IEEE Broadcast Technology

The technologies to deliver information and entertainment to audiences worldwide, at home and on the go

Pandemic-Driven Remote Production; Lessons Learned – see p. 19

BTS IEEE

Third Quarter 2023

President's Message

Paul Schulins, BTS President

I find it hard to believe that we are well into summer already, and it has certainly been a busy time for the BTS. While the BMSB was larger than usual, with over 312 papers presented from more than 23 countries, I was gratified to see the success again this year in bringing students together to share their research and skills. The theme this year was "Multimedia Communication for the Future," and the content of the papers did not disappoint! I also want to thank the attendees who traveled long distances to attend, as well as those taking advantage of the virtual component. Many thanks to the organizers, Yiyan Wu, Tao Peng Yu, and Peter Siebert (our conference chair) for working though all the coordination. This event took months of careful planning, and was complicated by the international flavor of the event when it came to currency exchange and insurance, but our staff worked though all these challenges and, in the end, we had an extraordinarily successful event. We are already looking forward to next year's conference in Toronto!

Inside

President's Message 2
From The Editor 3
IEEE BTS BMSB 2023 Explores The Future Of Broadcast Technology 5
BTS Young Professional Workshop Part Of BMSB Activities . . . 8
ATSC Insider 10
DRM News 16
'We Are Now Stronger, Smarter And Better Equipped...' 19
5G MAG 24
DAB Radio News And Views 25
ATSC 3.0 And 5G Broadcast: Candidates For Terrestrial Broadcasting Services 29
FOBTV Technical Committee Meeting Provides Updates On Global TV Initiatives 34
RF Report 39
Women In Broadcast 45
Asia Media Summit Focuses On Green Technologies And Sustainability 47
The Downward Path To Broadcast Engineering—No. 32 49
ITU Report 51
Upcoming Events 52
What's New 53

At the same time, my good friend and well-known RF (Radio Frequency) engineer, Jim Stenberg, is chairing the 2023 ABS (Annual Broadcast Symposium) at the brand new NAB (National Association of Broadcasters) headquarters in Washington, D.C. this fall. This is a great venue and a good opportunity to bring the event home to the U.S. capital where it all started more than 80 years ago! We have been looking at dates carefully to do our best not to conflict with other major industry events, and have decided that November is a suitable time when the weather is still good, and it seems not to compete with other conferences. Please check our website for the dates, hotels, technical program, and registration details.

Artificial Intelligence And Broadcasting

Artificial Intelligence is making its way into all our lives at a rate nobody saw coming. It has significant implications for every industry including broadcasting. While companies are quickly figuring out how to capitalize on this technology, there are ethical questions that come into play. One of those is what is identified as real, and what is synthetic? As a photographer, I have been experimenting with AI when processing digital images. It is mind boggling to see what is possible, and even more shocking to see how easy it is to manipulate images to make convincing photos depict whatever your mind can imagine! On one hand, this can be considered a form of art and expression, allowing efficient generation of images that entertain, inspire, tell a story, and convey feelings. The dark side of course is using AI to convince people that what they are seeing is reality rather than an artistic expression. Applying this technology to broadcasting, we can see the many benefits to AI. We can in many cases relieve the mundane research tasks of talent and programmers to provide compelling content more efficiently for viewers and listeners. We can even create cloned voices of well-known talent to present their content over the air flawlessly, and in a way that is impossible to distinguish from the real thing. But do we have an obligation as public trustees to identify what is real and what is synthetic? We already employ voice tracking on the radio, and that makes it impossible to tell that the DJ's voice may have been recorded days or weeks ago. Are we taking a further leap with AI that may or may not be in the public's best interest?

These are just some of the ethical questions that AI raises and will have to be addressed by society. It is my feeling that

continued on page 9

Cover: Rustin Richtarik, network operation engineer at Nebraska Public Media (NPM) operates the facility's IP-based network management control system. The system, purchased and installed prior to the Covid outbreak, allows enhanced monitoring and control of network insulations throughout the state. Cover Photo courtesy of Al Krause, NPM network operations manager

From The Editor

Busy Times Ahead This Fall

By James E. O'Neal, Editor-in-Chief,
BTS Life Member

As I write this, summer has finally technically reached its "home stretch," with just a matter of weeks now until the first calendar day of the autumn season and the promise of cooler weather. (However, the very long stretch of hot weather we've been experiencing in my U.S. east coast base of operations—and in many other parts of the world— hasn't ebbed in the slightest, sometimes making me wonder if temperatures will ever fall.) Regardless of the weather, the coming fall season does offer the promise of a number of industry-related events and activities. The first arrives slightly ahead of the official summer-fall demarcation. I speak of course of the upcoming IBC show in Amsterdam in mid-September. I'm planning to be there, and am looking forward to a great event and renewing a lot of friendships, as the 2023 IBC show will likely have its highest attendance since the global pandemic put the brakes on travel and mass gatherings in 2020. Stateside—and closing out the month—there's the national meeting of the Society of Broadcast Engineers, which takes place in Columbus,Ohio Sept. 27 and 28. October brings with it the Society of Motion Picture and Television Engineers' "Media Technology Summit," which is being held in Hollywood, and just about a week after that Oct. 16-19 conference there's the 2023 "NAB Show New York" trade show (which in recent history) is held concurrently with the Audio Engineering Society's annual convention (this one celebrates the 75th anniversary of the founding of that organization). November brings with it our own BTS Broadcast Symposium, which is returning once again to Washington, D.C. The Nov. 14-15 conference is being held at a rather different venue this time, the brand-new National Association of Broadcasters headquarters in southeast D.C. If you can only attend one industry event this fall, be sure and make it the BTS Symposium! I look forward to seeing you there!

The Museum of Broadcast Technology's Tom Sprague (foreground) and Paul Beck (background) have been delighting young and old NAB Show attendees for years with items from their large collection of retro technology. Here they show off a 1970s vintage Ampex AVR-2 two-inch quadruplex VTR. How about providing a story or presentation about your own involvement with such equipment or even a description of the broadcast workflows that existed early in your career!

'What's Past Is Prologue '(Or, 'If You Don't Study History, You're Doomed To Repeat It')

The first quotation in the above subhead comes from William Shakespeare's "The Tempest," and the second is attributed to philosopher and writer George Santayana, and is usually somewhat abridged from the original, which reads: "Those who cannot remember the past are condemned to repeat it." I'm invoking Shakespeare and Santayana here, as they "hit home" with regard to two recent and closely related events. The first was an email from BTS member Lanny Nass, who mused:

"Hi my friends. Maybe I've been watching too much TV lately. However, it has caused me to wonder if anyone else has ever proposed a series on the technical history of television broadcasting. Details to include transmission, recording, cameras, receivers.…"

The second event that same day was a virtual presentation from yours truly, at the request of a broadcast-themed museum in the Washington, D.C. area (the National Capital Radio & Television Museum), in which I provided a look at the creation and evolution of technology for linking the television networks to their affiliated stations across the United States. (This initiative began in 1940 as a one station hookup between the NBC network's flagship station in New York and another fledgling TV station in Schenectady, New York, some 130 miles away.) I was only too happy to be asked to share my knowledge of this "ancient" technology with members of the museum. Not to brag, but the audience for this mostly unadvertised event was fairly large, and I received some very nice feedback. I believe that my presentation may be in line with the historical accounts of broadcast technology that Lanny is seeking.

Although I don't really like to think of myself as an "old timer," I have, during my career in broadcast engineering, witnessed a number of pretty significant

technological "sea changes" and "landscape shifts," including the move from vacuum tubes to transistors, and then on to integrated circuits, and eventually the microprocessor and all that came with it.

I lived some of my network interconnection presentation, as early in my career, I assisted in the construction and maintenance of a multi-hop intercity microwave system for delivery of NBC network programming to the station where I was employed. This system spanned a distance of about 150 miles, and was not a trivial undertaking. (Due to location of AT&T Long Lines circuits and associated construction and operational costs, the "common carrier" approach was not an option.) The "hands-on" experience I gained was invaluable—textbooks don't tell you everything—and served me well throughout my career.

In preparing and delivering the presentation, I realized that the construction of private cross-country microwave links has now become something of a "lost art, "due to the immense amount of readily-available and inexpensive fiber connectivity that exists in the 21st century. Consequently, I was glad to pass on some of what I'd learned about "first-generation" video connectivity to younger members of the Zoom audience.

Likewise, I was involved in another almost "lost art" early in my career—the making of "kinescope" recordings (also called "tele-transcriptions" and "tele-recordings"). I put together another PowerPoint presentation on this technology after speaking with a younger engineering technician about some of the obstacles that limited the quality of this early form of television content recording. He asked why weren't the programs "videotaped" instead of using this somewhat primitive technology of preserving television content on film, not knowing that the first practical videotape recorder was not perfected until 1956, a full decade after the post-WWII TV boom.

Again, I was glad to share the knowledge that I have on this topic with younger audiences.

While a number of history books document the advent of broadcasting and its evolution during the past hundred years or so, these histories focus mostly on broadcasting personalities, programming trends, business aspects and the sociological impact of the medium, with little in-depth information on the engineering side of things. So, Lanny couldn't have been more correct about the need for histories involving broadcast technology itself. And the best source for this information if from those who have participated in it.

I would like to see others within our society heed Lanny's call and add some chapters of their own involving their particular areas of expertise in broadcast engineering. These needn't be PowerPoint presentations such as I put together; written accounts would serve just as well. I'm sure that some very interesting presentations/articles could be generated about the installation, operation and maintenance of early television transmitters, what it was like to set up an image orthicon camera, the "timing" of broadcast facilities prior to the creation "black burst" technology for this very necessary operation, the setup and operation of a first-generation two-inch quadruplex videotape recorder, registration and color balancing of early color TV cameras; even the procedure for changing out the CRT in a color monitor! Few of those working in broadcasting now have a clue about these and other operations that were part of the day-to-day activities just a generation or so earlier. Although the examples I've listed are television specific, there are an equal number of radio-related technologies that are now obsolete and need to be described and documented.

And there is a lot of interest in these areas by younger people in the business. If you've been to a Las Vegas NAB Show in recent years, you may have noticed the crowds that exhibits put on by the Museum of Broadcast Technology (MBT) attract. Volunteers from the MBT have for several years brought retro technology to the show. While a lot of us "old timers" like to look at the sort of gear we grew up with, there are plenty of younger people who are attracted to the MBT exhibit. In recent years, museum volunteers have demonstrated two-inch VTRs tube-type black and white image orthicon cameras. The most recent MBT NAB exhibit was centered around two Norelco PC-70 plumbicon cameras that were restored to operational condition.

I'm also member of another broadcast themed organization—the Early Television Foundation (ETF)—which is headquartered near Columbus, Ohio. This group is an offshoot from a museum dedicated to preserving television's technological history, with mechanical TV receivers (and scanners) dating back to the 1920s, pre-WWII receivers, early color sets (mechanical and all-electronic), prototype sets, CRTs, cameras and imaging tubes; even a very early OB van and a 1950s TV transmitter in its entirety. Many of the receivers have been restored to operational condition, with continuous demonstrations provided. The museum attracts a wide cross section of attendees, and hosts an annual conference, with presentations and demonstrations involving television's technological history. Membership in the ETF continues to grow and, with more and more younger people signing up and participating in the yearly conference. The organization also offers a monthly Zoom program which frequently features presentations on television technological history and almost always attracts a large viewership, both in the United States and elsewhere.

Broadcast-themed museums continue to flourish and attract a wide cross section of visitors, with a new one opening up just a few years ago (the Texas Museum of Broadcasting & Communications in Kilgore, Texas) and continuing to expand its collection and displays, even during the global pandemic.

Also, if you're a SMPTE member, you very likely are familiar with the history feature published in each of that organization's journals, as well as occasional papers highlighting a particular aspect of early television or film technology.

So, it would seem that Lanny is "spot on" about the need for accounts of television's technological history. How about adding yours!

James O'Neal
Editor
Broadcast Technology
IEEEBTSeditor@gmail.com

IEEE BTS BMSB 2023 Explores The Future Of Broadcast Technology

Conference Features Presentations On Diverse Range Of Contemporary Broadcasting Arena Topics

By Peter Siebert
BTS Vice President Of Conferences

BEIJING

The 2023 IEEE Broadcast Technology Society BMSB broadcast symposium, which was held here June 14-16, brought together industry professionals, researchers and experts from around the world to exchange knowledge, share insights, and discuss the latest advancements in broadcast technology.

The 2023 event focused on such cutting-edge topics as next-generation broadcasting standards, digital media distribution, immersive audiovisual experiences, 5G integration, AI-driven content production, and virtual and augmented reality applications. The sessions were curated to provide attendees with valuable insights into the latest trends, emerging technologies, and industry best practices. Prof. Ping Zhang from the Chinese Academy of Engineering served as general chair for the 2023 BMSB, and was supported in his efforts by executive general co-chairs Xuesong Qui from the Beijing BTS chapter, and Yiyan Wu from Canada's Communications Research Centre.

The 2023 conference's "call for proposals" yielded some 300 contributions, with 250 of these selected by the program committee for presentation in either the oral or paper sessions. Registration totaled 198, with 121 of these participating in person. Attendees came from 12 countries, contributing to a very international audience.

Renowned Keynote Speakers

One of the highlights of BMSB conferences is the lineup of distinguished keynote speakers who are recognized experts in the field of broadcast technology. On the first day of the conference, the keynote address was presented by Dr. Weiliang Xie, a senior wireless expert at China Telecom. He spoke about "Trends and Challenges in Broadcast and Multicast Industry." In addition to the keynote presentation, the opening ceremony included a message from BTS president Paul Shulins, and an introductory note from the conference chair, Prof Ping Zhang.

The second day of the event featured an address by Prof. Pablo Angueira from Spain's University of the Basque Country, in which he spoke about the use of Inter-Tower Communications Network (ITCN) in connection with NextGen TV. Angueira explained how transmitting towers in a broadcast network can be interconnected wireless, using the same spectrum as the broadcast signal.

The second keynote address that day was presented by Dr. Sung-Ik Park from Korea's Electronics and Telecommunication Research Institute (ETRI). Park presented a comparison of the spectral efficiency of ATSC 3.0 and 5G Broadcast, with the results clearly showing that ATSC 3.0 has significantly better performance. He noted that for stationary reception, the difference is about 3 dB, and said that with mobile reception, that difference increases to about 7 dB. Park explained that the main reason for this difference is the missing time interleaver in 5G Broadcast.

On the final day of the conference, the keynote address was presented by by Dr. Qingjun Zeng, the deputy director general at the China Broadcasting Network, who spoke on Broadcasting in the Era of 5G." His address focused on broadcasting based on 5G New Radio, in which he provided the results of field trials from various TV transmitting towers in China.

BMSB 2023 Features Both Oral And Poster Presentations

The BMSB conferences provide a platform for researchers and industry professionals to present their latest findings, innovative solutions, and case studies through both oral and poster presentations. These technical sessions enable participants to delve deeper into specific areas of interest. This time, there were 24 oral sessions, each with about six presentations, and there were 11 poster sessions, with each featuring about 10 posters.

In addition to conference presentations, participants also had the opportunity to experience featured

Conference organizer Peng Yu welcomes attendees to the 2023 BMSB conference.

technical demonstrations and exhibitions showcasing the latest advancements in broadcast technology. Leading companies, equipment manufacturers, and research institutions used the event to exhibit their products, services, and research findings, providing attendees with a hands-on experience and facilitating networking opportunities.

Another highlight of the event was the Young Professionals (YP) workshop, jointly organized by Zhuqing Jiang from Beijing's University of Posts and Telecommunications and Marta Fernandez from University of the Basque Country. (Please see their account of the event, which follows this report.)

The BMSB2023 conference provided plenty of networking opportunities for participants to connect with industry, researchers, and professionals from around the world. Coffee breaks, lunches and dinners afforded opportunities for discussion, meeting old friends and getting to know each other. The highlight was the Gala Diner, which was held the evening of the second day of the event. In addition to a wide culinary offering of Chinese and international specialties, the event also featured an artistic program, with various dance groups, a magician and also a "face" changer who is skilled in swapping face masks in just a fraction of a second.

In Conclusion

For me as the BTS vice president of conferences, it was a special moment the join in activities at the event. I was very happy to meet so many young students and professionals eager to learn and to contribute. It gave me a good feeling about the future of our industry. It was also good to meet old friends and to catch up with the latest development in the wider broadcast world. I also want to point out the excellent organization of the event by Prof. Peng Yu and his young team of highly motivated volunteers.

As is usual at BMSB events, the location of the next conference was announced at the end of the proceedings. Next year's BMSB event will take place at in Toronto, Canada June 19-21, 2024, and will be organized by colleagues at Toronto's Humber College. I look forward to another great event demonstrating the relevance of broadcast in media delivery.

In-person attendees at this year's BMSB event numbered 121 and came from 12 countries.

Jingyi Xue presents her poster on content label systems.

In addition to dance groups and a magician, a 'face changer' was also part of the entertainment lineup at the conference's Gala Dinner.

Author Siebert poses with the group of volunteers who helped in a big way to make the 2023 BMSB event a success.

BTS Young Professional Workshop Part Of BMSB Activities

By Marta Fernandez
BTS Young Professionals Chair
And Zhuqing Jiang
BTS 2023 Young Professionals Workshop Chair

A face-to-face Young Professionals (YP) workshop was held on June 14, as part of this year's BMSB activities, with young professionals such as PhD students at the conference being able to attend the workshop. This was the second full in-person YP event following pandemic-related restrictions. We hope to continue organizing these types of activities in the coming years, as they are very beneficial for the students and for the Society members.

The workshop was part of the BTS YP program designed to assist students in their transition to young professionals. This year's event was a great opportunity for both students and young professionals, as it allowed them to attend an educational forum of experts and to participate by presenting information about their research activities. Participants were also able to receive constructive feedback and to develop collaborative opportunities. Each speaker could share information about his or her current research work and future goals during five-minute presentations. A total of 11 speakers, including two researchers, six master's degree students and three PhD students, presented information on a wide variety of topics, including terrestrial broadcasting, signal processing for image enhancement in areas such as object detection, as well as contributions related to positioning techniques, 3D reconstruction and improvements in computer networks.

About 30 attendees from different universities and centers attended the presentations, and were able to socialize and exchange ideas with others during a coffee break.

We also had a great time taking group photos, and would like to extend thanks to all who joined and participated sharing their work and ideas. It was a pleasure to have attendees from different places of the world, such as from the Beijing University of Posts and Telecommunications (BUPT), Communication University of China, THU, University of The Basque Country (UPV/EHU), University of Cagliari, Mediterranea University of Reggio Calabria and NRTA Academy of Broadcasting.

Comments From YP Presenters

As this workshop would not have been possible without the young participants, we would like to offer comments from two of the presenters:

Some 30 Young Professionals took part in this year's BMSB workshop event. They're seen here with the BTS's vice president of conferences, Peter Siebert (first row; third from the left).

"This workshop was remarkable for its breadth and diversity of topics, spanning from broadcasting domains like Terrestrial Broadcast and Positioning to visual signal processing areas like Underwater Image Enhancement and 3D Reconstruction. Besides showcasing technical innovations, it also featured overview presentations such as Zhou Yun's talk on Development of UHDTV in China. As a project designed to foster exchange and spark ideas among Young Professionals, it was very beneficial to have presentations from various backgrounds that expanded the academic horizons and perspectives of young scholars," said Wang Yiran, whose presentation was entitled "Research on Underwater Image Enhancement Methods."

