Broadcasters Gear Up For ASTC 3.0 Television

Early adopters find few bugs to iron out

By Bob Kovacs

WASHINGTON, D.C.

This past November, the FCC issued a Report and Order (FCC 17-158) authorizing television broadcasters to transmit using ATSC 3.0 modulation. As the industry knows by now, it's voluntary at present—stations can continue to broadcast in ATSC 1.0 without any repercussion.

The Report and Order is complicated, as you might expect when the government wants to encourage new technology but doesn't actually order it. In fact, FCC 17-158 states:

"This authorization is subject to broadcasters continuing to deliver current-generation digital television (DTV) service, using the ATSC 1.0 transmission standard."

Okay… so how do you voluntarily transmit ATSC 3.0, while still broadcasting ATSC 1.0?

The FCC's solution is to "…require Next Gen TV broadcasters to simulcast the primary video programming stream of their ATSC 3.0 channels in an ATSC 1.0 format, so that viewers will continue to receive ATSC 1.0 service. Broadcasters will meet this requirement by partnering with another station (i.e., a temporary "host" station) in their local market to either: (1) air an ATSC 3.0 channel at the temporary host's facility, while using their original facility to continue to provide an ATSC 1.0 simulcast channel, or (2) air an ATSC 1.0 simulcast channel at the temporary host's facility, while converting their original facility to provide an ATSC 3.0 channel."

FCC 17-158 further states that the programming aired on the ATSC 1.0 simulcast channel must be "substantially similar" to the programming aired on the ATSC 3.0 channel. This means that the programming must be the same, except for programming features that are based on the enhanced capabilities of ATSC 3.0, advertisements and promotions for upcoming programs. The "substantially similar" requirement will sunset in five years from the Report and Order's effective date, unless the FCC takes action to extend it.

As for licensing, FCC 17-158 requires that an ATSC 1.0 or ATSC 3.0 channel aired on a host station be licensed as a temporary second channel of the originating broadcaster. The FCC will create a streamlined "one-step" process for reviewing and licensing most such applications.

For the purposes of the "must carry" rule, cable companies will be required to continue to carry broadcasters' ATSC 1.0 signals, but will not be required to carry ATSC 3.0 signals.

Finally, FCC 17-158 says, "… we conclude that it is unnecessary to adopt an ATSC 3.0 tuner mandate for new television receivers. We require broadcasters to provide advance on-air notifications to educate consumers about [ATSC 3.0] service deployment and simulcasting."

And according to FCC spokesman Mark Wigfield, LPTV and TV translators are exempt from the simulcast requirement.

For any station considering transmitting in ATSC 3.0 in the near future, Wigfield clarified the FCC's current licensing approach.

"The licensing process first must be approved by the Office of Management and Budget before it can be implemented at the FCC," he said. "There are a few stations that already are transmitting in ATSC 3.0; those stations are operating are pursuant to experimental licenses, which are temporary authorizations. Other than those stations that have experimental licenses, there are no stations that are yet permitted to broadcast in ATSC 3.0."

With the regulatory issues out of the way, let's see how some actual broadcasters are working with ATSC 3.0

ATSC 3.0 Frontrunner

WRAL-TV in Raleigh, N.C., has been a long-time pioneer with the latest broadcast technologies, starting with ATSC 1.0 and its enhancements such as ATSC-M/H. On June 29, 2016, the station became the first commercial broadcaster in the United States to transmit its news in ATSC 3.0.

Pete Sockett

"Since we launched [ATSC 3.0], we have run a 24/7 simulcast of WRAL-TV," said Pete Sockett, director of engineering and operations for WRAL and two sister stations. "On top of that, we run separate services of 4K product we have shot over the last couple of years—mainly, we are looping through our 'Out & About' programs. In summer 2016, we achieved the first terrestrial broadcast of the Olympics in 4K."

Sockett so far has been impressed with ATSC 3.0.

"In the physical layer, we have been testing various modulation and coding rates (ModCods) and adding physical layer pipes (PLPs)," he said.

Each PLP carries a data load that can be a program or IP data. For example, one PLP could be a 4K program feed, another PLP could be a 720p program, another PLP reserved for an SD program feed, and a fourth PLP set aside for a mobile video service. Each PLP can be set up with its own

Screen shot from WRAL's regularly scheduled 4K "Out & About" broadcast.

coding rate, from QPSK to 4096-QAM. These ModCods allow a broadcaster to trade off bit rate for robustness.

