretical one that goes to the FCC.

Be aware that the FCC's curves are based on two to 10 miles, but say you've got something past that, and your 60 dBu is not getting past a hill. That will not show up in your standard FCC coverage map. It can be difficult to determine why without using software. It can be of help, in combination with looking at a real-world situation.

You don't want errors in installing the antenna. A large station in Los Angeles, for which I was consulting, was experiencing a lot of Mexican interference. Their antenna was a couple of years old. The manufacturer was ERI, so Tom Silliman himself flew out and climbed up the tower and found that one of the four antenna bays had been installed upside down. You've got a hardware problem there that isn't going to show up in our software.

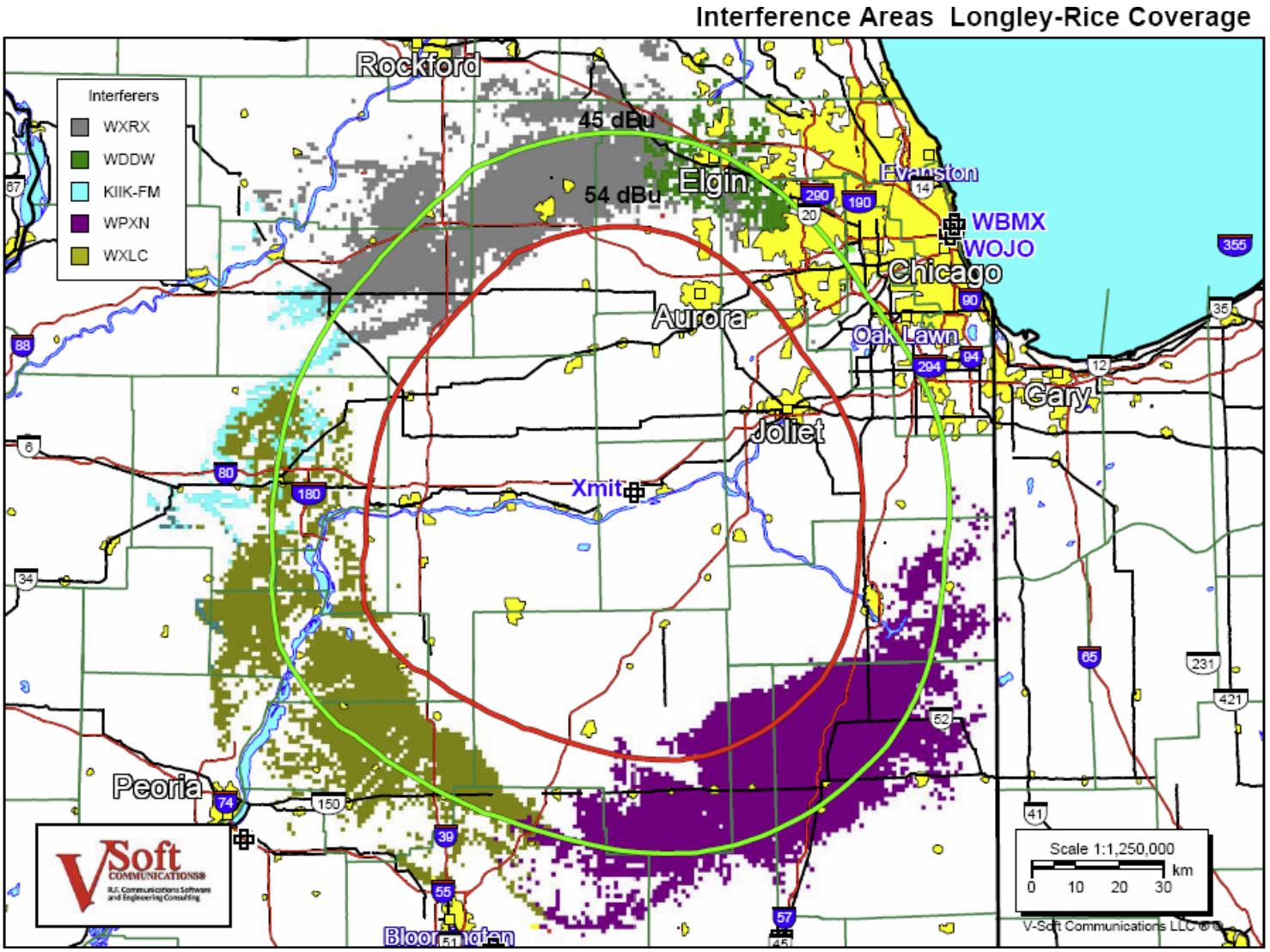
Doug Vernier

RW: Beyond troubleshooting, what strategies do you see being put in action?

Vernier: A lot of stations will use an existing tower, doubling or tripling up on it, but they're not really placing the antenna based on service. This happens a lot with stations out at the rim of coverage, the "rimshots" that come into a given city. They may operate with a lot of power but are sending it to areas that are less populated. Even though an FCC contour shows them serving the city of license, they may be weak getting through buildings, they don't have good penetration.