"This workshop was excellently planned and organized in terms of time and content. By giving each speaker a fair amount of time, the meeting proceeded smoothly and calmly. By interacting with young scholars from diverse backgrounds, I obtained many fresh insights, such as Fang Honglin's innovative model on Edge Computing, which opened up new avenues and approaches for research. So I was very fortunate to attend this workshop!" said Chen Yuling, who participated in the workshop by presenting the work entitled "Fingertip Reading Recognition Based on Object Detection Algorithm".

President's Message

continued from page 2

there are qualities possessed by a good broadcaster that cannot be entirely replaced by machine learning, and that the successful broadcaster will use all the modern tools available to supplement, but not to replace, the human ingenuity and decision making that makes us who we are. Computers cannot tell a story, only humans can do that!

ExCom Activities

Our ExCom has been meeting monthly, and I am encouraged by the level of engagement by our officers and executive team. We are looking at several new initiatives this year including sponsoring workshops in Italy for young professionals, and engaging students in our society so they may benefit and contribute to our programs. We are making excellent progress partnering with other allied societies and I envision our future with them as strengthening our ability to educate and connect engineers rather than to compete for members. We are also in the middle of generating proposals for new initiative funding that if approved will allow us to broaden our footprint worldwide as we will be able to provide services to underserved regions that can benefit from our technology.

The Advantages Of Being A BTS Member

I am so glad that you are a member of BTS, but remember that being a member is more than paying dues and reading our newsletter. We have so much to offer from our resource center to the many conferences, webinars, and opportunities for students and young professionals, scholarships, and networking with the brightest minds in the industry. We have so much potential to advance technology for the good of humanity, and that is what IEEE is all about. I hope that you find your membership valuable, and that you visit our website often to find out how you can more fully engage with our society to maximize your investment. If you know of any friends who can also benefit from being a member, please refer them to our website: *https://bts.ieee.org*.

Thank you for your continued support. Things are changing as we grow our membership and address modern technology. BTS is here to serve our members, and to support students and young professionals by encouraging easy access to our highly qualified professors and industry leaders. My goal is to make sure we encourage new and younger members to become more active in what we do. The future is yours to build and I want BTS to be front and center in your toolbox.

Please reach out to me at the email address below at any time, as I would love to hear your story. I look forward to seeing you at our next event!

Paul Shulins
paul.shulins@ieee.org

ATSC Insider

By Madeleine Noland and Jerry Whitaker,
Advanced Television Systems Committee

Broadcast Conference Serves As Focal Point For New ATSC 3.0 Developments

The 2023 ATSC 3.0 NextGen Broadcast Conference was held June 14–15 in Washington, D.C. The event showcased a number of exciting developments, not the least of which was observance of the 40th anniversary of the organization. Events during the week included the Annual Member Meeting, Technology Group 3 meeting, and Board of Directors meeting, in addition to the conference itself.

Award Winners

During the Anniversary Awards Ceremony, Glenn Reitmeier was named the 2023 recipient of the Bernard J Lechner Outstanding Contributor Award, and Saankhya Labs was named the recipient of the 2023 Mark Richer Industry Leadership Medal.

Glenn has exemplified the characteristics of the late Bernie Lechner, dedicating his technical prowess and leadership skills to numerous ATSC projects and initiatives over the years. His body of work spans so much of ATSC's history, and it is only fitting that he receive this award on ATSC's 40th Anniversary.

Saankhya Labs was the 2023 Mark Richer Industry Leadership Medal recipient. The company has been the vanguard of the experimental activity in Bengaluru and Delhi, India with ATSC 3.0 Direct-to-Mobile (D2M) broadcast services. Saankhya Labs has not only demonstrated their value as technical implementers and relationship managers, but also as exemplary team members working collaboratively with the entire ATSC community. Saankhya Labs has worked with key Indian organizations including TSDSI (Telecommunications Standards Development Society, India), IIT-Kanpur, and Prasar Bharati to ensure that stakeholders understand the benefit of D2M services to the Indian people and how ATSC 3.0 is a leading technical solution for video, radio, and data services for fixed and mobile devices.

ATSC NextGen Broadcast Conference

The NextGen Broadcast Conference showcased a number of key areas relating to ATSC 3.0, including the NextGen TV Consumer Experience, and presentations examining a wide variety of applications and opportunities for NextGen TV. The conference featured an all-star cast including remarks from CTA president and chief executive officer, Gary Shapiro; a dialogue with FCC Commissioner Nathan Simington; and a special session exploring a topic that created huge buzz at this year's NAB Show: "using ATSC 3.0 as a back-up GPS system for precision timing in the event of a disruption in GPS services," which some have described as a matter of national security. The VIP line-up was capped off by remarks from the NAB president and chief executive officer, Curtis LeGeyt. Speaker comments were especially important in light of the newly launched Future of TV Initiative spearheaded by the FCC and NAB.

The ATSC is focused both on how to ensure ATSC 3.0 is successful in the marketplace, and also how to ensure that the organization is planning for what's next. From television services in the United States, to D2M field trials in India, to broadcast core network development, to precision timing over broadcast—speakers unpacked these topics and more. Other speakers focused on business continuity, examining how cyber security needs to develop as we move to IP-based workflows, cloud computing, and the ATSC 3.0 IP-based broadcast standard.

In the current data-hungry environment, broadcasting remains an optimal way to get the same data to many devices simultaneously. In a perfect world, each data session could be examined and routed through the most appropriate network for its particular use case. Technology to efficiently steer data to this network or that network is needed in order to realize the benefit of optimizing network usage. ATSC is studying

how to determine which traffic travels over which network and how the data gets routed to the selected network. The Broadcast Core Network is central to this work. It will manage data distribution among broadcast transmitters, and also coordinate data distribution across multiple different networks by connecting with other Core Networks, such as the 5G Core. Along these lines, ATSC has been studying the opportunities for ATSC 3.0 and 5G harmonization.

Key Initiatives

The ATSC Board of Directors has identified a number of key initiatives. Among these is the international adoption of ATSC 3.0. ATSC 3.0 represents the state-of-the-art in broadcast technology. A growing number of countries and regions are expressing interest in this technology—from Brazil to India, from the island of Jamaica to the island nation of Trinidad & Tobago, from Ghana to Guyana. There are some common goals for terrestrial services regardless of where you are in the world: television broadcasters want to deliver a great consumer experience, enhance emergency information distribution, and create a return on the investment in upgrading technology. But the details of what this means and how to achieve these goals varies widely. Every region has its own unique set of use cases and key technical requirements, including broadcast traffic offload that can utilize a 3.0–5G link, D2M services, re-use 1 network design, emergency preparedness, bridging the digital divide, and fostering cultural unity through local news and content creation. ATSC 3.0 is proving its flexibility as engineers successfully implement solution designs optimized for each unique use case.

New PT And IT Groups

To ensure that ATSC remains at the vanguard of broadcast technology development, the Board has formed a number of Planning Teams and Implementation Teams. These teams act as bookends to our central work in the Technology Group. Planning Teams explore technologies and opportunities that may impact future technical work, while Implementation Teams work with newly specified technologies—putting prototype systems together and facilitating new market and vertical development. Two new groups have been launched since the last issue of Broadcast Technology:

- **PT9 – Planning Team on Sustainability.** PT9 will study the benefits of broadcast data delivery as relates to sustainable energy usage in a world increasingly dependent on data delivery. The team will consider linear and file-based media delivery as well as linear and file-based data delivery. PT9 will report the results of this work to the Board. If technical work in ATSC is recommended, PT9 will further document rationale for the work and ideally also document possible architectural approaches and requirements, such as interoperability with existing networks, which would accommodate the identified use cases. PT9 does not draft standards or recommended practices; it may draft New Project Proposals and/or Planning Team Reports.
- **IT7 – Caribbean Implementation Team.** IT7 provides a central point for communication to and from Caribbean nations and ATSC regarding ATSC 3.0 adoption and implementation, working closely with national and regional organizations (e.g., BCJ, CTU, CBU) to develop and support national, regional, and coordinated solutions and strategies. IT7 reports to the ATSC Board of Directors. It does not develop ATSC Standards or Recommended Practices; however, it may provide input to technical document development based on its experience with specific Caribbean requirements.

The Planning Team on Automotive Applications (PT5), meanwhile, is beginning a new phase of work, based on recent developments in the marketplace. Current thinking is that PT5 may transition to an Implementation Team.

International Activities

The TSDSI (Telecommunications Standards Development Society, India) is India's telecom standards development organization. It recently completed transposing ATSC 3.0 standards to TSDSI standards. Adoption of ATSC 3.0 standards as TSDSI standards creates a path for Indian technical developments to be incorporated into the standard, such as optimizations for mobile and converged 3.0-5G services. This is a milestone in the path to ATSC 3.0 potentially becoming an Indian National Standard. While India has not committed to upgrading their broadcast system to ATSC 3.0, the keen interest is exciting to consider, and with 1.2 billion cell phones in the market, they are in a position to be a world leader in D2M broadcasting.

Two broadcasters in Mexico have become the first in that country to file for experimental ATSC 3.0 licenses. Multimedios and one other station will be testing NextGen TV signals this year with the support of ATSC members led by Thomson Broadcast. They will stage a hands-on workshop later this year demonstrating ATSC 3.0 capabilities in Mexico to key stakeholders, broadcasters, and government officials.

In Canada, the Calgary Emergency Management Agency (CEMA) has announced plans to consider the merits of ATSC 3.0 in a variety of areas, including emergency alerting, first responder networks, and remote education applications. The project includes planning for Canada's first ATSC 3.0 SMART city. Project leaders are in the process of securing Canadian Broadcasting Corporation's support to utilize their Calgary broadcast infrastructure to deploy demonstration services. The Humber College Broadcast-Broadband Convergence B^2C Lab will participate in this effort.

Developments In U.S. ATSC 3.0 Deployment

Even with all the progress made so far, there remains plenty of work ahead for ATSC and the broadcast industry.

The new Future of TV Initiative, announced by FCC Chairwoman Roseworcel in April at the NAB Show, is now getting underway. This is welcome news, as the group will tackle a number of tough, complex questions as the work moves forward. Fortunately, with the Future of TV Initiative, the right people are in the room to work through these questions and identify the path toward common goals. ATSC is pleased to be part of this conversation. As the technical experts on the ATSC 3.0 system, ATSC can provide clarity on how the system works, why certain technical design choices are beneficial, and help ensure the participants understand the system's wide-ranging capabilities.

On June 23, the FCC issued a third Report & Order pertaining to ATSC 3.0. In the new Report and Order, the FCC provided clarification on several items related to "diginets" in ATSC 3.0 market transitions, non-commercial station hosting rules, and also adopted a sunset date of July 17, 2027 for the "substantially similar" requirement for simulcasting ATSC 1.0. This development is seen as good news among the U.S. broadcasting community. Together with the Future of TV Initiative, stakeholders across the U.S. broadcasting ecosystem are forging the path to full transition to NextGen TV.

Get Involved

ATSC Membership offers the opportunity to shape the industry through standards development, educational opportunities, and networking with peers, business partners, and leaders across the globe. Membership includes access to members-only activities, including Technology and Planning Team meetings, along with documents and projects in development. Specifically:

- Involvement in developing and approving Standards and Recommended Practices for the digital terrestrial transmission industry
- Involvement in Planning Teams exploring new technologies and verticals that are emerging in the broadcast industry
- Develop and share information on the implementation of ATSC Standards and Recommended Practices
- Coordinate/harmonize with standards-setting bodies around the world
- Access to the flow of information through the ATSC "members-only" workspace
- Monitor activity around the world that can impact the global digital terrestrial broadcasting ecosystem
- Develop strong relationships with fellow members across the broadcast ecosystem

Returning to the 40th anniversary of ATSC, the authors wish to thank the organization's membership for their contributions over the years. Members are the driving force behind not only ATSC, but also the thriving television and tech community. It is their innovation, energy, and pursuit of success for the broadcast ecosystem that fuels everything ATSC does.

The 2023 ATSC 3.0 NextGen Broadcast Conference celebrated the 40th anniversary of the organization's founding in mid-1983 as 'The Grand Alliance,' with some 240 registering for the in-person event.

The 2023 ATSC Meeting In Pictures

ATSC pre-conference activities included a 1980s-themed Wednesday evening reception, dinner and awards ceremony, with music provided by a group comprised of ATSC members, 'The Multicasters.' (The group includes the BTS's Bill Hayes, who is seen with his guitar and 'shades' on the right.

This year's Mark Richer Leadership Medal was awarded to India's Saankhhya Labs, with the company's Prashant Maru and Parag Naik (far left and left in the photo) accepting the award. Mark Richer, past ATSC president is at the center of the photo, with current president Madeleine Noland, and ATSC board chair, Richard Friedel, on the right.

Glenn Reitmeier (center) was the recipient of the ATSC's 2023 Bernard J. Lechner Outstanding Contributor Award. Here's seen here receiving the award from the ATSC president, Madeleine Noland, and ATSC board chair, Richard Friedel.

Seen here in one of the discussions on NextGen TV are (left-to-right:) Skip Pizzi, Skip Pizzi Media Consultants LLC; Parag Naik, Saankhya Labs; Cordel Green, Broadcasting Commission of Jamaica ; Jay Jeon, NextGen TV international project specialist; and Kurleigh Prescod, Telecommunications Authority of Trinidad and Tobago.

FCC Commissioner Nathan Simington was a special guest at the conference. He was interviewed by ATSC president Madeleine Noland, and also answered questions on the ATSC 3.0 rollout posed by attendees.

Three long-serving ATSC board members—(left-to-right) Lynn Claudy, Brian Markwalter, and Andy Scott—were recognized for service to the organization by President Noland as part of the June 15 conference activities.

About The Authors

Madeleine Noland *is president of the, Advanced Television Systems Committee (mnoland@atsc.org). Widely respected for her consensus-building leadership style, she chaired the ATSC technology group that oversees the ATSC 3.0 broadcast standard before being named ATSC president in May 2019. Previously, as a representative of LG Electronics, she chaired various ATSC 3.0-related specialist groups, ad hoc groups and implementation teams since 2012. A 15-year industry veteran, Noland held key technology management and standards roles at Backchannelmedia Inc., Telvue Corp. and LG. She received* ***TV NewsCheck's*** *"2019 Futurist" Women in Technology Award and was named one of 2018's "Powerful Women in Consumer Technology" by* ***Dealerscope*** *magazine. In 2016, she received ATSC's highest technical honor, the Bernard J. Lechner Outstanding Contributor Award. She graduated cum laude from the University of Massachusetts.*

Jerry Whitaker, *Vice President for Standards Development, Advanced Television Systems Committee (jwhitaker@atsc.org). Whitaker supports the work of the various ATSC technology and specialist groups and assists in the development of ATSC Standards and related documents. He currently serves as secretary of the Technology Group on Next Generation Broadcast Television, and is closely involved in work relating to educational programs. He is a Fellow of the Society of Broadcast Engineers and a Life Fellow of the Society of Motion Picture and Television Engineers. He has served as a board member and vice president of the Society of Broadcast Engineers.*

DRM News

By Yogendra Pal
Honorary Chairman
DRM Indian Chapter

Small Coverage Pop-up Stations In India Through The Use Of DRM

All India Radio (AIR), the country's public service broadcaster, is providing terrestrial radio services in MW, SW and FM bands. Commercial broadcasting in the FM band is licensed to private radio stations. Community radio stations are also allowed on the air for non-commercial use.

The nation's communications regulatory body, Telecom Regulatory Authority of India (TRAI), has now invited comments from the public on the possibility of allowing the commercial use of low-power terrestrial FM broadcasting for short-range coverage in residential complexes, industrial exhibitions and in small businesses. This could also deliver sports commentary, and could be used in conjunction with public addresses, music concerts, cultural events, and political rallies. It could also be used for hospital radio and similar services.

The DRM Consortium considers this to be a very worthy initiative that will enable dissemination of information to the public, and also reduce the audible noise pollution associated with the use of high-power public address systems with multiple loudspeakers in reaching groups at outdoor public gatherings, concerts, rallies and similar events, as audio would be delivered via the low-power FM transmitters directly to individuals via portable radios with headphones, or FM reception-enable cell phones. The DRM Consortium foresees that there will be similar demands for many other commercial applications. So, the policy being developed should not only refer to the present situation, but should also meet future demands, thus delivering a future-proof solution for infrastructure, regulations, and features.

About The DRM Digital Radio Standard

DRM digital Radio is the most modern, non-proprietary, open digital radio standard. It is recognized and endorsed by relevant organizations such as the ITU and ETSI. It is currently in use in India on MW and SW broadcast bands, and the digital radio technology has enjoyed a speedy market penetration, with more than six million cars equipped with DRM radios as of mid-2023. DRM broadcasting is delivering one-to-many services, providing service to an unlimited number of listeners within a given coverage area.

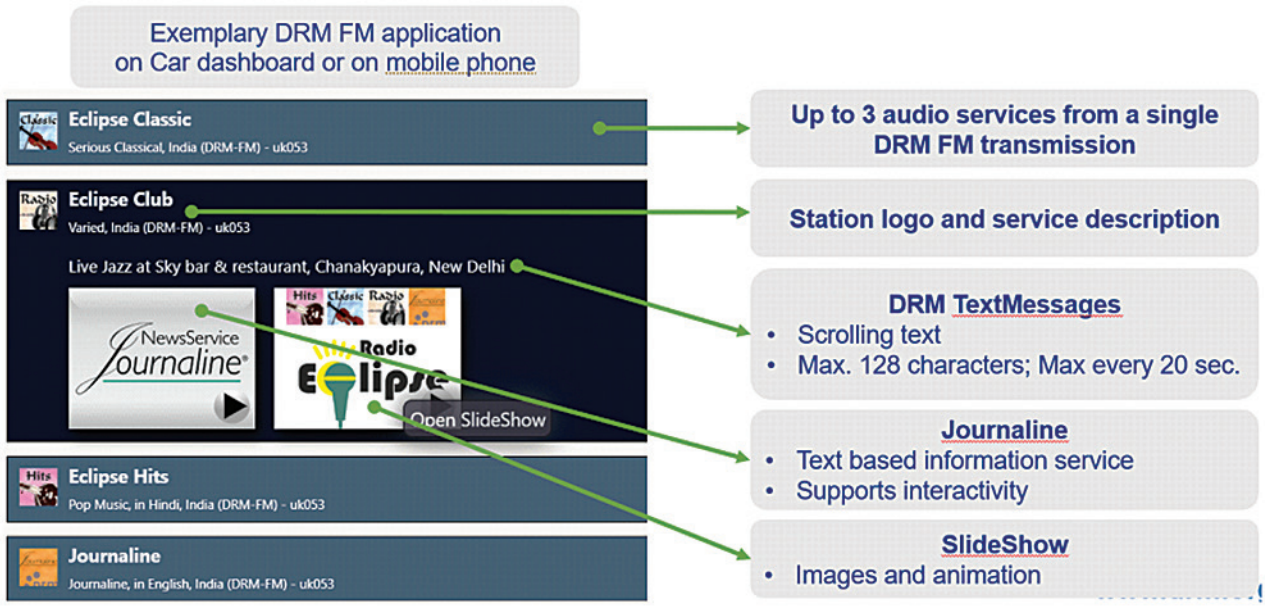


Fig 1: Multiple services in DRM within an allocated frequency spectrum of 100 kHz

Justifications For Using DRM In Short-Range Terrestrial FM Broadcasting

Short-range broadcasting can benefit from the myriad services and features made possible by DRM digital radio. For optimal future radio services in this area, the DRM Consortium has suggested adopting the DRM Digital Radio rather than analog. Here are some of the justifications and facts:

- **State-of-the-art future-proof technology** - Analog FM gives reasonably good quality audio service, but it is a 20th-century technology with limited innovation scope. It's both spectrum and power hungry, providing only a single audio service per frequency. Digital broadcasting in the FM band provides multiple services (see Figure 1), within the same allocated frequency band at a much-reduced power, along with a host of other value-added services.
- **Requires only one-half of the spectrum** – One audio channel in analog FM requires 200 kHz of spectrum. By comparison, one block of DRM digital radio requires only 100 kHz, or half the spectrum allocated for analog FM transmissions.
- **Multiple single audio channels and value-added services** – With analog FM broadcasting, only one audio program can be accommodated within the 200 kHz of bandwidth allocated. DRM digital radio provides the capability for broadcasting up to three audio programs along with additional multimedia services in just 100 kHz of bandwidth. The availability of two additional audio channels is very important for providing commentaries in multiple languages for sporting events and other programming. Today, movies being aired on TV may be accompanied by as many as 20 language tracks simultaneously. Since multiple DRM blocks (up to eight blocks) can be carried by a single FM transmitter, it's possible to use multiple adjacent channels for broadcasting programs in more than three languages. By comparison, with analog FM radio, several transmitters would have to be needed, along with the use of larger frequency offsets and additional combiners.
- **No additional spectrum required; efficient white space usage** – Large white spaces already exist between frequencies used for high-power FM broadcasting. This spectrum can't be used for analog FM transmission, but can be utilized for digital DRM transmissions, as with DRM digital operation, frequencies can be allocated to at least three users in a single white space of 600 kHz that may exist between the operating frequencies of two analog FM transmitters. Thus, many low-power short-range channels are possible in DRM digital by utilizing such white space.
- **Much Lower frequency offset required** – In India, a center-to-center spacing of 800 kHz is maintained between two analog FM transmitters (i.e., a 600 kHz frequency gap). However, a DRM digital transmitter can be installed with a spacing of only a 50 kHz from an analog

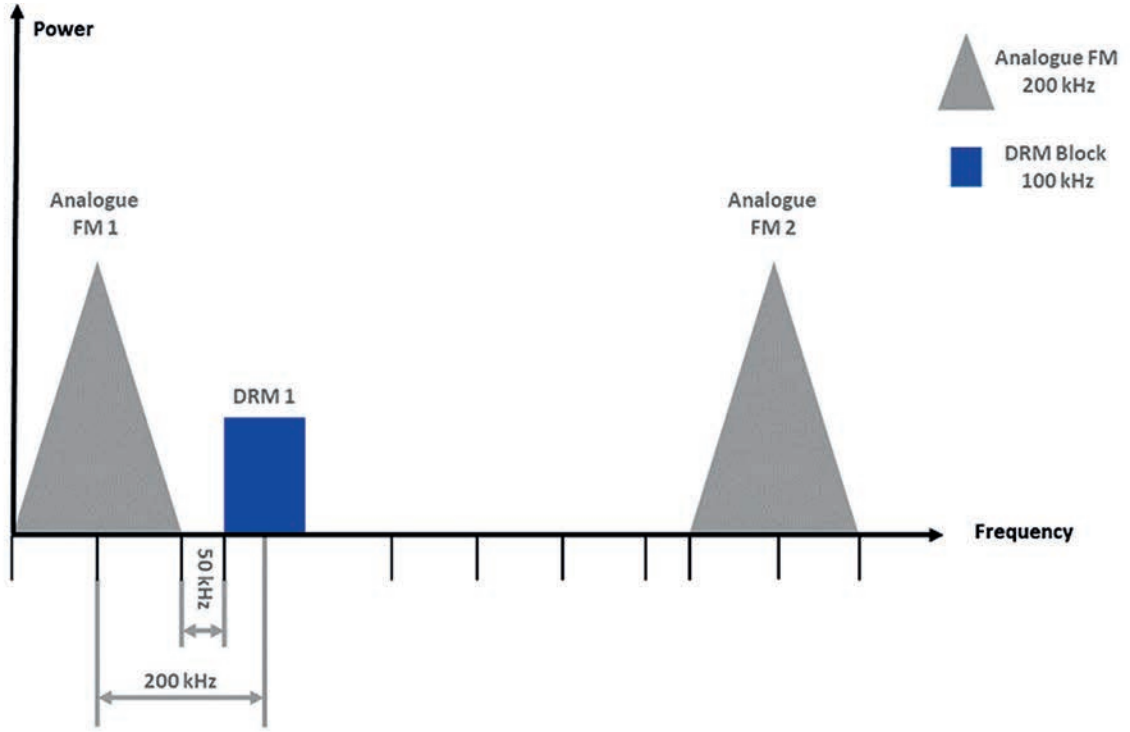


Fig 2: Insertion of a DRM block from a separate transmitter in the white space between existing FM transmissions, showcasing an exemplary frequency gap of 50 kHz

FM transmitter and/or another digital transmitter (See Fig 2). Thus, DRM digital permits the operation of many more radio services within the FM broadcast band, a very attractive feature, particularly in major cities where available broadcast spectrum is limited.

- **Innovation** – While analog FM offers little in terms of innovation and services for varied audiences, DRM digital radio is the newest, most complete, and internationally recognized standard for digital broadcasting. Through use cases involving limited area broadcasting, an innovative single DRM receiver with a built-in local Wi-Fi hotspot is sufficient to make the DRM services available to listeners nearby on their existing mobile phones. Additionally, DRM digital radio offers three audio services and additional data services such as Journaline and SlideShow, which fits use cases where audio service in multiple languages is desired, with the audio being accompanied by text and graphics, such as subtitles, hospital info, and ads.
- **The timing is right** – Now is the perfect time to introduce low-power FM by using the benefits of the DRM standard. This will be fully in line with the TRAI's recommendation to introduce digital service within FM band and to demonstrate the advantages of digital radio over analog to both broadcasters and their audiences.

Mobile Phone Update

Some of the mobile manufacturers have stopped incorporating FM Radio reception capability in their phones. In this connection, Indian IT Ministry has recently issued an advisory to Indian mobile phone manufacturers to continue to provide this feature in their products, as it will also enable the availability of DRM digital radio reception in mobile phones without any additional hardware.

The TRAI (Telecom Regulatory Authority of India) has received several comments, and its recommendation for short-range low-power FM broadcasting in India is eagerly awaited.

Reference

[1] *https://www.trai.gov.in/consultation-paper-issues-related-low-power-small-range-fm-radio-broadcasting*

About The Author

Yogendra Pal *is the Honorary Chairman of the India Chapter of the DRM Consortium, and is also an honorary member of the DRM Consortium's board. He was advisor with the Ministry of Information & Broadcasting in connection with the implementation of the Digitization Addressable System (DAS) in the Cable TV network in India, and was closely associated with the strengthening of the community radio network in that country. He retired from All India Radio & Doordarshan after serving more than 36 years as its additional director general. During his career, Pal was involved in the implementation of a state-of-the-art fully digital studio setup in Delhi, as well as "News-on-Phone," Internet and AIRNET services and networking of AIR stations. He is a Life Fellow of the Broadcast Engineering Society (India) and the Institution of Electronics & Telecommunication Engineers.*

‘We Are Now Stronger, Smarter And Better Equipped...’

Broadcasters Have Adapted To Overcome The Challenges Of Covid-19, And In The Process Have Become More Resilient

By Phil Kurz

[Editor’s Note: Shortly after the global Covid pandemic brought a lot of the “norm” to a halt, Broadcast Technology published a story [“Serving The Public Interest, Convenience, And Necessity In A Pandemic”] in our 2020 second-quarter issue. As we all are only too aware, the pandemic changed many things virtually overnight. Among these were mainstream broadcasting activities, with lockdowns and quarantines forcing broadcasters to resort to non-conventional workflows and other operations in order to stay on the air and keep the public informed. Now that the pandemic appears to be ebbing, it’s interesting to examine some of these “improvisations” and see how they have reshaped the broadcasting landscape. Veteran industry reporter Phil Kurz now provides a look at some these changes and their impact on the way broadcasters function.]

This past May, the U.S. Department of Health and Human Services declared that the Covid pandemic was over—a little more than three years after it began.

The move, which followed an announcement by the World Health Organization (WHO) about a week earlier declaring an end to the public health emergency, was welcomed by the public, which had grown weary of the heavy toll the pandemic had taken on its physical, social, psychological and economic well-being.

WHO statistics reveal the price paid worldwide in illness and death. Since the outbreak, it has confirmed some 76 million Covid-19 cases around the globe. Nearly seven million have died. In the United States, the Center for Disease Control (CDC) pegged the number of people hospitalized with Covid at 6.2 million as of late June, 2023. Deaths in the United States had exceeded one million.

Mary Kay Kleist, WBBM-TV meteorologist, provides her portion of the station’s news block from an improvised home studio. Scenes such as this one were played out all over the world when Covid-imposed lockdowns took local production away from station facilities.

In terms of the economic impact, an estimate from the University of Southern California reveals a cumulative loss of $14 trillion from the U.S. Gross Domestic Product (GDP) over the three years of the pandemic, or $103 trillion actual versus $117 trillion estimated without Covid.

Impact On The World's Broadcasters

Like nearly everyone else, broadcasters and broadcast workflows took a hit, too. Generally, production ground to a halt. Live sporting events, such as the NCAA Division I men's basketball tournament, were cancelled or play indefinitely suspended. Perhaps most importantly, ad spending on linear TV cratered. It was down 20 percent in the first half of 2020, and off by 2.5 percent in the second half, which amounted to an annual decline of 12 percent, according to the research firm Statista. All the while, broadcasters, production companies, mobile facilities providers and vendors sought viable alternatives to well-known workflows that accommodated "the new normal."

With the pandemic in the rearview mirror, it's time to look at how broadcasters adapted, what they did to overcome, whether workflow and technical issues remain, and what lessons were learned that could help in the future if a similar circumstance should ever arise.

While it would be impossible to interview every broadcaster, those contacted for this story represent a good cross-section of the industry, including large, medium-sized and small station groups, a family-owned broadcasting company and a public broadcaster.

Flexible And Agile

For Tom Schenecke, vice president and director of operations at WBBM-TV, the CBS owned-and-operated facility in Chicago, the workflow challenges broadcasters faced during the pandemic were similar to those involved with remote sports and entertainment production, but occurred on a daily basis.

Tom Schenecke

"A wise person once told me a long time ago, that 90 percent of being a technical manager sometimes is non-technical. Rather, it's operational; it's functional," said Schenecke. "I grew up in sports production, and what you quickly learn is whatever is on the truck that day is what you have to work with.

"I think as we got into this [pandemic], we all had to just kind of look and see what we all had in our bag of tricks and get that to folks who maybe didn't have the same level of experience."

The WBBM "bag of tricks" is quite large, and the station took full advantage of its resources. For instance, when it looked as if health requirements might make it necessary to lock people out of its headquarters, the station deployed a half-dozen ENG trucks outside its building that were tethered to its router, noted Schenecke.

"The setup gave us a way to switch a newscast and get something on TV while still using our [main] router, and giving us a way to keep our operations people separated," he recalled, adding that the pandemic-driven design also set aside a corner outside the building for the anchor to present the newscast in isolation.

Ultimately, the Covid restrictions proved far less Draconian, making it acceptable to have workers in the WBBM-TV building as long as they maintained the requisite social distancing, making the ENG setup more of a proof-of-concept test. However, the configuration was used for one 5 p.m. newscast, according to Schenecke.

Breaking Away From The 'Norm'

One of the lasting effects of broadcasters' responses to Covid will likely be a willingness to discard firmly held beliefs about what technologies and workflows are and aren't acceptable in broadcast.

Two instances are top-of-mind for Schenecke. One relates to WBBM-TV meteorologists working from home during the pandemic without all of the video monitors they were accustomed to on set to orient their green-screen presentations.

"Our weather people were great," he said. "They were like, 'You know what, Lake Michigan doesn't move so the base graphics aren't going to change.'"

After rehearsing with the control room crew, the meteorologists were able to get by with only an Apple iPad for return video to orient themselves.

"They knew if they pointed at a certain quadrant on the screen, they were pointing to Lake Michigan," said Schenecke. "If they pointed at another, they were pointing at the temperatures. After a while, they realized they didn't need the monitors."

Another example was the use of Airpods in place of conventional IFB. "What's an IFB?" Schenecke asked rhetorically. "You don't need a separate box. You can call the station dial-in system and the director can talk to you. It can even be the microphone if needed."

Michael Fabac

Michael Fabac, director of news and marketing at News-Press & Gazette, echoes Schenecke's views on how important it was to be able to adapt, improvise and rethink commonly held views of what was and wasn't suited for broadcasting.

"I think the Covid experience opened our eyes to the value of being flexible," he said. "We're definitely much more flexible and much more open to things that probably didn't even seem possible, let alone technically feasible in the past."

For example, all departments and workflows at News-Press & Gazette stations went remote in March 2020 as the pandemic was declared. "There were things you normally would be hesitant to do, but you were forced into doing them," he said. "Like being told, 'you cannot have the assignment desk in the studio.'

All right, when you are forced to, you not only make it work, but make it work efficiently. That definitely opens your eyes."

Utilizing Existing Tech

Many broadcasters benefited from steps they had previously taken to derive greater efficiencies that just happened to help them out of the jams they faced with the pandemic.


Stefan Hadl

As an example, Stefan Hadl, Hearst Television senior vice president of engineering and technology, points to the station group's content prep, QC (quality control), and playout hub in Orlando, Florida and elsewhere, which existed long before the pandemic, and made it possible to maintain operation while reducing the scope of the steps that otherwise would have been necessary to maintain appropriate social distancing at individual group stations.

"We have three little mini-hubs where we basically distribute the work [prepping content for air]," said Hadl. "We already had this workflow in play. It wasn't new, but it absolutely helped during the pandemic because we were that way already. We could execute these critical workflows without involving a ton of people and in-person interactions. That's what you were trying to avoid."

Nebraska Public Media (NPM), too, benefitted during the pandemic from a technology it had put in place prior to the outbreak of Covid, and really had nothing at the time to do with minimizing the impact of a pandemic on workers. Two years prior to the pandemic, NPM issued a request for proposals for an IP-based network management control system to enable remote control and monitoring of disparate broadcast technologies around the state, including its translators and transmitters, studio production technologies, uplinks and other technologies associated with its facilities.


Ling Ling Sun

"We basically integrated and expanded our Network Monitoring and Control System [NMCS] to cover all of the functional areas in our operations," said Ling Ling Sun, chief technology officer for the public broadcaster. "In hindsight, that was the right choice—one that served us well during the pandemic."

Like other broadcasters, NPM vacated most employees from its premises to keep them separated and safe in the early days of the pandemic. However, its NMCS made simple work of remote control and monitoring of its systems, she observed.

The public broadcaster also had a limited number of Virtual Desktop Infrastructure and Virtual Private Network seats to meet the initial demand for remote work. After assessing the situation, additional licenses were acquired to support "non-essential" staff work, while critical services with maintained on site while complying with safety protocols, according to Sun.

NPM also acquired and tested new remote kits to support its radio personnel who worked from home, as well

This screen shot of Chicago station's WBBM-TV news block with talent in disparate locations is typical of such broadcasts taking place around the world in the early days of the pandemic.

as expanding its Avid editing capabilities to support its video production personnel who were working remotely, noted Sun.

News-Press Gazette also took advantage of a proprietary software development effort led by former NPG vice president of technology Jim DeChant, which powered remote operations, especially those related to news prep, said Fabac.

While NPG reporters and news photographers had all of the technology needed to report from the field, they were also equipped with proprietary software developed under DeChant that made it easy to move video files.

"The easiest part of the process was saying, 'All right, all of the newsgatherers, move out and use the equipment you have.' That was one of the most interesting things to me—how well that part of that puzzle worked for us and that we already had this philosophy in place that our newsgatherers should be able to work in the field," said Fabac.

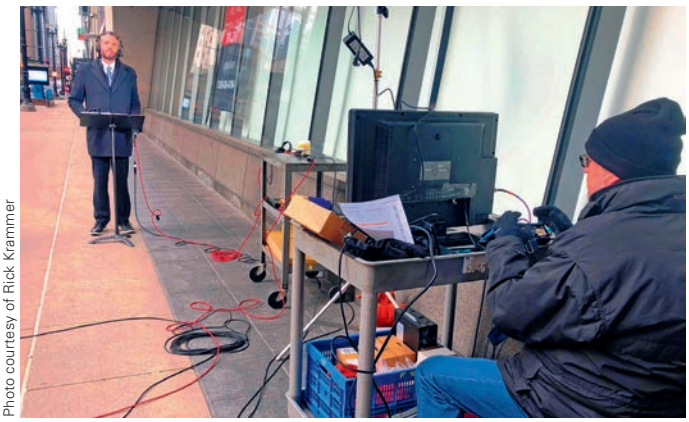


Photo courtesy of Rick Krammer

In the early days of the pandemic, Chicago's WBBM-TV resorted to doing newscasts on the sidewalk in front of its studio building. Shown are news anchor Brad Edwards and technician Mark Losiniecki.

New Opportunities

The pandemic struck as the Sinclair Broadcast Group was already in the midst of trialing a new approach to newsgathering and production. This was based around an emerging story-centric news model that organizes operations around 24/7 news delivery via multiple digital and social platforms and linear TV, as opposed to a traditional rundown and newscast focus.

"The 'Newsroom of the Future' was a proof of concept in 2019," recalled Scott Livingston, vice president of news at Sinclair. "We were working with five of our newsrooms. We wanted to try to figure out a new normal that shifted our news mindset to be more agile to our approach to news coverage."

Central to the concept was establishing workflows for reporters, news photographers and multimedia journalists (MMJs) that made it possible to spend more time in the field unearthing stories, reporting and creating news content and less time spent in commuting to and from stations, and also reducing time spent in the newsroom, Livingston noted.

The Sinclair Broadcast Group had implemented its 'Newsroom of the Future' in 2019 as a 'proof of concept,' with reporters 'embedded' in communities and reporting from home. The project proved to be especially valuable as the pandemic set in. Here a Sinclair reporter is shown recording a show segment. (Note the 'mask required' sign on the door.)


Scott Livingston

While TV reporters have a long history of reporting from the field, the concept behind "embedding" journalists more deeply in the community, or their 'beats' was to enhance their news product, making it more distinctive from the competition and increasing story count to satisfy news appetites across multiple platforms, added Livingston.

"I think Covid simply accelerated this change that we had already begun," he said. "We have no intention of returning to the old normal. We will remain agile and forward focused."

Today, all Sinclair news producing stations have adopted the "Newsroom of the Future" model. What that means from a workflow perspective is many more journalists hit the street, and do their reporting directly from home by logging into a video conference to participate in morning editorial calls. The time otherwise spent commuting each morning can be "bought back, allowing them to go much deeper with their storytelling," observed Livingston.

If reporters need additional time for researching documents or collaborating with colleagues for a particular story, they can always return to the newsroom. But the decision is always based on what's best for supporting Sinclair's story-centric news orientation, noted Livingston.

During the pandemic, the "Newsroom of the Future" was a natural fit for a news organization looking to vacate premises to reduce possible Covid exposure from co-workers while meeting the twin goals of producing more stories and going deeper with coverage, he added.

> *"…we didn't know how to do pandemics; now we do."*
> (Pete Sockett, WRAL TV)

Supply Chain Issues During And After The Pandemic

Like the rest of society, supply chain disruptions touched most facets of broadcasting to one degree or another. At the Capitol Broadcasting Company, Pete Sockett, WRAL-TV's director of engineering and operations, reported that most broadcast-technology-related shortages have resolved themselves. However, that's not the case with other necessary gear and services.