"Lately, we have begun testing a layered division multiplex (LDM) layer," said Sockett. "So far everything is working as advertised!"

As many in the industry now are aware, LDM provides for an ultra-robust upper layer, usually modulated as QPSK. It's paired with a less-robust, higher-data-rate lower layer, typically using QAM modulation and transmitted in the same spectrum, with power being adjustable for each layer. This allows more power to be assigned to the mobile/indoor service on the upper layer, while allowing the lower-power service on the lower layer to target outdoor antenna reception applications. By cancelling the upper layer, the lower layer signal is isolated and captured.

LDM has been shown to be much more efficient at carrying data than the more traditional time-division multiplexing.

WRAL-TV is using HEVC/H.265 encoding for its ATSC 3.0 programming, which includes its news broadcast in 1080p and "Out & About" in 4K.

Sockett said that the way to think about broadcasting in ATSC 3.0 is to consider it a pipe into which you slice up the bits any way you want.

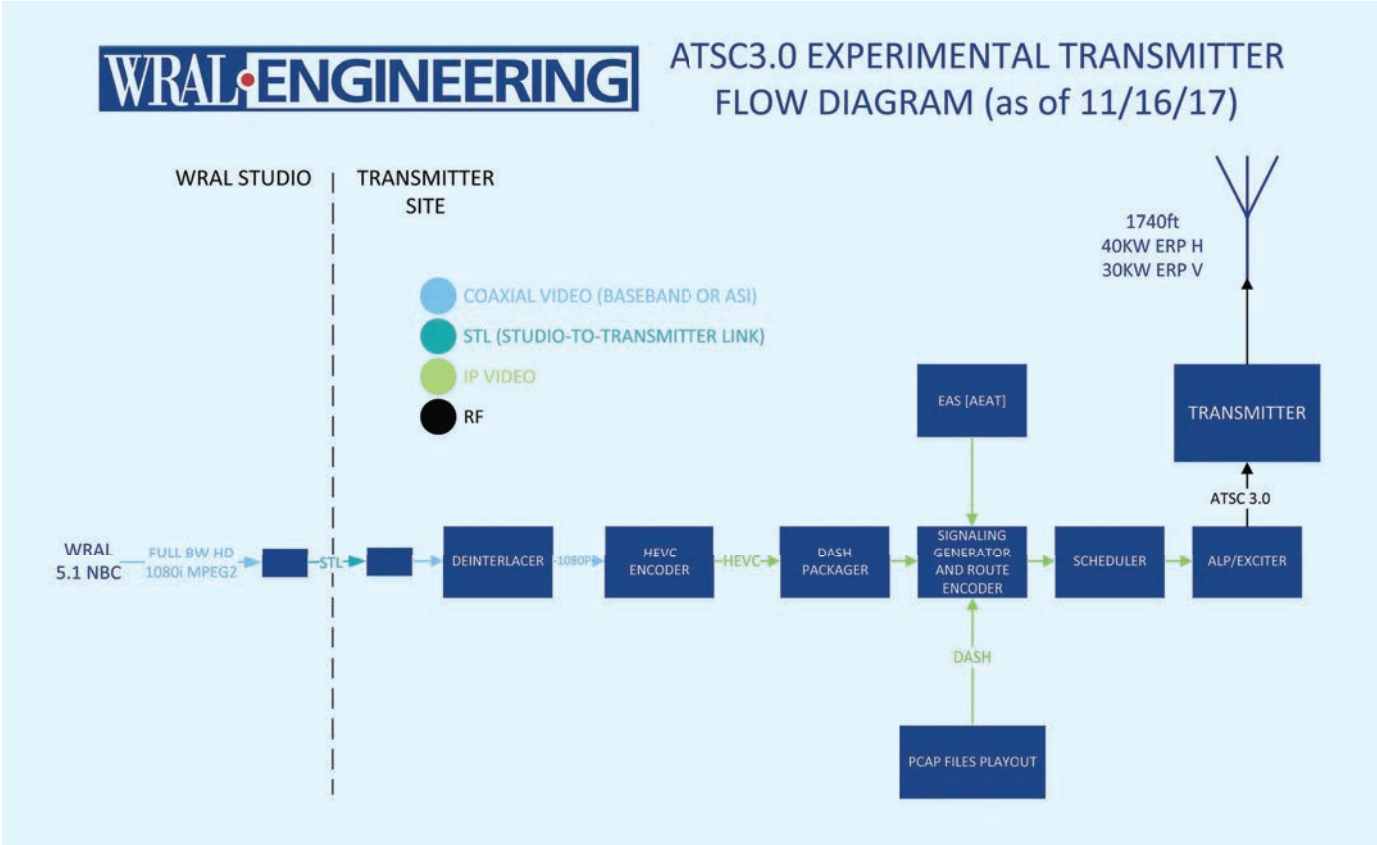
"It's all about the ModCod and your bit allocation," he said. "There is no rocket science here; if you set your ModCod for 26 mbps of throughput for example, you get to decide how you want to use it. It's all about the encoder(s) at that point, not the standard."