So, if you're going to place a signal, place it in the middle of the city if you can, where you might get five or 10 times the signal into the houses and buildings.

Our FMCommander program is designed primarily for analyzing FM upgrades, moves and frequency searches. Have a consulting engineer who uses good software look at your spectrum situation to determine if it could be



Above
A map generated by Probe 5 software showing where a transmitter's incoming interference from other stations is received.

improved — not only by moving your antenna site, for example, but even going to a higher class. The FCC calls it a one-step: If you show that there is an available location where a transmitter for a higher class could serve the city of license, you submit a minor change application to go from a Class A to a Class C3 or B1, for example, or even a C2. A one-step analysis for an existing commercial station is an important capability.

Having line of sight also is important. I've been to a station that had all kinds of multipath fairly close to their transmitter and they didn't know why; when we looked at it with software, we determined that the high-income area they wanted to serve was down in a tiny valley, and the signal was going off the walls and bouncing around.

That station also was on a common antenna with several stations combined. Many of those pylon and top-mounted common antennas have scallops in their coverage where you'll get about 60% coverage, even though that station was filed as an omnidirectional. You have to put things together: "Well, maybe if we went with our own antenna somewhere else, we could do a heck of a lot better job."

Consider beam tilt too. Your engineer should not overlook that; it's possible to go right over everybody's heads if you don't have a good beam into an area, particularly if your site is way up on a mountain and the population is very close.

In terms of polarization, you need to have a signal in both planes, preferably circular. You don't see many stations operating only horizontal anymore, but there are noncoms still running vertical-only because of Channel 6 protection. The FCC rules haven't changed yet; they're designed for analog, but TV is digital now and there's very little interference. That's something the commission is looking at, which may be helpful for a noncommercial station that can't increase power because of their required interference protection to Channel 6.

What about single-frequency networks?

Vernier: Our Probe software has an optional module to check out how an SFN might work.

I had a client who wanted to purchase a station that claimed it had major coverage over a particular area

from a booster located between the station and the city. Sometimes you can make those work, but in this case we saw all kinds of interference because it was basically in a flat area.

There are places like Las Vegas where this kind of thing can work, with a booster right downtown and the station way out in the distance, and since the broadcaster is only interested in the local downtown area, they don't care about what, if anything, they're losing. You can synchronize those pretty well when you're that far away from the major transmitter.

To avoid interfering with their own signal, I've known stations to transmit only in horizontal polarization while the booster would be in vertical or cross-polarized. You avoid a lot of interference when you do that, essentially giving up your big signal for a little one that generates more population.

Then there's the question of subcarriers. I don't want to be a purist; but if you want the best mobile coverage, don't run a subcarrier, because when driving, if you have multipath, you hear noises, "blip, blip, blip," as the subcarrier and the 19 kHz pilot mix.

How about going mono?

Vernier: My answer is yes. If you have problems and you're all-talk, why not? You can get better signal-to-noise ratio, because stereo has a price.

It used to be that costly tuners wouldn't tune in monaural, as they skipped right over the mono signal when they did a channel run; they had to have the pilot light on to catch the station.

Back when I was managing university stations, we had we had an Optimod, a good box at the time, which had a timer in it. When NPR came on the air, we would go to monaural, which would enhance the signal and coverage; it sounded really good for talk. However, NPR in its infinite wisdom started to run stereo, particularly on their music bridges and for other purposes, so you were losing that.

Have the software tools and underlying data become a lot more powerful?

Vernier: It's how you apply the algorithms that predict the signal. All of these algorithms will produce one signal point, but how you interpret it, on a larger scale, is what our software can do very well.

For example, with the Longley-Rice model, we can generate a map of the whole coverage and show exactly where there are signal problems, by interrogating each point in a grid, as finely as you want to. And now we have really great terrain databases. You can get right down to a database with resolution of one arc-second, or 30 meters.

Do you see other common themes in coverage strategies?

Vernier: Other than the major O&Os, such thinking may not be the top issue, especially at smaller stations. They'll say, "Well, the sales department will do fine," but if the station starts getting listener complaints, they're going to be thinking about it.

> **"You've got to start thinking about how you can reach people better, with better audio and with greater coverage, if you want to stay in the game."**

Some station owners would still like the FCC to squeeze in a new FM class between Classes A and C3, called C4. Those stations might be thinking about it more often.

But I think ownership and management are thinking about how they can continue to keep their head above water. In certain circumstances, a power increase might be an answer; but frankly, the ultimate goal with that kind of a thing is to sell the station to somebody.

I wonder if all the attention broadcasters are putting on streaming and online digital products translates to less attention being paid to the broadcast footprint.

Vernier: I agree with you 100%. Streaming is pretty expensive though and it doesn't always reach the people you want. Right now it's touch and go for cars, although the industry is working on that. But stations are going to be on dashboards with all kinds of other new competition. So, I don't think it's the full answer. You've got to start thinking about how you can reach people better, with better audio and with greater coverage, if you want to stay in the game.