"Ordering times aren't nearly as bad today as they were when it comes to broadcast equipment," said Sockett. "But I'm trying to get some new chillers, and they [the HVAC companies] are telling me anywhere from 35 to 55 weeks out."

Sockett also credits the foresight of Ross Video, one of its major broadcast suppliers, which stocked up on components before the pandemic could take a toll on product availability, and kept WRAL well-positioned for its "strategic mode" response to the pandemic when longer term projects were temporarily shelved and the priority was maintaining existing operations.

"One of the first things we did was to stop our newsroom renovation," recalled Sockett. "First, because of the supply chain, and secondly, because we couldn't bring other people in to our building to do the actual renovation."


Pete Sockett

Only now has the station put its newsroom renovation project back on track, with design work underway to be followed by deployment and commissioning, according to Sockett.

Prepared For The Future

Universally, the broadcasters interviewed for this story attributed their ability to succeed during the pandemic to a willingness to be flexible and agile and openness to trying new things that under other circumstances would never have been considered.

Video conferencing apps such as Zoom and Microsoft Teams are good examples. Not only did these types of tools make it possible for reporters to interview newsmakers without risking possible exposure to Covid, but they have also facilitated regular client calls for sales staff and management communications with various departments.

"This [Zoom and other video conferencing apps] is a tool that I would call one of the greatest hits coming out of the pandemic because of the immediacy," said WBBM-TV's Schenecke. "If you decide five minutes before a show that you can get somebody for an interview, you don't geographically have to be there."

Broadcasters interviewed for this story agreed that Zoom and other such apps will play an important role in news and other workflows for the foreseeable future.

Another lesson learned from the pandemic that will serve broadcasters well is to remember is that disaster recovery (DR) plans may prove to be wholly irrelevant to possible eventualities, and that an effective response may best originate from on-the-fly decision making rather than a formal plan.

"We had a DR plan put together [prior to Covid] to go to another building in downtown," said Schenecke. "Ironically, it was the first building in Chicago to be closed for Covid. That's nothing you can prep for."

"If you formed a committee of the smartest minds in the company, [and] gave them six months of weekly meetings to come up with the ultimate disaster recovery plan, it wouldn't have looked anything like what we pulled off in three days because what we did wasn't framed in DR, but in just getting from one day to the next."

WRAL's Sockett echoes Schenecke's comments about learning on the fly and responding appropriately.

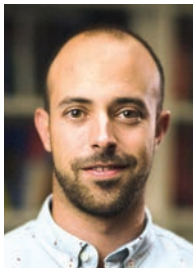
"You know, we know how to prepare for a hurricane," said Sockett, whose station is frequently near or in the path of Atlantic Ocean hurricanes. "We have all of the stuff we need—everything—and we know how to do hurricanes."

"Well, we didn't know how to do pandemics," he said. "Now we do."

5G MAG

By Jordi J. Gimenez

A 5G Broadcast System For TV; Radio And Emergency Alerts Updated to 3GPP Rel-17



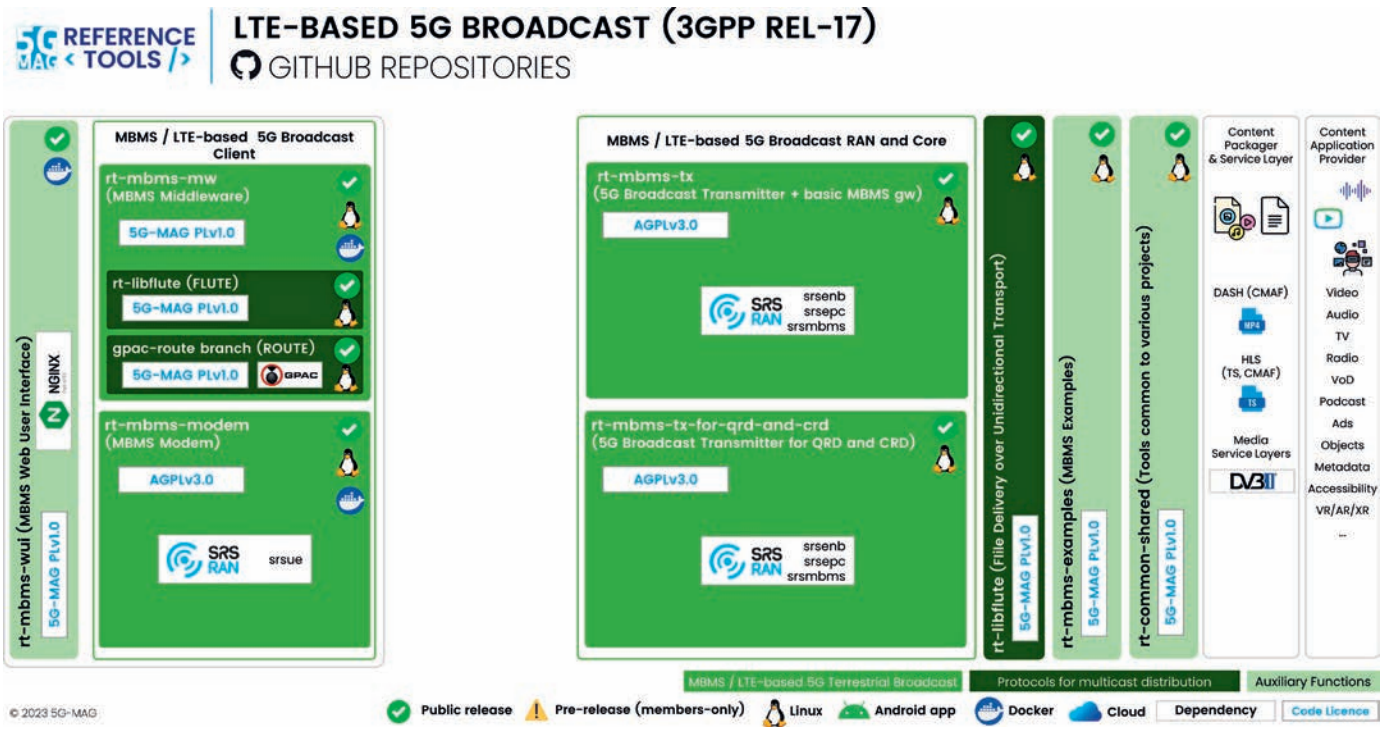
Jordi Gimenez

5G-MAG members have been working during the past year on several updates to the ETSI Technical Specification ETSI TS 103 720. This document defines the 5G Broadcast system for the distribution of broadcast services including TV, radio and emergency alerts. This work has been conducted through three 5G-MAG Work Items. More information can be found at *https://www.5g-mag.com/5gbroadcast.*

About ETSI TS 103 720

ETSI TS 103 720 introduces the LTE-based 5G Broadcast System along with its associated features. LTE-based 5G Broadcast is a profile of existing 3GPP specifications focused on the support of the following aspects:

- Support of Free-to-Air (FTA) and Receive-Only Mode (ROM) services
- A network dedicated to linear television and radio broadcast, with an example being the use of supplemental downlink channels and spectrum as an example
- Single Frequency Network (SFN) deployments with Inter-Site Distances (ISD) significantly larger than those associated with typical cellular deployments
- Support for mobility scenarios, including delivery at speeds as great as 250 km/h (155 mph) to support receivers in cars via external omnidirectional antennas
- Support for common streaming distribution formats such as Dynamic Streaming over HTTP (DASH), Common Media Application Format (CMAF) and HTTP Live Streaming (HLS)
- Support for IP-based services such as IPTV or ABR multicast
- Support for different file delivery services such as scheduled delivery or file carousels
- Support for services that use unicast and broadcast delivery methods
- Support for typical broadcast channel bandwidths of 6/7/8 MHz
- Support for public warning and emergency alerts based on the Cell Broadcast Service



continued on page 28

DAB Radio News And Views

By Les Sabel, S-Comm Technologies

Understanding DAB+ Transmissions Through Field Testing And Demonstrations


Les Sabel

For experienced engineers, field testing provides valuable information about the quality and coverage of DAB+ transmission, and can be used for performance verification purposes. When developing a plan to establish a new broadcasting technology, field testing provides significant opportunities for engineers to gain a good understanding of the nature of transmissions, propagation conditions, multipath impact, single frequency network operation and coverage expectations. This article focuses on the benefits of field testing and practical experience including when assessing DAB+ for country adoption.

Introduction

When a country embarks on the process of establishing a new digital broadcasting standard, there are many activities which need to be undertaken. The process of establishing DAB+ as a national digital radio broadcasting technology is discussed in detail in the **WorldDAB ebook**. (See reference 1 for the link to this free publication.)

Physical demonstration of a new technology provides unique opportunities to gain a deep understanding of the practical aspects whether it is engineering knowledge of how the system works, specific details of coverage capabilities, or the benefits of the technology for the listeners and broadcasters alike.

Practical demonstrations were shown to provide valuable insights in previous workshops sponsored by WorldDAB in conjunction with the Arab States Broadcasting Union (ASBU) and Asia-Pacific Broadcasting Union (ABU).

Who Should Be Involved?

When choosing a new broadcasting technology, the options need to be assessed against a set of national requirements which are normally the responsibility of the national telecommunications regulator. The requirements include aspects such as understanding the need for new services which may not be possible due to congestion in the FM band, the advantages of new features that will be provided by digital broadcasting and determining how much of the population should be covered and when.

There are also technical questions to be answered particularly regarding planning field strength requirements, interference and overspill allowances and how to integrate features such as emergency warnings and service linking.

These topics affect the entire radio ecosystem and consequently, it is normal to see a wide range of stakeholders becoming involved, including the Government department and regulatory body to broadcasters/content providers, network providers and the retail sector. This process also helps ensure suitable receiver products for both domestic and automotive use. The establishment of an independent national digital radio champion body is highly recommended and has shown to be beneficial, for example Digital Radio UK and Digital Radio NL.

Who Benefits, And How?

Running a technical trial or demonstration is an activity which initially involves technical and engineering staff and management. The important aspect is how the information and knowledge acquired is used to support other less technical aspects of standard adoption and systems establishment.

First let's look at the educational process. Field trials are often undertaken in conjunction with technical workshops. The workshop provides the participants with the details of the DAB+ system's operation from the input audio and Program Associated Data (PAD) such as text and images, to the transmission of on-air signals. This includes details of the structure of the transmission signal, including modulation and FEC coding, the way the multiplexing is done, supporting signalling, as well as source coding and system interfaces. Transmission planning is also covered, with details of the various concepts and equations, and references to the applicable standards found in reference 2.

It is one thing to understand the block diagrams and signal equations, and another to experience how the delivered transmission works in the field.

Planning Your Field Trials

When developing a field test plan there are a wide range of considerations. First, what are the specific outcomes required? These can include the gaining of a deep understanding of the operation of DAB+, including aspects such as the impact of the guard interval on single frequency network (SFN)

operation; impact of terrain and building clutter on propagation in different environments; receiver sensitivity and the behavior of receivers near minimum received field strength, as well as the operation of features such as announcements and service following.

This information then flows on to processes such as establishing the planning levels for different classes of environment, adopting protection ratios for interference, and establishing rules for coverage and spillover. As every country is different, these aspects will usually be undertaken by the regulator. However, other stakeholders such broadcasters and network providers should also be involved to benefit from their deep existing knowledge base. An example is the updating of the base level parameters used to define the planning field strength levels in Australia. Reference 2 provides the field strength derivation equations. Base level parameters such a location variation standard deviation, the impact of building entry loss and manmade noise, and the gain of receiver antennas in different implementations, including both vehicular and domestic environments, will all impact the resulting planning levels. Every country chooses the set of such parameters that the regulator believes best fits their environment. Without the adjustment of such parameters to ensure accuracy, the planning of DAB+ across Australia would have been very difficult, if not impossible, due to the very limited spectrum available. A Digital Radio Planning Committee was established to tackle this issue, and was composed of representatives from the government and regulator, as well as from public service, commercial, and community broadcasters.

To establish a trial the first thing required is the availability of spectrum. This can be difficult when analog TV is still operating in VHF Band III in the country, or adjacent countries, or if that band is also used for DTV transmissions, such as is the case in South Africa and Australia. A portion of spectrum is required that will not impact those existing transmissions. Fortunately, the ITU has recommended protection ratios for all cases, (Reference 3). When existing broadcast services are in the area where field testing is planned, incumbent broadcasters may wish to see studies to assess potential interference. Those studies can provide recommendations for preferred frequency blocks and test transmission characteristics.

Once the frequency block(s) and transmission characteristics—such as ERP and the transmission horizontal and vertical radiation pattern (HRP and VRP)—are defined, the regulator will need to issue a transmission license, often in the form of a "scientific test" license.

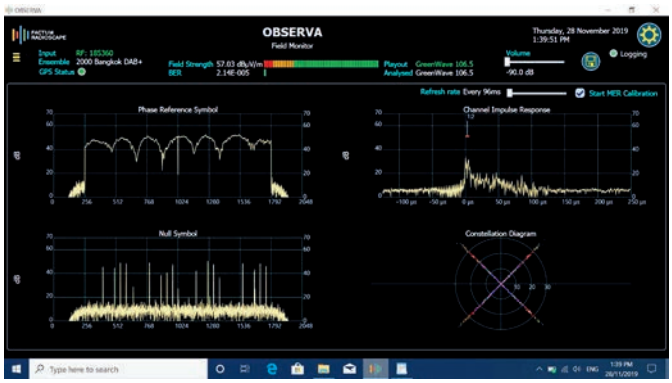


Figure 1: Example measurement showing the received signal CIR (top right) and signal spectrum (top left).

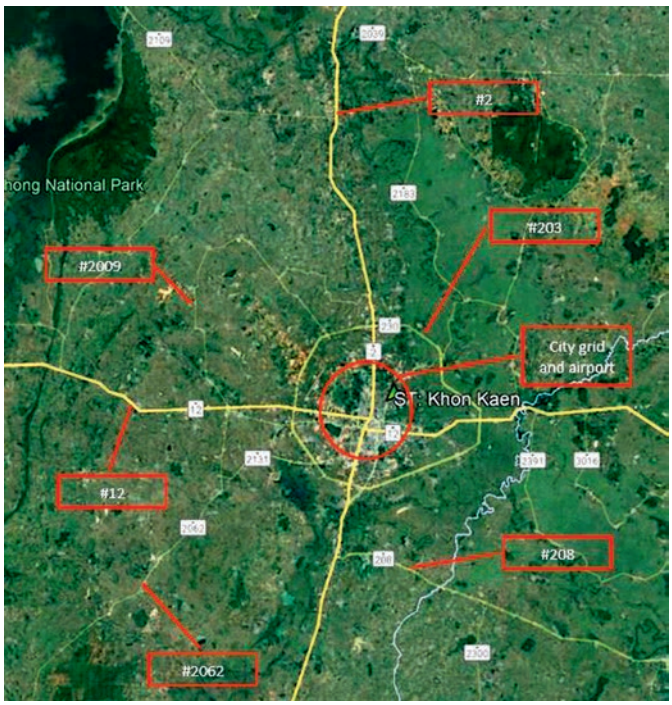


Figure 2: Planned field testing routes and areas, the transmitter site is in the NE sector of the central circle.

A test transmission site will need to be selected. Ideally, this will be an existing site used for FM or TV; however, such existing sites can be expensive to access and may have limited tower aperture. Alternative sites are common for low-power demonstrations where the test transmission may be located on a tall local building.

Initial tests and demonstrations vary significantly. Initial demonstrations are often at very low power levels—for example, an ERP in the hundreds of Watts. However, in some of the more forward-looking countries the trial transmissions are precursors for adoption and rollout. An example of this latter approach is in South Africa, which has 100 kW ERP sites in Johannesburg and Pretoria set up as an SFN. (See reference 1 for further examples.)

The audio and PAD feeds may be live from FM services, as in the trials in South Africa and Thailand, or may be specifically constructed for smaller demonstrations.

The on-air signal is gradually increased to the full nominated power, and then demonstrations and tests can occur. There is a wide range of test equipment that can display the full range of signal

aspects from RF spectra and channel impulse responses (CIR) to audio error rates and signalling. The example in Figure 1 shows the measured CIR and resulting spectrum where there is high-power multipath nearby causing significant rippling in the spectrum that can then impact the bit error rate (BER).

Such measurements can be made in a range of locations to demonstrate reception performance in multiple environments, such as line-of-sight (LOS) locations, or black spots that only receive limited field strength due to heavy shadowing. The examination of a range of environments will provide improved technical understanding of the robustness of the DAB+ signal.

Planning test routes is also important. Figure 2 shows planned coverage testing areas around the city of Khon Kaen in Thailand. This field test is to provide coverage assessment and tuning of the coverage predictions through logging of the received field strength using calibrated test equipment. We see the recommended route includes lateral roads through the city, north-south and east-west, the ring road, and grid measurements in the city that may be used to identify possible blackspots due to clutter shadowing from buildings and similar tall structures.

Indoor testing may also be conducted to assess the impact of the local structures on building entry losses. This can be quite instructive, and often demonstrates the usefulness of windows for improving in-building reception, as well as the impact of different building materials, the height of the receiver within tall buildings, and the level of manmade noise.

Analyzing The Results

Demonstrations reveal the impact of the real world on received signal characteristics and field strength impacts. The latter is very useful for the "tuning" of coverage predictions. Coverage from a transmission site is modelled using state-of-the-art software tools and propagation models including ITU-R models such as P.525/526 or P.1812, as well as custom models like CRC-Predict. These models use digital terrain maps (DTMs) and clutter models of the building and foliage cover in the area under study, as well as the details of the transmission itself as inputs. These models then output the predicted coverage field strength in each pixel in the digital terrain map. The models rely on parameters such as diffraction loss due to buildings and terrain, with that diffraction loss initially set to a general value. The field test measurements can then be used to adjust the diffraction loss so that the prediction better fits the measured data.

Figure 3 shows the predicted coverage of the Chiang Mai area in Thailand along with the field test measurements. The field measurements were used to tune the prediction with the resulting correlation shown in Figure 4 which indicates 97 percent correlation, with an average error of 0.75 dB, and a standard deviation of 3.33 dB—a very good result.

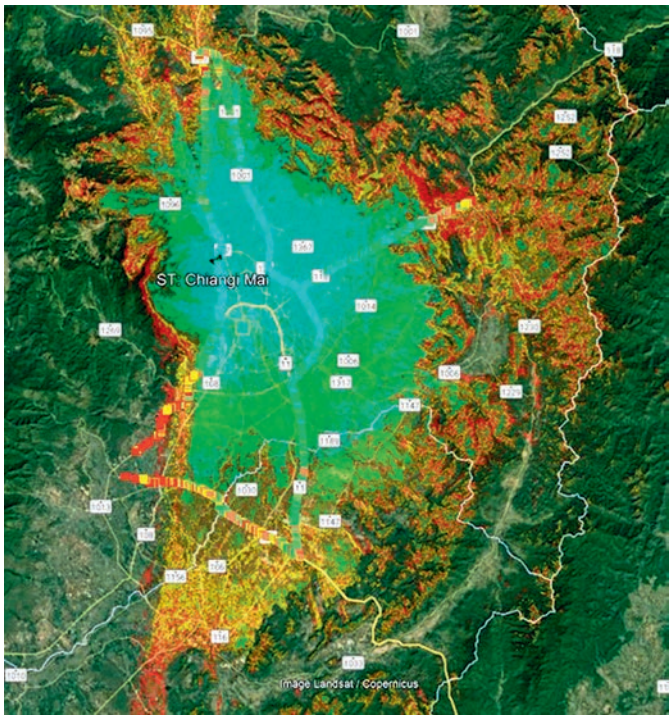


Figure 3: Coverage prediction and field test results for Chaing Mai.