How's The Coverage?

Broadcasters are always concerned about how a new standard might change reception in their licensed areas. At WRAL-TV, coverage with ATSC 3.0 seems to be at least as good as ATSC 1.0, if not better.

"So far, the claims about ATSC 3.0 approaching the 'Shannon limit' seem to be true," Sockett said. "We've only begun to quantify the testing beyond go/no-go, but yes, it's working quite well!

"Once you really dig into it, you realize it's simply a high-power IP delivery system. We're now able to deliver bits in a very similar way to any other IP-based system. Video and



WRAL-TV ATSC 3.0 transmission flow diagram.

audio are just bits, as are the other benefits of the system: advanced emergency alerting, interactive data and targeted advertising. It's all about how to we want to use our bandwidth—we're now limited only by our imaginations!"

Another broadcaster hot on the ATSC 3.0 trail is the Sinclair Broadcast Group. Like WRAL-TV, Sinclair has been an active participant in testing digital TV, with a strong record of important work with both ATSC 1.0 and 3.0.

As of this writing, Sinclair has two active over-the-air tests of ATSC 3.0, and is in the process of organizing upgrades to all of its stations to make the ATSC 3.0 transition smooth.


Jerald N. Fritz

"Sinclair, along with its subsidiary, One Media 3.0, LLC, is pushing forward on the new standard on multiple fronts," said Jerald N. Fritz, executive vice president for strategic and legal affairs at Sinclair. "With the recent approval of the standard by the FCC, we are working with our consortium partners (Nexstar, Univision and Northwest) to identify initial rollout markets—announcement on target markets is coming post CES."

Fritz described the work currently underway at Sinclair.

"Deployment will be on multiple towers with provisions for single-frequency network expansion concurrent with ATSC 3.0 deployment," he said. "We're currently testing SFN capabilities in the Washington/Baltimore markets using pre-repack channels. Sinclair has committed to convert all its stations to ATSC 3.0, and will do so simultaneously with the channel repack dictated by the FCC. We are also heavily invested in receive-side chip development activity with our partners in India at Saankhya Labs."

Based on the considerable experience gained from Sinclair's ATSC 3.0 testing, Fritz was impressed with the performance of the new standard.

"ATSC 3.0 is superior to 1.0 by several orders of magnitude," he said. "It's IP-based and uses OFDM modulation—those two elements in and of themselves permit integration with the Internet and all related devices, and for the first time allow for robust mobile reception. Add in flexibility for multiple program streams, targeted programming and ads, dramatically higher-quality pictures and sound, direct audience metrics and new data business opportunities, and you can see that this change is more profound even than the move from analog to digital. The emergency information capabilities alone make the case for rapid deployment."

Fritz is sure that broadcasters across the U.S. will quickly see the benefits of switching to ATSC 3.0.

"If they don't, they may as well turn in their licenses," he said.

From The Consumer's Perspective

On the viewer side of the equation, Fritz said that one advantage stands out.

"Viewers will, for the first time, be able to receive instantaneous (no pixilating/buffering), high-resolution television on truly mobile devices—for free—which is something that *all* viewers will appreciate," he said.

Sinclair's experience with coverage is similar to what has been said by many others. There's a twist with Sinclair, however.

"Coverage should generally be equivalent [to ATSC 1.0]," Fritz said. "The real bonus, however, is the expansion afforded by use of single-frequency networks."

Fritz also mentioned the fortuitous impact of the on-going channel repack on the rollout of ATSC 3.0.