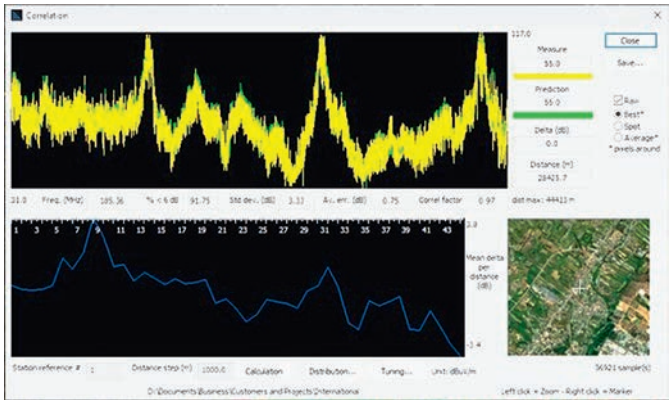


Figure 4: Tuned coverage prediction correlation with the field measurements.

Using The Knowledge

Field testing provides a wide range of benefits. At the start of the DAB+ adoption process it provides practical demonstrations of the impact that terrain and clutter have on the characteristics of the received signal. This allows a better understanding of the ability of DAB+ receivers to successfully decode the signal in areas of difficult terrain and clutter. Better understanding allows for more accurate planning.

Accurate predictions are essential for efficient and accurate signal design, particularly when planning service rollouts. Accuracy ensures that the characteristics of multiple transmission sites in terms of ERP, antenna HRP/VRP and height will result in both accurate coverage and interference predictions, providing the best possible planning solution. Without the field test data and coverage modelling approach we currently use, DAB+ coverage planning would be much more conservative and could

result in poorer service for the listeners and fewer listeners for the broadcasters.

Conclusion

Field testing has many useful aspects, some of which are discussed in this article. The ability to provide accurate coverage maps for broadcasters, regulators, retailers, and the listening public provides positive reinforcement in the adoption and best use of DAB+ digital broadcast radio.

("Establishing DAB+ Digital Broadcast Radio" by Dr Les Sabel is available at *https://www.worlddab.org/resources/establishing-dab-plus-ebook*.)

Acknowledgement

The author thanks The Royal Thai Army Broadcasting division and the Office of the National Broadcasting and Telecommunications Commission of Thailand for the images used in this article.

References

[1] *www.WorldDAB.org*

[2] ITU-R BS.2214, "Planning parameters for terrestrial digital sound broadcasting systems in the VHF bands"

[3] ITU-R BS.1660, "Technical basis for planning of terrestrial digital sound broadcasting in the VHF band"

About The Author

Dr. Les Sabel's *involvement with DAB started when he joined Radioscape, London, U.K. in 2002 as vice president of engineering when they were pioneering DAB receivers using Software Defined Radio, which was "cutting-edge technology" at that time. They also produced multiplexing and monitoring systems, also as software platforms, and among his responsibilities were standards development where he participated in the development of the DAB+ standard in 2005 that is commonly used today.*

Today, Les is the principal consultant at S-Comm Technologies Pty. Ltd. and regularly assists WorldDAB, and broadcasters and regulators around the globe with the introduction of DAB digital radio and other aspects of radio communications technologies. He may be contacted at Les.sabel@scommtech.com.au.

5G MAG

continued from page 24

With a process driven by 5G-MAG and open to the industry through the 5G-MAG Standards GitHub (*https://github.com/5G-MAG/Standards/issues*), a series of feature from the 3GPP Rel-17 specifications have been the focus of the recent update. These are, in particular:

- Bug fixes, clarifications and upgrade to 3GPP Rel-17 specification
- Adding receiver requirements for consistent network planning, including requirements on demodulation performance
- Adding bandwidth information, including 6/7/8 MHz, and broadcast UHF spectrum (based on 3GPP RAN work items)
- Support of 5GMS over eMBM, with reference to 3GPP TS 26.501 including hybrid use cases
- Codecs and Formats with reference to 5GMS in 3GPP TS 26.511
- Support of emergency alerts

The new ETSI TS 103 720 specification is available in its version v1.2.1 at this website: *https://www.etsi.org/deliver/etsi_ts/103700_103799/103720/01.02.01_60/ts_103720v010201p.pdf.*

Time To Plan The Next Round Of Updates Towards Rel-18

The process for updating the ETSI 103 720 technical specification to reflect enhancements based on 3GPP Release 18 has now started. Comments, notification of bugs to be fixed, or requests for additional features, can be now submitted through the 5G-MAG Standards repository in GitHub, open to the community. It's located at *https://github.com/5G-MAG/Standards/issues.*

Open-Source Software Support For LTE-Based 5G Broadcast

Along with the work on specifications, 5G-MAG Reference Tools developers have also been working on a series of open source tools to support the validation and verification of the specifications, as well as the demonstration and trials involving LTE-based 5G Broadcast and hybrid services in combination with unicast. Currently, a series of repositories (*https://www.5g-mag.com/repositories)* are available in our GitHub relevant to LTE-based 5G Broadcast. These include:

- A 5G Broadcast Transmitter for MBMS-dedicated cells and basic MBMS Gateway
- A 5G Broadcast Transmitter for QRD (Qualcomm Reference Design) and CRD (Commercial Research Device)
- An MBMS modem
- MBMS Middleware

And recently, support for FLUTE (File Delivery over Unidirectional Transport) and ROUTE (Real-time Transport Object delivery over Unidirectional Transport) multimedia delivery mechanisms have also been included.

Work continues at high speed; stay tuned! More information is available at *developer.5g-mag.com*.

ATSC 3.0 And 5G Broadcast: Candidates For Terrestrial Broadcasting Services

By Seok-Ki Ahn, Sungjun Ahn, Sunhyoung Kwon and Sung-Ik Park
Electronics and Telecommunication Research Institute
Republic of Korea

Introduction

In 2020, the ITU granted official approval to 5G Broadcast as a part of the IMT-2000 (5G) standard. 5G Broadcast is an LTE-based terrestrial broadcasting technology, which improves further evolved multimedia broadcast multicast service (FeMBMS) in 3GPP . Unlike native terrestrial broadcasting standards such as ATSC, DVB, ISDB, and DTMB, 5G Broadcast utilizes mobile communications technology as its foundation. Due to its potential ability to cater to a vast user base—perhaps billions of LTE devices and 5G devices—5G Broadcast is widely acknowledged as an appealing technology for both broadcasters and consumers seeking high-quality services. Nonetheless, 5G Broadcast suffers from a technical drawback compared to native terrestrial broadcasting standards, the degraded performance stemming from the inherent limitations imposed by its foundation on mobile communication technology.

This article evaluates the performance of 5G Broadcast compared to ATSC 3.0, the most advanced terrestrial broadcasting technology . It explores the physical layer capability of 5G Broadcast and ATSC 3.0, highlighting its substantial impact on the capital expenditures (CAPEX) and operational expenditures (OPEX) associated with broadcasting services. Expanding the scope, the analysis further delves into the CAPEX/OPEX comparison in terms of the number of transmitters required for target throughputs and coverage, assuming wireless environments in Bengaluru, India.

TABLE I
CONFIGURATIONS FOR DATA CHANNELS (8MHZ BANDWIDTH)

		Svc1	*Svc2*	*Svc3*
ATSC 3.0	Code Rate	8/15		
	Constellation	QPSK	16-NUC	64-NUC
	Data Rate	5.36Mbps	10.73Mbps	16.09Mbps
	Required CNR (AWGN)	1.2dB	6.4dB	10.4dB
5G Broadcast	MCS Index	8	14	20
	Code Rate	0.58	0.54	0.553
	Constellation	QPSK	16-QAM	64-QAM
	Data Rate	5.41Mbps	10.04Mbps	15.44Mbps
	Required CNR (AWGN)	2.3dB	7.3dB	12.1dB

Comparison Of Physical Layer Features And BLER Performances

To guarantee the quasi-error-free performance required for stable broadcasting services, bit-interleaved coded modulation (BICM) components in the physical layer should be carefully designed to protect the data bits over wireless environments , . For this reason, very long LDPC (low-density parity-check) codes of length 16200 and 64800 are employed in ATSC 3.0, which are intensively optimized during the standardization process , . On the contrary, 5G Broadcast employs convolutional and turbo codes, which were designed for 3G/LTE . Moreover, ATSC takes advantage of additional shaping gains from the non-uniform constellation (NUC), which is more advanced than 5G Broadcast's regular QAM constellations . In addition to the components within the BICM chain, the application of time interleaving is another crucial factor profoundly impacting the physical layer performance in fading environments. Notably, the time interleaver effectively mitigates the impact of deep fading frequently encountered in mobile environments. While ATSC 3.0 embraces this technique in its data bit-conveying subframes, 5G Broadcast, unfortunately, lacks support for its implementation .

To figure out the impact of such physical layer differences, the reception performance is compared between ATSC 3.0 with 1.125 kHz subcarrier spacing (SCS) and 5G Broadcast with 1.25 kHz SCS. For a fair comparison, the physical layer parameters are chosen as comparable as possible between the two standards. In addition, as for the channel decoding algorithm, the sum-product algorithm with 50 iterations and the maximum a posteriori (MAP)-based log-MAP algorithm with eight iterations are used for LDPC codes and turbo codes, respectively.

This analysis explores the block error rate (BLER) performance in data channels. The presented

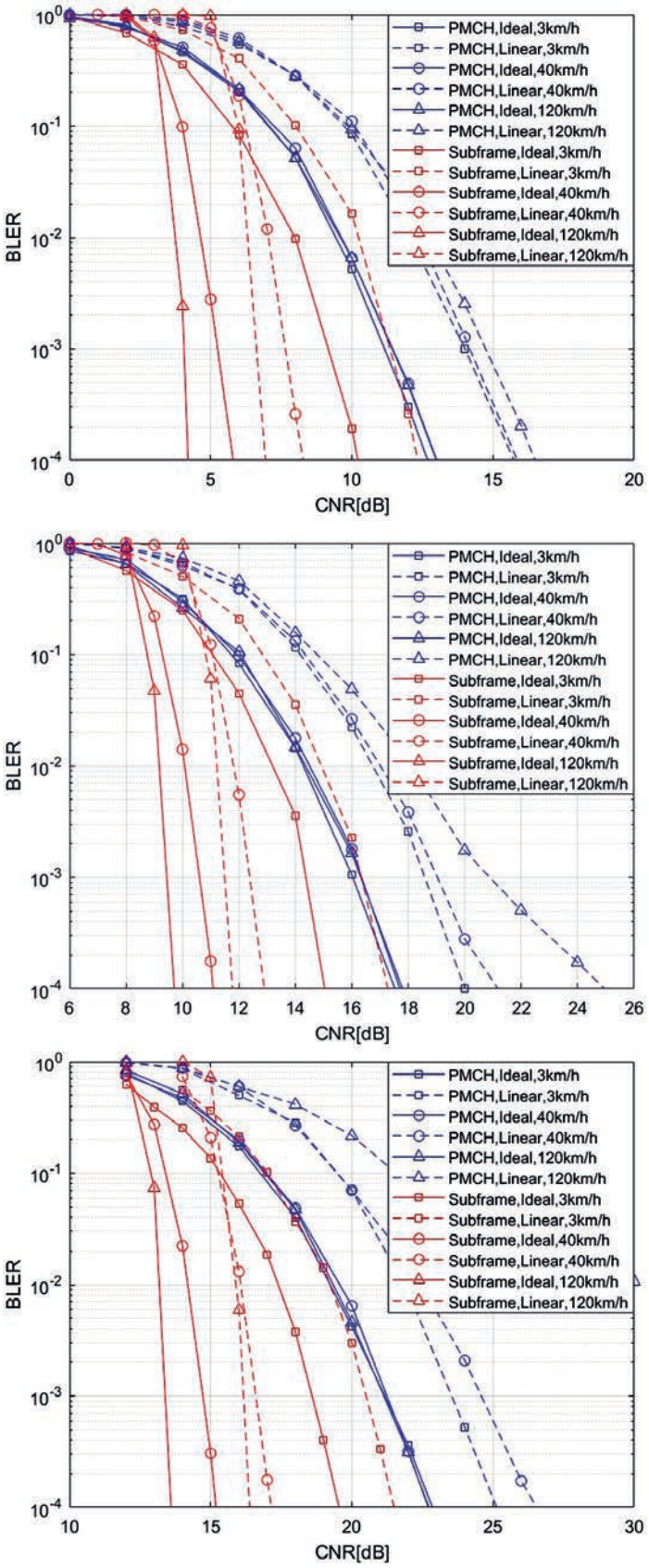


Figure 1. Performance of ATSC 3.0 subframe and 5G Broadcast PMCH over India-Urban channels.

evaluation considers target data rates of 5 Mbps, 10 Mbps, and 15 Mbps realized by the service (Svc) class configurations presented in Table 1. This table also shows the baseline performance measure, the carrier-to-noise-ratio (CNR) required to achieve BLER = 10-4 over an AWGN channel. Basically, thanks to the superiority of the BICM components, ATSC 3.0 has lower required CNRs than 5G Broadcast, implying that it has a higher capability to support large coverage.

To verify the effect of time interleaving in harsh fading environments, BLER performance of ATSC 3.0 and 5G Broadcast is evaluated over an India-Urban channel, whose channel profiles are given in . In our evaluation, two different channel estimation rules, namely, ideal estimation and low-complexity linear estimation, are used as the upper and lower bound for realistic channel estimation. The BLER performance of the subframe and physical multicast channel (PMCH) is presented in Fig. 1, representing data bit transmission for ATSC 3.0 and 5G Broadcast, respectively.

In Fig. 1, ATSC 3.0 consistently exhibits superior performance compared to 5G Broadcast, with the performance gain increasing as UE (user equipment) mobility rises. The performance gain of ATSC 3.0 thanks to the FEC and NUC varies according to the target data rate, whereas the time diversity gain from the time interleaver varies according to the UE velocity. As a result, the steepness of ATSC 3.0's BLER curves amplifies with higher UE velocities, leading to further increased performance gains in high-speed scenarios with more rigorous target BLER. These findings confirm the effectiveness of time interleaver for mitigating the deep fades in mobile reception, making ATSC 3.0 a superior solution, especially in high-speed mobile scenarios.

Comparison Of CAPEX/OPEX For Terrestrial Broadcasting Services

Generally, spectral efficiency is recognized as an important financial factor for running physical networks. The cost of the network is identified within the tradeoff between throughput and service reliability. Intuitively speaking, the number and size of participating towers will determine the network cost. Given the necessary infrastructure for service coverage, evaluating the network cost involves site construction, utility charges based on transmission power, and expenses for dedicated backbone connectivity to maintain the single frequency network (SFN) synchronization. Even if the SFN operator can reduce the CAPEX by reusing existing infrastructure, persistent OPEX still remains. Note that such expenses directly depend on the number of operational towers, and physical layer efficiency quantifies the infrastructure required for each standard. Given the desired service area and QoS (quality of service), the protocol efficiency can directly be

translated into the network economy.

A practical case study focusing on the bustling urban metropolis of Bengaluru, India may be useful in illustrating this point. The Bengaluru plateau shows predominantly flat terrain, which necessitates reliance on low-power/low-towers (LP/LTs). This investigation gives a spotlight on handheld use cases in an LP/LT SFN environment. To ensure the analysis aligns with real-world conditions, data from existing telecom stations, terrain clutter information, and population demographics are incorporated . Using this input data, this article compares ATSC 3.0 and 5G Broadcast technologies in terms of the required number of SFN transmitters (NoST) to achieve a 95 percent reception probability within the target area of interest (AoI).

The simulations are conducted using data obtained from the existing mobile telecom sites located in Bengaluru, encompassing a total of 1,576 sites within the AoI. All sites are uniformly assigned an effective isotropic radiated power (EIRP) of 55 dBm. In accordance with the Indian region ITU-R UHF band plan for broadcasting, the simulations assume an 8 MHz bandwidth centered at a frequency of 500 MHz. The other descriptions for the test scenario are stated in Table II.

Figs. 2 and 3 provide insights into the required operational sites for ensuring network feasibility. Leveraging site location data, an optimal subset of tower sites is identified to satisfy QoS throughout the AoI while minimizing overlap. The results for Svc1 demonstrate that 5G Broadcast necessitates 55 percent more SFN transmitters compared to ATSC 3.0. This indicates that ATSC 3.0 offers significant cost savings over 5G Broadcast. Similarly, as demonstrated in Fig. 3, ATSC 3.0 may save 30 percent of network cost compared to 5G Broadcast when 10 Mbps service (Svc2) is intended. This cost-saving aspect of ATSC 3.0 becomes particularly advantageous within the LPLT environment, as it mitigates ongoing charges for leased lines to secure studio-to-transmitter links (STLs), which are directly coupled with NoST.

TABLE II
SCENARIO DESCRIPTION

Center Frequency	500MHz
Transmit Power	40W (46dBm)
Tx Antenna Height	14 – 100m (avg. 32m)
Tx Antenna type	Omni-directional
Tx Antenna Gain	9dBi
EIRP	55dBm

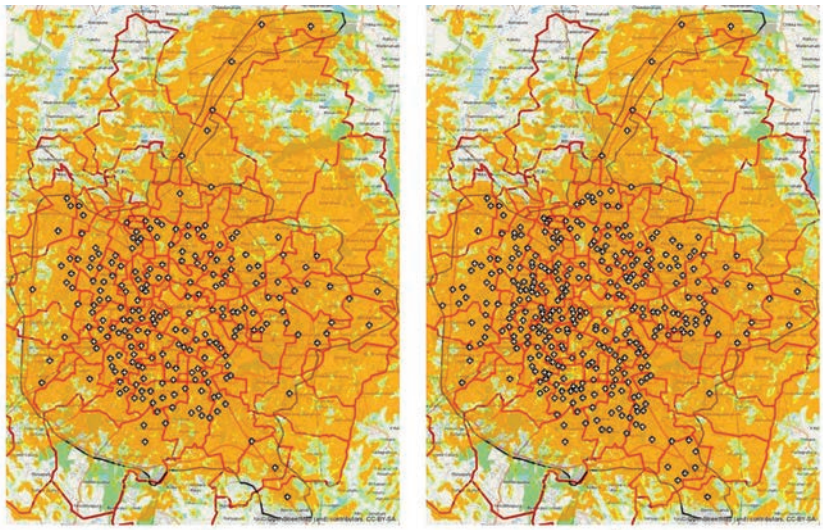


Figure 2. Required tower deployment for Svc1 (5 Mbps): (a) ATSC 3.0 (223 sites), (b) 5G Broadcast (345 sites).

Conclusion

This article investigated the physical layer performance and network cost for ATSC 3.0 and 5G Broadcast, placing particular focus on mobile handheld use cases. ATSC 3.0 here proved its promise with superior, well-crafted BICM components and time-interleaving capability. Such observation was resounded through CAPEX/OPEX analyses, finding ATSC 3.0 as a more cost-saving choice over 5G Broadcast.

About The Authors

Seok-Ki Ahn *is a senior research engineer at Korea's Electronics and Telecommunication Research Institute (ETRI). From 2013 to 2018, he was a senior engineer at Samsung Electronics. His current research interests are in the area of channel coding, evaluation of the physical layer of broadcasting and communication systems, and development of new DTT-related advances for future broadcasting systems.*

Sungjun Ahn *is a senior research engineer at ETRI. He and his group have created various opportunities based on ATSC 3.0 with a broad range of technical contributions, including system design, verification, and theoretical analysis. He currently participates in research activities on the physical layer of ATSC 3.0 and 3GPP DTTs, with special interests in mobile media, DTT-5G interworking, and DTT-related advances for enhanced media distribution and beyond.*

Figure 3. Required tower deployment for Svc2 (10 Mbps): (a) ATSC 3.0 (415 sites), (b) 5G Broadcast (590 sites).

Sunhyoung Kwon *is a principal member of ETRI's research staff. He currently participates in research activities on ATSC 3.0 & 5G convergence/interworking, vehicle-targeted chipset design, and DTT-related advanced technologies for enhanced media delivery.*

Sung-Ik Park *is with ERTI's Broadcasting System Research Group, serving as project leader and principal member of the research staff. His research interests are in the area of error correction codes and digital communications, in particular, signal processing for digital television. He has led several terrestrial DTT projects such as SFN optimization, MATV system development, ATSC 3.0 & 5G convergence, 8K-UHD delivery, vehicle-targeted chipset design, and others.*

References

[1]*ETSI TS 103.720 V1.1.1, "5G broadcast system for linear TV and radio services; LTE-based 5G terrestrial broadcast system," Dec. 2020.*

[2]*ATSC Standard: Physical Layer Protocol, Washington, D.C, USA, Doc. A/322:2021, Jan. 2021.*

[3]*L. Fay et al., "An overview of the ATSC 3.0 physical layer specification,"* **IEEE Transactions On Broadcasting** *vol. 62, no. 1, pp. 159-171, March. 2016.*

[4]*S.–I. Park et al., "Performance analysis of all modulation and code combinations in ATSC 3.0 physical layer protocol,"* ***IEEE Transactions On Broadcasting*** *vol. 62, no. 2, pp. 197-210, Jun. 2019.*

[5]*K.-J. Kim et al., "Low-density parity-check codes for ATSC 3.0,"* ***IEEE Transactions On Broadcasting****, vol. 62, no. 1, pp. 189-196, March 2016.*

[6]*S.-K. Ahn et al., "Comparison of low-density parity-check codes in ATSC 3.0 and 5G standards,"* ***IEEE Transactions On Broadcasting*** *vol. 65, no. 3, pp.489-495, Sept. 2019.*

[7]*3GPP TS 36.212 V17.1.0, "Multiplexing and channel coding (release 17)," March. 2022.*

[8]*N. S. Loghin et al., "Non-uniform constellations for ATSC 3.0,"* ***IEEE Transactions On Broadcasting****, vol. 62, no. 1, pp. 197-203, March. 2016.*

[9]*P. Klenner et al., "Physical layer time interleaving for the ATSC 3.0 system,"* ***IEEE Transactions On Broadcasting*** *vol. 62, no. 1, pp. 253-262, March. 2016.*

[10]*S. Ahn et al., "Characterization and modeling of UHF wireless channel in terrestrial SFN environments: urban fading profiles,"* ***IEEE Transactions On Broadcasting****, vol. 68, no. 4, pp. 803-818, Oct. 2022.*

[11]*S.-K. Ahn et al., "Evaluation of ATSC 3.0 and 3GPP Rel-17 5G broadcasting systems for mobile handheld applications,"* ***IEEE Transactions On Broadcasting****, early access, Nov. 23, 2022, doi: 10.1109/TBC.2022.3222988.*

Attend the 2023 Annual Broadcast Symposium

This year's IEEE Broadcast Symposium comes to NAB headquarters in Washington DC on Tuesday, November 14 and Wednesday, November 15. Broadcast Leadership Through Relentless Change This year's IEEE Broadcast Symposium comes to the beautiful new NAB headquarters in Washington DC on Tuesday, November 14 and Wednesday November 15, 2023. Come join us in DC to hear thought-provoking presentations on the technical aspects of broadcast transmission for radio and television. Real world experience and technical expertise on current and future broadcast transmission topics in an industry faced with relentless change will be shared.

Our goal is to help others in the industry benefit from what some have learned solving problems in today's broadcast systems. If you are a broadcast technical leader who wants to hear about; vendors that go above and beyond with products that solve real world problems, tests being conducted, results being obtained from those tests, and future technologies under evaluation then you should be here. The IEEE Broadcast Symposium focuses on technical presentations and not on product marketing, the speakers identify problems and objectively discuss solutions through longer sessions and open Q&A. The keynote speakers during our two lunch breaks are meant to give views into other fields and allied activities.

Visit bts.ieee.org/broadcastsymposium for conference information

FOBTV Technical Committee Meeting Provides Updates On Global TV Initiatives

By James E. O'Neal

The Technical Committee of the FOBTV (Future of Broadcast Television Initiative) hosted a hybrid in-person/virtual meeting on April 17, 2023 in conjunction with the annual NAB Show in Las Vegas Nevada, with representatives from several television standards organizations and research facilities providing updates on their activities during the past year.

The event marked the first-ever combination in-person/virtual meeting, with presenters and other participants situated in Las Vegas and at sites around the world.

The meeting was called to order at 12:00 noon Eastern Daylight Time by secretary general and acting chair, Yao Wang, who was assisted by the National Association of Broadcasters' Lynn Claudy. The initial order of business was a rollcall, with 13 persons in attendance in the audience and another 27 logged into the GoTo meeting.

In opening the meeting, Yao first saluted the NAB on its 100th anniversary, and then recognized the ATSC's president Madeleine Noland, who provided information on her organization's activities, beginning with a discussion of work on broadcast core networks and their importance, harmonization initiatives in connection with a convergence of broadcast and 5G, along with a description of a "portrait mode" initiative in connection with viewing of video content on cell phones and also for sign language captioning.

She also noted on-going work on inter-tower communications for linking video to tower sites.

Noland recognized the work of the ATSC's TG3 Active Specialists Groups, and also updated the work being done by the ATSC Planning Teams and Implementation Teams, noting especially the work of one of these groups in connection with on-going DTV initiatives in Brazil and the Caribbean.


Madeleine Noland

And she particularly focused on convergence of various global video delivery indicatives.

"We should work together and we should converge our technologies and our messaging as much as possible whenever possible," said Noland, adding that in some areas this effort might be too late, but still possible in others."

She commented on the continuing importance of traditional high-tower/high-power broadcasting, noting that this technology would still be viable as we move into the next decade and beyond.

"This infrastructure needs to be protected and valued and maintained and, in fact, improved," said Noland. "It's one of the most sustainable ways of getting large amounts of content to a lot of people and a lot of devices. When we think about what's good for the planet, we need to think about our high-power/high-tower infrastructure.

"I know that people think it costs a large amount of money to run a tower, and it does, but when you compare that with how much energy it takes to send everybody the same amount of content separately on a unicast network, the high-power/high-tower is orders of magnitude more efficient than unicast networks.

She added that cooperation between broadcasters and operators of other networks was important going forward, as the need for the most efficient and practical means for data transmission is essential now, and will be even more critical as time passes.

"I think broadcast networks need to interface with those other networks in order to facilitate the best use of a network (for a particular use case) and you can easily switch data from one network to another," said Noland.

"If we think that the world's need for data is going to go down, we're dreaming."

She concluded by stating that we need to think of this high-power/high-tower infrastructure not only for TV delivery, but for delivery of other services as well.

"This is where I see the core network as coming in to be important," adding that "If we don't get it together by 2035 or whenever, we're really going to be in the soup."

Report From The National Association Of Broadcasters

The NAB's Lynn Claudy was next to speak, and described the ATSC 3.0 transition now taking place in the United States.

He noted that there had been a "lot of misinformation" outside the United States about the transition, noting that it had been described by some sources as "in peril "or "stagnant."

"Nothing is further from the truth," said Claudy. "I want to explain the ATSC 3.0 transition in a positive light.

In his description of the U.S. ATSC 3.0 transition, Claudy referred to a map posted on the ATSC website showing cities and population coverage. He noted that currently there were NextGen TV signals on the air in 66 markets, covering 61 percent of the country's television markets

"In the top 20 cities in the United States, 15 of them have NextGen TV."


Lynn Claudy

"The goal this year is to increase coverage to 75 percent of U.S. households" said Claudy," adding that within the past six months, 3.0 signals have become available in an additional 13 U.S. markets.

"We feel very good about the transition and the coverage we're achieving."

He also commented on the branding of some TV receivers with the NextGen TV logo, and recognized Sony for their decision to provide 3.0 capability in all receivers shipped to the United States, adding that he wished this was the case for all sets coming in to the country. He noted that the number of 3.0-capable sets reaching the consumer was continually increasing, and that other devices for enabling NextGen TV reception, such as converter boxes, were also beginning to reach the market.

"The transition is going very well," said Claudy. "The next steps involving working with the regulator, our Federal Communications Commission," noting that the U.S. analog-to-digital conversion was on a very strict timeline with established rules governing all aspects; however, the move from 1.0 to 3.0 is strictly voluntary on the part of the broadcaster.

"Government action can facilitate the move to ATSC 3.0," said Claudy.

"When we did the analog-to-digital conversion, we had 402 MHz (of "loaned" spectrum) to play with," said Claudy. "That was enough for every television station in the United States to continue on their analog channel and to add a digital channel. "Now we only have 210 MHz. That has to carry both existing digital television and the new ATSC 3.0 service, and there are about the same number of broadcasters, about 1,700. There is a math problem there. We have to do (this) transition with channel sharing," adding that this limits the data rate available for 3.0 and this hinders ancillary services and enhancements.

He cited the need for action on the FCC's part, noting that channel sharing forever to achieve the 3.0 transition is a bad idea.

"I hope the FCC has an open mind [with regard to] accelerating the transition."

Claudy noted that at the time of his FOBTV presentation, the FCC chair was scheduled to make an address concerning the 3.0 transmission at the NAB Show, and a press release that previewed this address stated that the Commission was planning to establish the working groups to help move the 3.0 transition forward, including the establishment of post-transition rules and regulations.

"That's breaking news out here," said Claudy, "We are really excited about this," as he wrapped up his presentation.

DVB Report

Emily Dubs, head of technology at DVB, followed Claudy, and began with an overview of some of the work going on within her organization, including DVB-I (service discovery via Internet), DVB-NIP (native IP broadcasting), low-latency streaming, targeted advertising, and video/audio coding.

In speaking about the DVB standard and IP, she remarked that "DVB-I's network-agnostic service layer (makes it) a very good tool for broadcasters to transition to IP."

She noted a late-2022 updating of the related DVB Bluebook A177r4, includes "server-side service list generation based on a receiver's indications, and the provision of service lists via a CI Plus (common interface plus) CAM (computer access module)." She also observed that the next updating of the A177r5 document, which is scheduled this June) will include signaling of the availability of HbbTV applications to provide accessibility features, and support of the European AVMS (audio-visual media services) Directive, which now requires devices to "ensure the appropriate prominence of audio-visual media services of general interest."


Emily Dubs

Dubs stated that several DVB-I implementations were taking shape, including some important trials in Italy and in Germany. The latter trial involves 19 partners, including both private and public broadcasters, who will demonstrate the feature set available within DVB-I that includes network switching, regionalization, and also DRM capabilities through HbbTV (hybrid broadcast broadband TV) applications.

She also touted a recent live demonstration of DVB-NIP that took place in Delhi, India in February 2023, calling it "very impressive." (The demonstration allowed persons with legacy cell phones to view live OTT services being transmitted via a DVB-T2 tower, some 15 km distant.)

Dubs concluded by describing video and coding initiatives underway within the DVB, including dual-layer codecs and also the establishment of Study Missions in the areas of "object-based media; energy-aware service distribution and consumption; and volumetric video."

Japanese Television Update

Ryoichi Nakai, director of the research and development headquarters for the Japanese Association of Radio Industries and Businesses (ARIB) standards organization provided

the next presentation—a very succinct overview of the advanced television activities taking place in his country. He called attention to the "Technical Review Schedule," that was now set to be issued as a final report in 2023. "It will include work on video coding, audio coding, multiplexing, conditional access, and transmission channel coding," said Nakamura.

He concluded his presentation with an update on the on-going work by the AIRB on standardization.

The AIRB's Nakai was followed by Kenichi Tsuchida, an executive researcher with Japan's NHK Science And Technology Research Laboratories (STRL), who spoke about both NHK's "Future Vision for 2030 to 2040" and on-going developmental work associated with a new advanced terrestrial broadcasting system being developed for Japan.

In connection with the "Future Vision" initiatives, Tsuchida described the transition from 2D 8K imagery to a 360-degree "full" dome form of three-dimensional presentation. He also noted the initiative for integrating broadcasting and broadband, as well as a methodology for volumetric data acquisition

Tsuchida also described on-going work in several other areas, including technology for generating sign language for the hearing impaired to be generated directly from Japanese news scripts, a light field head-mounted video display, and a "bendable, rollable display screen," noting that work was underway on both 30-inch 4K and 60-inch 8K versions.

He concluded his presentation with a review of the history of UHD-TV terrestrial development in Japan, noting that the initiative began in 2014. Tsuchida also reviewed on-going work in advanced coding systems for use in advanced television systems.

Advanced Television R&D In Korea

The next presentation was by Sung-Ik Park, principal researcher at Korea's ETRI organization, who provided information on several on-going projects. He began by describing research work involving ATSC 3.0 MIMO for transmission of 4K UHD signals within a 6 MHz spectrum bandwidth.

"MIMO generally does not provide backward compatibility, but we are finding a solution for this issue," he said. "ETRI successfully demonstrated transmission of four 4K UHD services within 6 MHz." He also stated that demonstrations addressed MIMO backward compatibility for legacy TV sets,

Sung-ik Park

and massive data transmissions (upwards of 200 Mbps).

Park also noted the work that ETRI is doing in other areas, including SFN channel profile research within the UHF TV spectrum; comparison of ATSC 3.0 with 5G television modalities in several areas, including overall costs; co-existence of both ATSC 3.0 and 5G Broadcast within a single RF channel; and work on a new generation of master antenna (MATV) systems that support both ATSC 1.0 and ATSC 3.0 television standards. In commenting on this later initiative, Park noted that this was important as "in Korea more than 60 percent of our population lives in apartment or common buildings." He noted that ATSC 1.0 legacy receivers would have to be supported after the sunsetting of that standard, so transcoding was employed to achieve this backward compatibility.

"We developed this system successfully with KBS…and will start to launch this system commercially."

Sinclair Broadcast Group Report

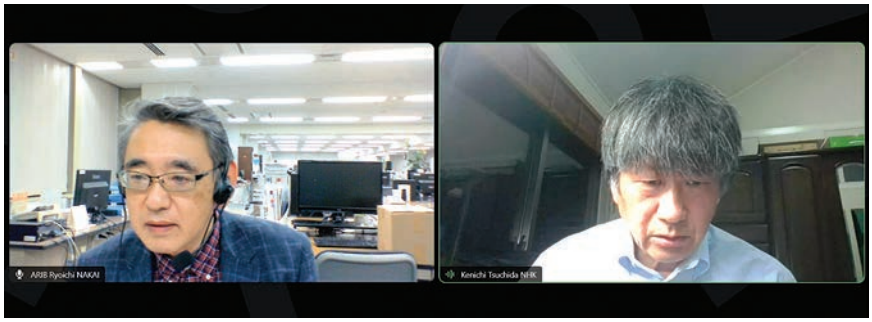
In his presentation on the transition from ATSC 1.0 to ATSC 3.0 in the United States, Mark Aitken, Sinclair Broadcast Group's senior vice president of advanced technology, offered "a prospective from a broadcaster who has been very much engaged in this activity."

He described the continuing "lighting up" of new NextGen TV transmission facilities and the corresponding increase in availability of signals for the U.S. population, with signals now available to more than half of the country's households. He also described a relatively new form of hybrid analog/digital broadcasting being undertaken by some low-power television stations operating on U.S. Ch. 6 (82-88 MHz).

"Now there are19 low-power stations that are engaged in 3.0, and a large number of these are 'Franken' FMs'," said Aitken, referring to the ability of Ch. 6 stations to provide an ATSC 3.0 digital service, and by slightly reducing the 6-MHz allotted for video, simultaneously transmitting an analog FM radio service on the 87.75 MHz audio subcarrier frequency formerly used in analog transmission. The 87.75 MHz (or more commonly, 87.7 MHz) is receivable on most radios, as it is close to the low end of the U.S. FM broadcasting band (88-108 MHz).

"This is an interesting point to note," he said. "There are many low-powers that are not yet under count, but (are transitioning to ATSC 3.0).

He also commented on the need to accelerate the move away from ATSC 1.0 and on to 3.0, observing that more effort is needed to make the public aware of ATSC 3.0 broadcasting and the features and advantages that come with it.



Ryoichi Nakai and Kenichi Tsuchida


Mark Aitken

"There has been some advertising in multiple markets that has gone on with respect to awareness of NextGen TV, but not nearly enough. I expect that this year will be the turnaround year when local broadcasters become much more engaged in promoting the NextGen activities of these stations."

Aiken also mentioned on-going efforts by his broadcasting group to work with local authorities in connection with their needs in the area of emergency alerting and how NextGen TV might be able to address these, and stated that other broadcasters should engage in such similar initiatives. He also described the use of ATSC 3.0 in connection with providing data services for the automotive industry. "This will have an important place in the future for ATSC 3.0."

He concluded with an update on progress in an on-going initiative for adoption of ATSC 3.0 technology in India.

NERC-DTV Update

Yao Wang, vice president China's NERC-DTV organization, next provided a look at recent television-related activities within his country.

He noted that much progress is being made in China with the deployment of UHD television, as there are now two 8K UHD broadcast channels and eight 4K UHD broadcast services in operation, and described a nationwide project involving 100 cities and with 1,000 public viewing screens that are being used in connection with the 8K trial. As of April 2023, some 500 8K outdoor screens are connected in 70 cities. Different emerging standards and technologies are deployed, including AVS3, SMT, HDR Vivid, and Audio Vivid.

He noted that there are a number of approaches underway for promoting the UHD television industry on several levels. By the end of 2022, the 4K UHD penetration rate in China was greater than 74 percent. By the end of 2023, all provincial broadcast TV programs will be transmitted in HD, and by the end of 2025, all of the city-level TV programs will be in HD.

Wang also reported on some research priorities from the NERC-DTV perspective, noting that the goal is to provide better public media service with enhanced broadcast techniques. He noted that research priorities include quality, versatility, ubiquity and immersion.

In the area of versatility, Wang described SMT-based multiservices for multiuser systems, with a unified encapsulation format, broadcast/broadband transmission network, and personalized content presentation. "The synchronization time has been moved from 200 ms to 120 ms," said Wang. "This is a big achievement to enhance user experience in connection with people watching video on big screens and listening to the audio with an app on their phone."


Yao Wang

In terms of ubiquity, Wang described the application layer cooperative transmission and network layer cooperative transmission. He said that the application layer cooperative transmission provided a repackaged transmission with synchronization with the application layer trigger, and the network layer cooperative transmission enables a scenario for the use of an SCC (supplementary carrier channel) along with the PCC (primary carrier channel) "live repackaging" to aid in lost data recovery and to provide two-way communication services.

In explaining the immersion initiative, Wang described the work going on in connection with 3DoF (degrees of freedom) adaptive presentation that includes behavior tracking FoV predictions and behavior parsing and adaptive presentation.

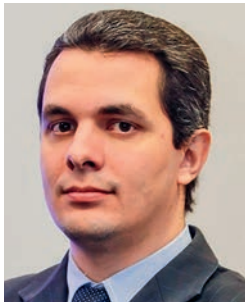
"We are also implementing 6DoF visual presentation that's based on volumetric object sensing, volumetric dimension reduction, video segment compression, and distributed network transmission technologies," he said.

Advanced Television Activities In Brazil

Luiz Fausto, chair of the Technical Module at SBTVD/TV Globo in Brazil, updated FOBTV members on the progress of his country's movement into what is termed "3.0," which in this case refers to the third-generation of television in Brazil.