"Deployment should generally follow the path of the repack," he said. "Some markets may move more quickly, but 2020 is a good target for substantial deployment. There are some deployment steps that broadcasters can take now as they anticipate conversion to ATSC 3.0. Among those steps is ensuring their antennas can accommodate both horizontal and vertical polarization. Maximizing the signal strength is also a wise action."

With both ATSC 3.0 and the channel repack hitting at the same time, manufacturers are finding that adding ATSC 3.0 capability is an easy sell.


Rich Redmond

"When it comes to installation, it's important to acknowledge that the peak-to-average ratio of the modulation has an impact on the entire transmission system," said Rich Redmond, chief product officer for GatesAir. "An ATSC 3.0 transmitter operates using OFDM modulation, and will require more peak capabilities to deliver the same average power as currently transmitted in ATSC 1.0. If the broadcaster is updating a legacy system, the transmitter will require that additional headroom to support the power capabilities you need, or you potentially will need to operate at a lower average power. In fact, some new systems in the market de-rate the ATSC 3.0 power capability, so this is an important capability to evaluate in any new purchase. In a GatesAir system, our latest Maxiva transmitters and software-definable XTE exciters offer the same power in an ATSC 3.0 system as a 1.0 system, simplifying the upgrade."

It's well known that ATSC 1.0, with its VSB modulation, results in fragile reception that falls apart quickly in mobile use. ATSC 3.0's OFDM modulation can be made much more robust for mobile reception. Early ATSC 3.0 trials demonstrated this feature, with clear HD broadcasts that were completely stable in moving vehicles—and that was not even the most robust ATSC 3.0 encoding possible.

Mobile Reception

Some broadcasters may have written off mobile reception, as it was never that good in analog television days and is nearly impossible with ATSC 1.0's VSB modulation. However, now that everyone has a viewing device in their pocket, this is a good time to re-think the possibility of free and reliable over-the-air TV reception. Once consumers see it, there could be solid demand.

"The reception capability in an ATSC 3.0 system—when the consumer is in motion—is far greater than what 1.0 can support," Redmond said. "Broadcasters are therefore transitioning to antennas that offer a certain amount of vertical radiation, and in some cases, circular polarization, to better target devices on the move. In order to keep the same ERP in the horizontal plane as today, the broadcaster needs to increase the transmitter's output power for that additional vertical element. The end goal is to properly size the transmitter and antenna system to maximize a station's coverage capability. This allows the broadcaster to take advantage of the new business opportunities that comes with mobile reception."

The tower for the test station in Cleveland, Ohio. The ATSC 3.0 station's antenna is side-mounted at about two-thirds of the way up the tower.

Redmond said that GatesAir has been involved in most of the U.S. testing of ATSC 3.0, as well as participating in South Korea's startup of ATSC 3.0 broadcasting. This included working with Sinclair on its SFN trials in the Washington/Baltimore area, and also in Korea's extensive SFN deployment.

So, what should station engineers be thinking and planning for ATSC 3.0?

"It's as simple as an exciter update for some stations, if the headroom exists to run ATSC 3.0 through the system," Redmond said. "However, many broadcasters are taking ATSC 3.0 very seriously and evaluating their entire RF chain. They are optimizing their antennas, and those adding vertical components to the design will need more transmitter power. In those cases, an investment in the transmitter is required.

"Repack has been an ideal platform for many stations to evaluate their systems' readiness for ATSC 3.0. Well over half of the broadcasters buying transmitters for new channel assignments are, at the same time, upgrading their systems to support ATSC 3.0. Since GatesAir matches power levels across ATSC 1.0 and ATSC 3.0, that planning becomes easier for our customers. However, there are still cases where additional transmitter power is needed, depending on final antenna configurations."

Lynn D. Claudy

The NAB has been working with television stations, the FCC and other industry organizations to promote ATSC 3.0.

"NAB is very grateful to the FCC for rapidly approving authorization of the next generation television standard and adopting rules for U.S. television stations offering ATSC 3.0 services on a voluntary basis," said Lynn Claudy, senior vice president for technology at the NAB. "NAB has been and continues to be an engaged participant at all levels of ATSC activity, and was one of the signatories (along with CTA, APTS, and AWARN) in the original Petition for Rule Making to the FCC in April 2016 that culminated in the Nov. 2017 FCC Report and Order."