Fausto described a plan for user interfaces for the new standard under development being based on user apps.

"Each broadcaster would have his own apps," said Fausto. "(With functionalities) completely integrated within each broadcaster's app."


Luiz Fausto

Fausto stated that there are three phases involved in moving to the country's next broadcasting platform and that the first two phases have already been completed, as described by him in previous FOBTV meeting reports. He said that the third phase involves the selection of technologies for "TV 3.0."

"This includes the application layer, coding for the transport layer, and OTA physical layer, and a broadband interface," said Fausto. "We are now performing laboratory testing, and at the end of this testing, two technologies will be selected for the field testing. At the conclusion of field testing, we will select one of the technologies."

"We expect that once we finish testing, we will be working on planning and{preparing) regulations (for the new service). We will probably be launching 'TV 3.0' in Brazil at this time next year."

A 5G-MAG Perspective

The final presentation of the meeting was offered by Jordi Giménez, head of technology at 5G-MAG/EBU, Europe.

He began by offering a summary of some of the latest activities being undertaken by the 5G-MAG organization, including content production and distribution, noting that 5G-MAG is not a standards organization, as such.

"Our work is not in making standards, but rather on reshaping existing standards," said Giménez. "We understand what is being developed, move into some standardization activities—mainly software development—[and] deployment and commercialization of this work."

Jordi Giménez

Giménez noted that his group's "work items" currently include standardization status and profiling, "onboarding" in non-public networks, an emphasis on content distribution and consumption, and accommodation of various viewing devices, formats and users.

He noted that challenges include bringing control back to service providers and engaging with the various standards that are being developed in content production and distribution. Giménez stated that a framework is needed for delivering OTT apps and to determine which services will be available via broadcast distribution and which services will be available via unicast Internet distribution. He also noted that this framework needed to address 5G media distribution for mobile, linear, and on-demand streaming, multicast services on mobile networks, and integration of emergency alerting via LTE-based 5G Broadcast.

Giménez stated that some work is being done in collaboration with organizations outside of 5G-MAG, primarily in the areas of support for mobile devices, file delivery, support of systems already developed for smartphone use, and the like. He noted that collaboration is currently underway with the DVB group, with a report in the works on a hybrid use case for integration of unicast-delivered services in connection with DVB-I. Work is also in progress in other areas, including advanced media services, virtual reality, non-traditional use of media for personalized storytelling, in-stadium multiple camera views, and volumetric video capture and display.

Due to the length of the various presentations, a planned panel discussion on "Global Research Trend Collaboration" was tabled by FOBTV chairman Wang. The next FOBTV organization meeting is now planned to take place on Sept. 17 in conjunction with the 2023 IBC event in Amsterdam.

RF Report

Open Source Software Dr DTV TS Measurements, Libdvbpsi and Libdvbtee, TSDuck, and Some SDR Experiments

By Doug Lung

The over-the-air DTV landscape is changing. Stations converting to ATSC 3.0 have to find stations to host their ATSC 1.0 program streams. In addition, some stations have been able to move from VHF to UHF channels. These changes may also impact what's carried on translator stations. In addition to these major changes, it isn't unusual for stations to drop and add multicast program streams. I've been looking for a simple open source solution for tracking these changes, and found some good options. I'll also provide some links to software defined radio experiments with ATSC 3.0 and HD Radio that I'll try to get to before my next column in hope some readers may find them interesting and let me know how their experience with them.

TSReader (*https://tsreader.com*) is one reason I keep a Windows virtual machine on my Linux desktop. It provides a detailed analysis of transport streams, whether from a connected DTV tuner, an Ethernet port, or an ASI to USB adapter. Its ability to create an html page with data on all the streams on a channel, along with thumbnails of the video, is very useful for sharing data on what's carried on a TV channel. The "Pro" version provides warnings of non-compliant streams. All this is for a reasonable price. Why look for an alternative? First, I wanted something that would run on Linux. Second, while TSReader works great for detailed analysis, as it only works on a channel-by-channel basis. Grabbing data on all the channels in a market like Los Angeles would take a long time.

I didn't find any program that duplicated all the functions of TSReader with the same ease of use, but by combining some available open source programs it is possible to grab data on all the channels available and, with some added scripts, capture short clips of the transport streams for further analysis, including in programs such as TSReader.

Libdvbtee

The first program I found was Michael Krufky's "libdvbtee", available at *https://github.com/mkrufky/libdvbtee*. I've not found binary versions of this program for Debian, Ubuntu, Fedora or Arch, but it isn't difficult to compile it from the github source. I've successfully compiled it on Fedora 37 Linux on my Thinkpad X1 as well as Debian on the ARM64 based Orange Pi 5 computer that I mentioned in previous columns. The "libdvbtee" software depends on "libdvbpsi", which is available as a binary on most Linux distributions. However, since the "libdvbtee" build script includes building a compatible version of libdvbpsi, I recommend letting "libdvbtee" build and install the "libdvbpsi" files. After I describe some of the program's capability, I'll provide some tips on how to build the libraries.

The "dvbtee" software included with "libdvbtee" is capable of scanning channels and saving the details about program streams on them as well as details on PID usage for all the tables. It can also save EIT and ETT guide data from each channel. It can be used to stream video, audio, and PSIP data to a network or a file. The data can be output in json format for analysis in another program.

I found "dvbtee" provides more reliable and faster DTV channel scanning than the "dvbv5-scan" and "w_scan" programs I've written about before. The output is not in a format usable by the dvbv5 utilities, but it is easy to convert it. Running this command from a console window will scan RF Channels 2 through 36 for ATSC programs streams:

```
dvbtee -s -A1 -c2 -C36 > channels.dvb
```

All of the command line text in this article, except for the scripts shown separately in figures, should be entered on one line. If a command line anywhere in this article text appears as separate lines, then combine the lines into one before attempting to use it.

The scan function is enabled with the "-s". The "-A1" parameter tells the program the input is ATSC (8VSB). The scan range is set using "-c" for the start RF channel (2 in this example) and "-C" for the stop channel (36 in this example). The "> channels.dvb" sends the output to a file named channels.dvb. Use the command "dvbtee -h" to see a full list of the command line options. They allow selecting a specific adapter and tweaking scan parameters for speed and redundancy. Figure 1 shows a segment of the file created during a scan in Los Angeles. This file can be converted to a "zap" formatted channel list using the simple Python script shown in Figure 2. The "zap" formatted list can be used with the signal measurement scripts I described in previous articles.

The "channels.dvb" file provides a good summary of all the over-the-air program streams available in a market, but additional data is available. While scanning channels with dvbtee

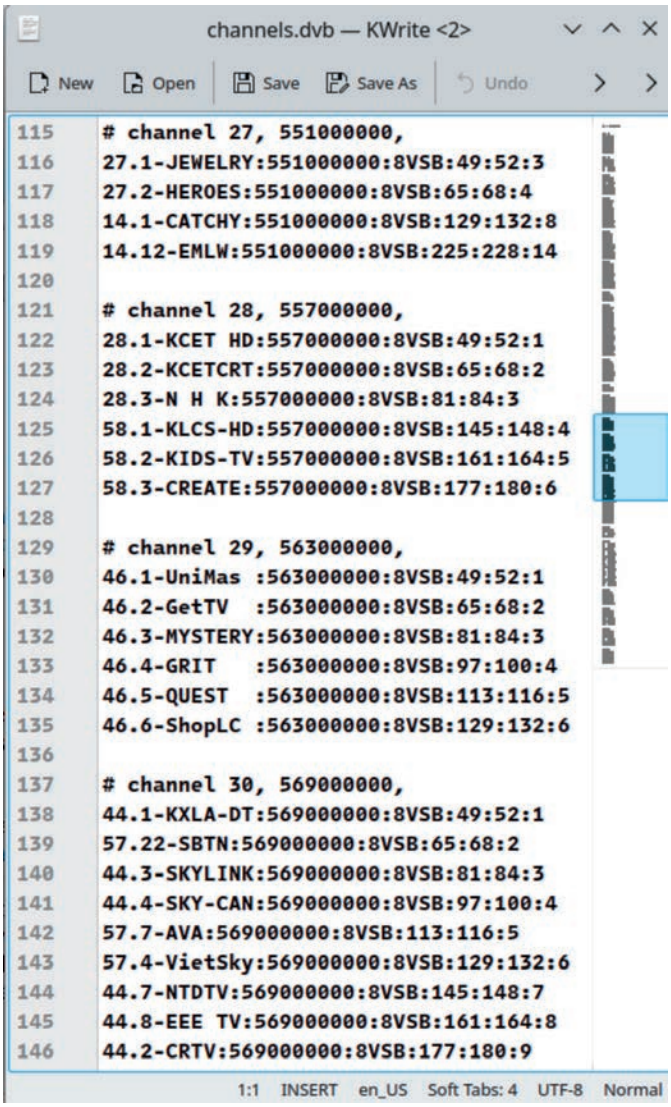


Figure 1. dvbtee channel scan output.

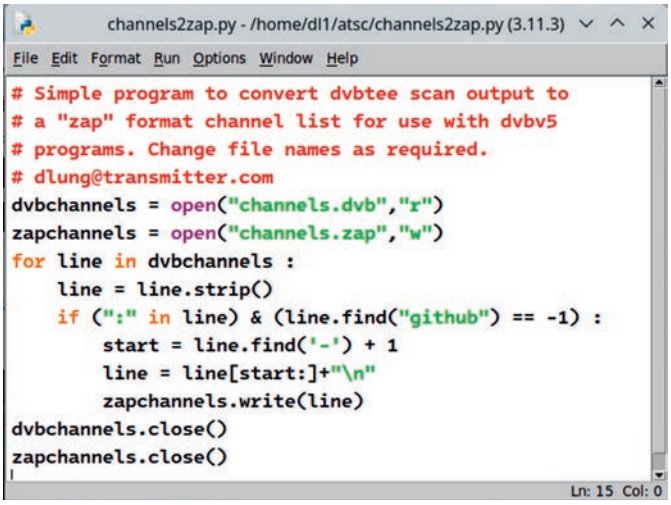


Figure 2. Python Sscript to convert dvbtee output to zap channel list.

you may have noticed detailed PSIP data scroll by. You can capture it by slightly modifying the command:

dvbtee -s -A1 -c2 -C36 &> channel-data.txt

The "&>" adds the console output to the file. This file is too large to show here as it includes all the program output including PSIP tables.

Adding "-E" to the above command will provide output of the EIT EPG guide. The number of tables can be restricted by adding a number to the parameter. "-E1" will limit it to the first table. The extended text table, ETT can be added to ATSC scans with the "-e" parameter. Here is a command I used to grab the first EPG table from each program stream during a scan:

dvbtee -s -A1 -E1 -c2 -C36 &> channel-detail.txt

In the Los Angeles hotel room where I did the channel scan, I had line-of-sight from the hotel window to the Mount Wilson transmitter site, so was able to receive most of the channels. It took "dvbtee" less than five minutes to collect PSIP and EPG table data from 21 stations and 165 program streams! Figure 3 shows a sample of the PSIP data and part of the EPG data for one channel (KCET's Channel 28) capture in a Los Angeles scan after some edits to remove extraneous program status messages had been performed.

The output file includes all the program status messaging and the data is displayed as it is received. Using a text search on the file can pull out data of interest, but I'm working on a Python script to present the data from the output file in a more usable format. Adding "-j" will provide detailed PID data in json format including descriptors. Email me if you are

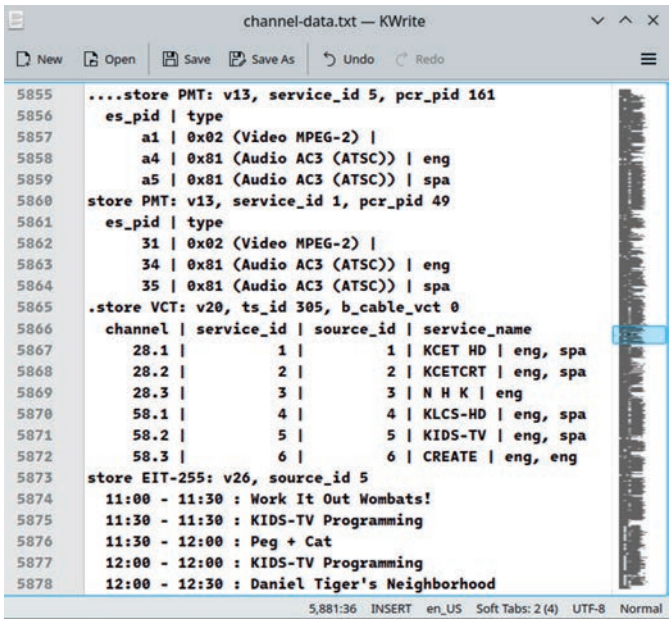


Figure 3. dvbtee channel PSIP detail.

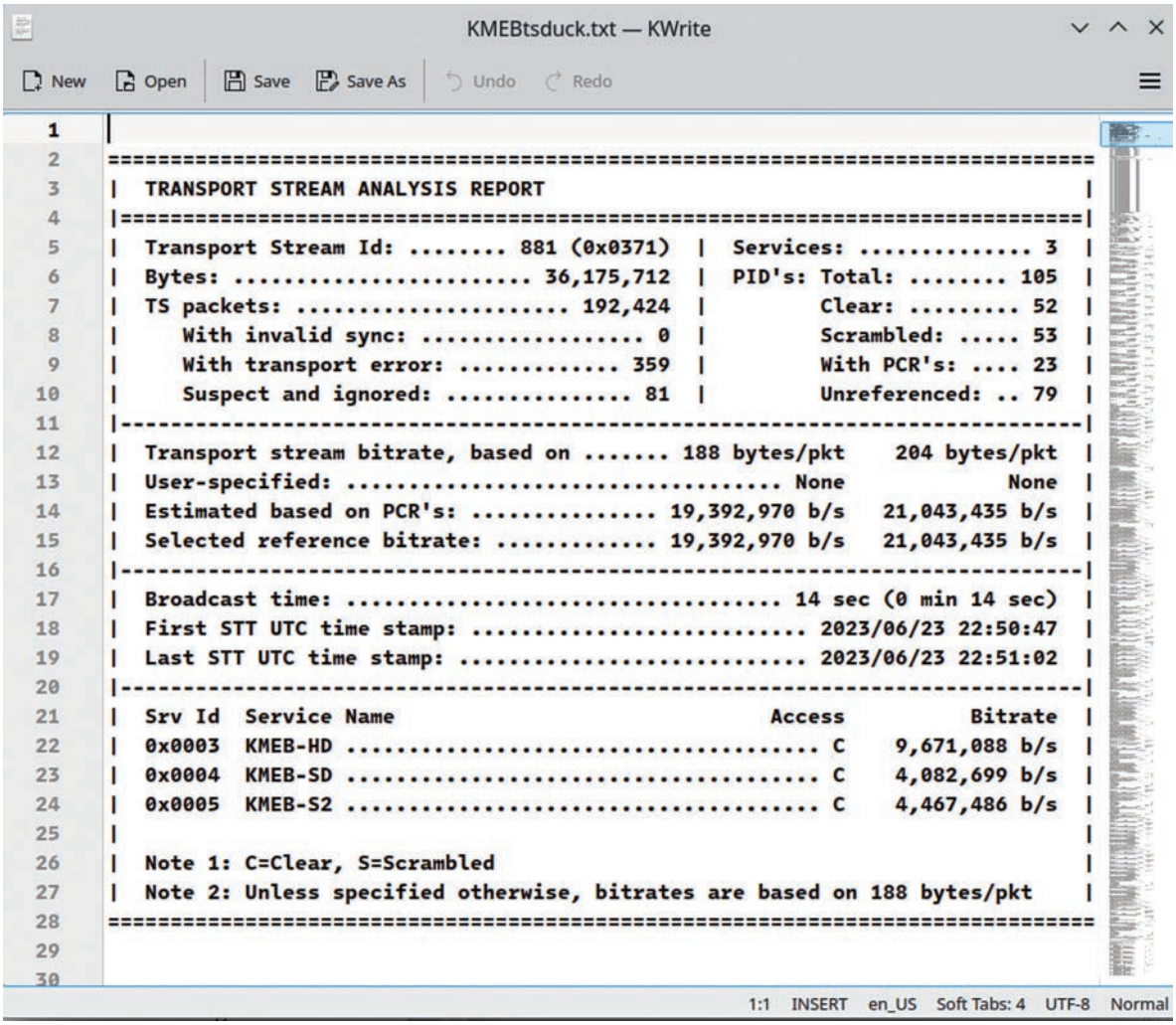


Figure 4. TSDuck Transport Stream Analysis.

interested in testing it. I'm especially interested in receiving the output from "dvbtee" scans in other markets to verify my script will work with different stations' PSIP settings.

To install "libdvbtee" and its associated programs, follow the instructions on the github link provided earlier. Watch for error messages that may indicate other packages need to be installed. The default build requires the HDHomerun libraries. For Fedora, these are the "hdhomerun" and "hdhomerun-devel" packages. For Debian on my Orange Pi 5, the packages to install are "libhdhomerun-dev" and "libhdhomerun4". After building the executable file can be found in the "dvbtee" directory of the github installation directory. If building on a Debian platform, there is a build script in the "deb" directory to use instead of the standard "build-auto.sh" file. Run "sh build_deb.sh" from the deb directory.

I've had mixed success using the transport stream output from "dvbtee". I have not yet been able to get tcp or udp streaming working even though I verified the network was capable of it by using the netcat (nc) command. Saving the transport stream to a file works:

```
dvbtee -c36 -t 60 -o > test36.ts
```

Each of the program streams can be viewed in mplayer (use the TAB key to switch between programs) but the file doesn't include all the PSIP information. Adding "-I" to the command allows selecting only one program number. For example, adding "-I3" will record only program number 3 and associated PIDs.

TSDuck

The output from "dvbtee" may be sufficient for a quick market survey, but more detailed information is available using the "tsanalyze" command from the TSDuck program available from *https://tsduck.io/*. Binaries are available for Windows, RedHat / AlmaLinux, Fedora, Debian, Ubuntu (Intel and ARM64) and Raspbian (Raspberry Pi 32 bits). It can also be installed on Mac OS using Homebrew. A Debian ARM64 binary was not available, but I had no trouble using the source available at *https://github.com/tsduck/tsduck* to compile a version that ran on my Orange Pi 5 with Debian Bookworm. If

you run into problems, I've found the contributors willing to help. I had an issue with the Fedora binary, and after a posting we tracked down the problem and an updated version was posted within a day or two. I may also be able to help.

TSDuck is an amazing program with capability well beyond the simple analysis function I describe here. It can work on live transport streams and modify, remove, rename or extract services. It can also analyze and inject SCTE 35 splice information. For more details see the 562 page user guide at *https://tsduck.io/download/docs/tsduck.pdf*.

Once installed, the command to analyze a transport stream file is simple. Here is one I used to check my local PBS translator:

```
tsanalyze --atsc KMEB.ts > KMEBtsduck.txt
```

Figure 4 shows the first page of the "TRANSPORT STREAM ANALYSIS REPORT' from the file. It includes the bit rates for each of the services. Note that while this station is not using statistical multiplexing and the bit rates are constant (CBR), the rates displayed on a station using variable bit rate (VBR) encoding will vary from sample to sample depending on the program content.

Figure 5 shows part of the "SERVICES ANALYSIS REPORT". This should be useful for stations looking to optimize bitrate settings as it shows the bitrates for the PAT, ATSC EIT and ETT, ATSC PSIP, and Stuffing (null packets). My captures include a large number of very low bitrate unreferenced PIDs, which show up in TSDuck and in TSReader.