Claudy's advice to stations: "Start planning now for when and how to begin ATSC 3.0-based service."

Pointing The Way

As for planning, Claudy has lots of operational experience with the WJW ATSC 3.0 test facility in Cleveland. That experience has pointed the way for smooth integration of ATSC 3.0 into broadcasters' future plans.

"The multiple-carrier modulation scheme in ATSC 3.0 is quite different than the single-carrier VSB modulation technique in ATSC 1.0, so that's new for the U.S. station engineer, especially with respect to exercising the flexibility for combinations of modulation and coding that are possible," Claudy said. "That means stations can trade off reliability within their coverage area for data rate, and build SFNs to maintain high carrier-to-noise ratios throughout the service area, which is a whole new level of television service planning in this country. Perhaps, oddly though, the RF portion of the system may ultimately be the easiest part of the learning curve for engineers in launching ATSC 3.0. As the first broadcast standard based on Internet Protocol, the television station becomes one big IP network, and engineering skills in the IT arena need to be as sharp as possible."

As far as Claudy is concerned, the spectrum repack and ATSC 3.0 could not have come along at a better time.

"It's some kind of wonderful combination of serendipity and skillful planning that the schedules for the channel repacking process and for the completion of the ATSC 3.0 standard have come into alignment," he said. "For the almost 1,000 stations that are being repacked, many will need to build new RF transmission systems. Now they can design those systems to be adaptable to eventual ATSC 3.0 operation. Most or all new transmitters, for instance, are capable of ATSC 3.0 operation via software upgrades, and engineers can plan for a desired degree of circular polarization of transmission signals as part of the design, anticipating mobile ATSC 3.0 service."

Claudy's final bit of advice to stations: plan to put as much ATSC 3.0-ready equipment as possible into your channel-moving plans.

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than it is to teach an IT guy about broadcast." He sees a path to success in educating current video professionals on the IT skills specific to their industry.

"The industry is catching on to and addressing the training issue," said Sony's LeCointe. He recommends that broadcast engineers strengthen their IT skills and "buy into that IT training you've been ignoring."

Voss advises one to "ask a lot of questions, and require detailed answers about how the new system integrates with the other systems, both IP-based and traditional broadcast." He also recommends getting up to speed on the technology behind IP video systems, such as multicast, before migrating a system. Learning the new test and diagnostic tools before needing to use them is equally important to him. "Become familiar with the tools and software before you need to use them to troubleshoot a broken IP system," he said.

"Early adopters need to be ready for a trial and error period," Conley observed. He noted that the biggest surprise in a migration project can be the amount of time required for both development and configuration. With an infinite number of possible configurations of a new system comes an infinite number of possible issues that have yet to be discovered.

Most every planner of IP-based broadcast systems will admit to having encountered "landmines" of one sort or another along the way; however, these should be regarded as learning experiences; not reasons to give up on adoption of technology which provides broadcasters with the functionality they require and the new flexibilities that only IP-based systems can offer. Many believe that all new (greenfield) facility builds should be considering IP and that such IP planning should not fundamentally change the mission of the typical broadcast plant, but rather augment it.

"Because if [it does], then it [IP technology] just won't be accepted," Paulsen noted. "The systems integrator, users and manufacturers are all learning as we go."

The standards around IP video were developed with users in mind, but they don't necessarily tell the user how to build a successful system. That will come from the shared experiences of the early adopters.

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The ATSC 3.0 Cleveland, Ohio test station transmitter.

With the 2009 digital transition still fairly fresh within the collective minds of the broadcast industry, transitioning yet again to another incompatible modulation standard seems counter-productive at best. However, since 2009, the population has gone mobile with amazing ferocity—if you don't carry a cell phone in your pocket, you risk becoming forgotten.

ATSC 3.0 offers the promise of updating the television broadcast standard for the next 10 years and beyond, providing a signal that can feed the insatiable appetites of mobile users—assuming receiver chips can be built into future mobile devices. (It helps in this regard that mobile devices are replaced, on average, about every 30 months.)

In addition to a real mobile service, ATSC 3.0 also offers advanced emergency warning capabilities, the ability to carry 4K programming, targeted advertising, and other IP-related features still in development. Once receivers offer built-in ATSC 3.0 tuners, it may become hard to resist the lure of a more flexible modulation standard.