Figure 6 is another part of this report, showing details on one of the program streams. This includes information on the video encoding, resolution, and aspect ratio. However, assuming @25Hz is supposed to be the frame rate, it is clearly wrong. Audio bitrate, language descriptor, and sample rate is also shown. In this case, it appears KMEB is using "fre" (French) for its audio description channel. In the United States, the language descriptor more often reflects which channel is primary and which is secondary since most sets and cable boxes default to "eng" (English) as the primary channel and "spa" (Spanish) as the secondary channel. Using a language other than "eng" or "spa" forces the viewer to select it manually. There is additional detail on each PID in the PIDS ANALYSIS REPORT section (not displayed here).

TSDuck also provides a "TABLES & SECTIONS ANALYSIS REPORT" that shows the repetition rate for various tables such as PAT, PMT, MGT, TVCT, and STT.

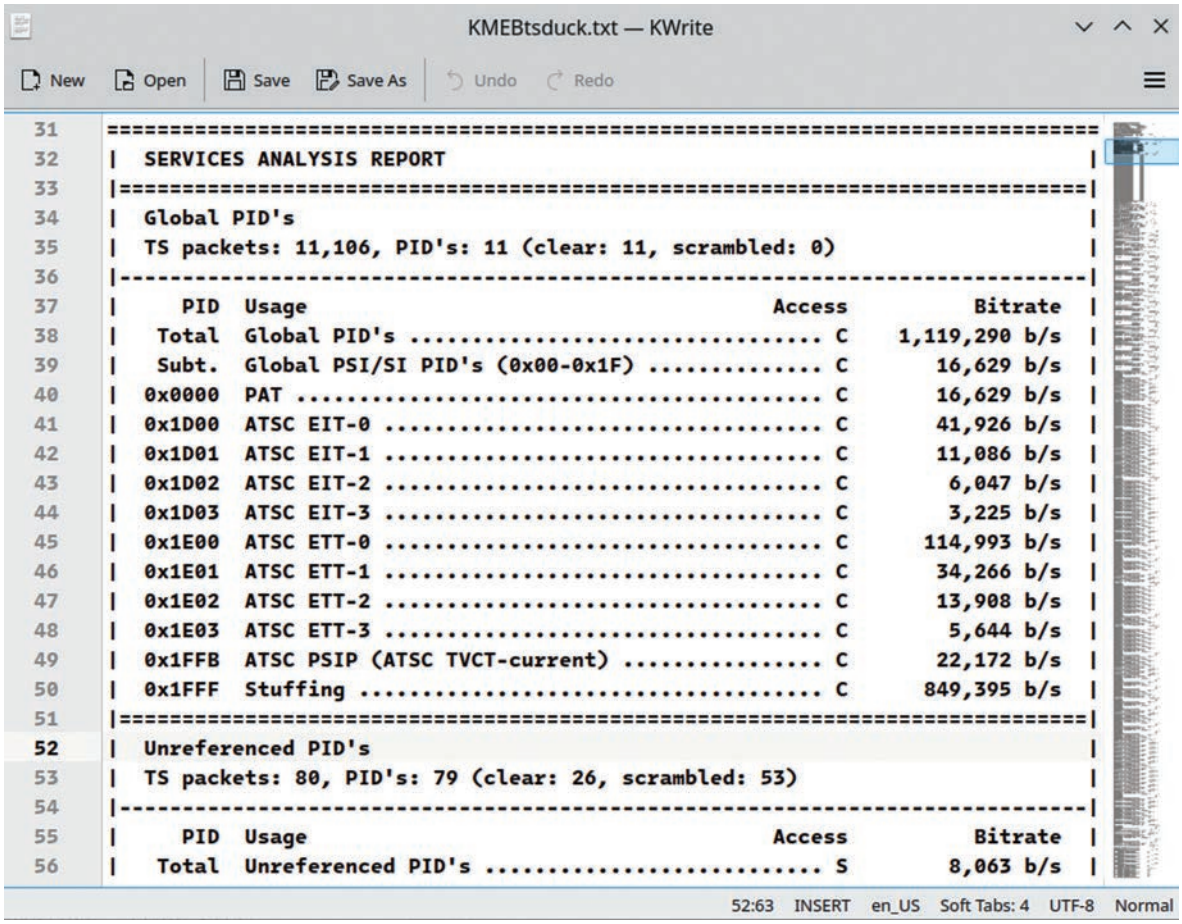


Figure 5. TSDuck Services Analysis Report.

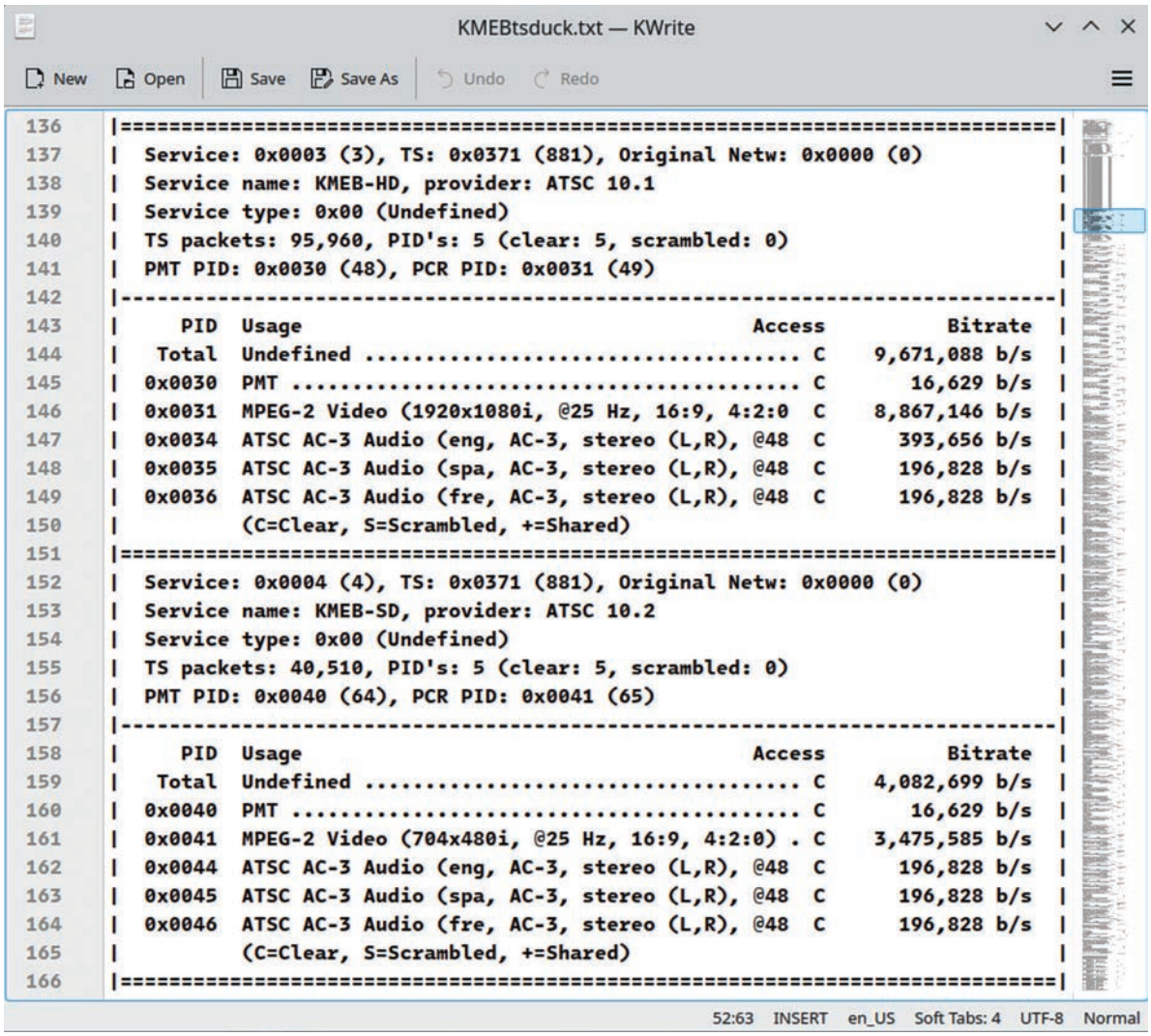


Figure 6. TSDuck Services Analysis Report (2).

TSDuck's tsanalyze can do much more. Refer to the user manual and web page. Run the command:

tsanalyze --help

to get a complete list of all the command line options, including parameters for IDSB and default settings for different areas such as Japan (--japan), Brazil (--brazil), Europe (--europe). Philippines (--philippines), and USA (--usa).

Please note that Thierry Lelégard, the TSDuck author and maintainer, is looking for user assistance in supporting and promoting the TSDuck project. See *https://github.com/tsduck/tsduck/issues/729* for details.

Capturing Transport Stream Files

As I mentioned earlier, if you use the captured file from "dvbtee", TSDuck will not display any of the PSIP information. TSReader displays some information from it, but it is not complete. The most obvious way to capture a transport stream file appeared to be using the dvbv5-zap program with a channels.zap file created as described earlier to select the desired channel.

This command provided a transport stream that TSDuck could analyze:

dvbv5-zap -C US -c channels2.zap -I zap "NBC4-LA" -P -t 30 -o 605000000.ts

The "-C US" sets the format to U.S. ATSC. The "-c channels2.zap" grabs the channel data from a file named channels2.zap. The "-I zap" is needed to use a ZAP formatted channel list. "NBC4-LA" is a program name in the channel list. Note that even though we're grabbing all program streams, dvbv5-zap needs the name of one of the streams to tune to the channel. The "-P" tells dvbv5-zap to output all PIDs and the "-t 30" limited the record clip to 30 seconds. The "-o" says to output the stream to the file listed after it. This worked and provided a stream TSDuck could analyze,

Figure 7. BASH script to capture a transport stream.

but it was full of continuity errors regardless of the channel selected and the length of the recording. The video and audio were unusable. A Google search showed others had the same problem, but it may work on your computer. Try it first, as this is the easiest way to capture a transport stream.

It took some additional research after I got back home to come up with an alternative method. I've tested this and it works both on my Fedora based Thinkpad X1 and Debian ARM64 Orange Pi 5. It involves capturing the transporter stream from the "dvr0" device Linux TV device drivers create. To capture the output, use a command like this:

cat /dev/dvb/adapter0/dvr0 >| KMEB.ts

The device will normally be "/dev/dvb/adapter0/dvr0" but if you have more than one tuner and want to use the second tuner, use "/dev/dvb/adapter1/dvr0".

After starting the "cat", run this command in a separate console to send the tuner output to it:

dvbv5-zap -I zap -c channels.zap "KMEB-HD" -P -t 30 -r

The parameters are the same as in the previous example, changed as needed to reflect the channel list and desired channel. The "-t 30" sets a 30 second output length. It can be deleted for continuous recording, but dvbv5-zap will have to be killed with a CTRL-C or "kill" command to stop it.

The dvr device will remain in use after dvbv5-zap ends, so it is necessary to kill manually using the command "killall cat" before it can be used for other recordings.

It is possible to combine all of these commands into a script. Figure 7 shows one example. If denied permission to run these commands, verify your user is part of the "video" group and add your user to the "video" group if needed.

My plan is to write a script that will use "dvbtee" to generate a channel list, grab the channel's PSIP data, iterate through the channel list (by frequency) to create a short transport stream (.ts) file from each channel using "dvbv5-zap", run each of those transport stream files through TSDuck's "tsanalyze "program" to grab bit rate data for each stream, and then perhaps grab a JPEG screen capture from each program stream to generate a complete report for all received transport streams. Since I've tested each of the programs necessary to do each step I'm hoping this won't be too difficult.

SDR Experiments: ATSC 3.0 And HD Radio

In a previous column I described how to generate an ATSC 3.0 physical layer signal using an Ettus B200 and a GNU Radio software defined radio (SDR). Ron Economos (DrMpeg) has added LLS to his implementation, which may enable it to work with ATSC 3.0 tuners beyond the SiliconDust HDHomerun. I'm hoping to have a chance to test it with my Airwavz Redzone receiver before the next column and if there is room in my suitcase I may actually take it to a place where I know there are some working ATSC 3.0 consumer receivers I can play with. If you want to give it a try, details are available at *https://github.com/drmpeg/gr-atsc3*.

Also, while looking for information on HD Radio, I found a project that uses GNU Radio to implement a hybrid-FM HD Radio transmitter and all-digital AM HD Radio transmitter. The FM works with the Ettus B200 or HackRF One. AM requires the HackRF One. Details are available at *https://github.com/argilo/gr-nrsc5*.

Let me know if you have a chance to try out either of these projects!

Email comments and questions are welcome. Contact me at *dlung@transmitter.com*.

Women In Broadcast

BTS At IBC 2023

Hosted By Samina Husain, BTS vice president

Dall-e.ai

We are excited and looking forward to IBC 2023, with a full program of exhibitors, latest technologies and lively discussions. As always held in Amsterdam, this year the show will run Sept. 15-18. Come meet the IEEE BTS team at the IBC Partnership Pavilion (8.F55).

BTS will be again hosting a half-day session to address pertinent issues for the broadcast industry. Session details and latest information can be found on our website, *https://bts.ieee.org*.

In this 3Q 2023 edition of **Broadcast Technology**, the article from Claudia Carballo González, PhD student at University of Cagliari, addresses the complexity of user demands and network management as a result of the continued and increased demands of mobile network. Her research aims to find an optimal solution to address these challenges.

If you are not already a member, consider joining IEEE WIE, it is a global network, and connects nearly 30,000 members in over 100 countries to advance women in technology throughout their life and career. The latest information can be found on *https://wie.ieee.org*.

Thank you for all your support and contributions, the articles address interesting topics, motivate young professionals and engage women in broadcast. Tell us your stories, please reach out and share your thoughts on women in engineering/broadcast, recognizing their extraordinary contributions and achievements. Email us at *bts@ieee.org*.

Softwarized Hybrid Terrestrial/Non-Terrestrial Network Connectivity For MBS Beyond 5G

By Claudia Carballo González
PhD student
University of Cagliari

According to a recent Ericsson report, mobile network data traffic has doubled in just two years, making network management even more complex. In this current landscape, the research community is focusing on developing future wireless networks to manage and support the enormous traffic growth, and adequately satisfy multiple users' requirements and service constraints. The Third-Generation Partnership Project (3GPP) has recently presented the project update for Radio Access Network (RAN) Release 18, marking the start of 5G-Advanced. The 5G-Advanced and Beyond will enable several groundbreaking applications with tight quality of service (QoS) requirements, directly impacting the economic, industrial, health, and educational sectors.

The future infrastructure will guarantee a ubiquitous 3D ecosystem composed of Terrestrial Networks (TNs) and Non-Terrestrial Networks (NTNs) to extend the service coverage area, transcending all traditional forms of current communication. TNs-NTNs integration is crucial to offer an adequate anywhere and anytime user perception, and manage various services, types of users, and mobility patterns. NTNs are essential in the future fully digital world due to their capabilities to fulfill the TNs' limitations in terms of coverage and deployment. They can be effectively exploited to cover unconnected areas and assist TNs during overcrowded scenarios and emergencies.

In Beyond 5G (B5G) scenarios, the same content can be requested by many users simultaneously. Early warning dissemination, massive Internet of Things (IoT) updates, and live events such as the football World Cup generate peak traffic, with hundreds of people demanding optimum experience and perception. This makes the Multicast/Broadcast Services (MBS) delivery essential to increase network capacity and optimize resource utilization. While the first Releases of the 5G development (15 and 16) were only focused on unicast communications, in Release 17 the 5G

network architecture includes MBS support, ensuring the smooth introduction of future functionalities and compatibility with legacy multicast/broadcast network nodes for service continuity. Further, Release 18 aims to increase energy and resource efficiency at each MBS session. In the envisaged MBS architecture, decentralized and distributed caching and edge computing capabilities are necessary to reduce service delay and backhaul data traffic.

The network slicing paradigm is another critical feature of B5G to introduce flexibility, dynamism, and isolation by creating several logically independent network slices (NSs) utilizing a shared physical infrastructure. Many unicast, multicast, and broadcast services can be mapped into several NSs to guarantee traffic management and efficient network resource utilization. Additionally, artificial intelligence (AI)/machine learning (ML) solutions must complement slicing to dynamically make proactive decisions over an ultra-dense heterogeneous differentiated environment in a hierarchical and distributed fashion. For example, the RANs can follow a cooperative ML strategy to determine the base station (BS) with the best conditions to satisfy multiple users requesting the same slice simultaneously.

This complex environment requires flexible and dynamic architectures such as Open RAN (O-RAN). This framework uses virtualized, disaggregated, and software-based elements to enable intelligent, resilient, and reconfigurable RANs. The BSs are connected to RAN intelligent controllers (RICs) through open interfaces to perform control actions following the defined Service Level Agreement (SLA). Then, multiple optimization tasks (e.g., spatial subgrouping for multibeam multicasting, power allocation for multi-layer non-orthogonal multiple access (NOMA), and TN/NTN selection for shared MBS traffic delivery) can be performed based on ML solutions and inserted in the O-RAN. This framework, aided by slicing, is envisioned as critical to meet the tight QoS requirements of B5G scenarios. The ML specifications must be designed for each use case, including training type, collaboration levels, computational resources, and privacy issues.

In this context, my research delves into dynamic and proactive BS selection, slice allocation, and load balancing following a softwarized approach in an O-RAN framework involving TN/NTN cooperation. The investigation aims to satisfy multiple user requests simultaneously, analyzing diverse network conditions, several types of users, priorities, and stringent service requirements. The research uses the slicing paradigm and multicast/broadcast capabilities to increase network capacity and optimize resource utilization. Moreover, deep reinforcement learning (DRL) solutions are considered to handle the complex and ample environment envisioned for B5G scenarios.

Asia Media Summit Focuses On Green Technologies And Sustainability

Broadcasters/Media Producers Urged 'To Act Responsibly'

By Amal Punchihewa

BALI, INDONESIA

Asia Media Summit (AMS2023) was held here May 22-25, and brought together innovators and thought leaders to share insights on the trends and developments taking place in the fast-paced television industry.

The Asia Media Summit is produced by the AIBD (Asia-Pacific Institute for Broadcasting Development) and is a leading global conference for media professionals, promoting innovation, collaboration, and knowledge sharing. This year's event was attended by a wide range of professionals including journalists, broadcasters, media executives, and content creators seeking to stay abreast of the latest developments in media and telecommunication, as well as to connect with industry leaders, exchange ideas, and explore emerging trends in the field. AIBD in collaboration with its partners and several international groups organized AMS2023, and it was hosted by Indonesia's public television broadcaster, TVRI.

Broadcasters Need To Set An Example

At the conference, AIBD and its members, partners and collaborators in the Asia-Pacific region were urged to "walk-the-talk" in their digital transformation, by assuming a strategic ambition of leading the future of television and other media to enable economic recovery and sustainable development. Conference speakers emphasized that it's time to act responsibly, ethically, and sustainably in serving their broadcast and media audiences, and to engage with them for better understanding, and to make sure that no one is left out by taking advantage of relevant technologies, including artificial intelligence.

AMS2023 highlighted that television, along with all other media, is constantly evolving, and that new technology, disruptive platforms and new products are revolutionizing the

choices available for both consumers and industry professionals. The conference served as a forum for assessing the latest industry trends and for looking at what may be on the horizon.

In connection with this, one of the speakers, Andy Quested, with the ITU-R's Study Group 6, provided a look at the future of television and media production, and its delivery and consumption. He emphasized that regulators and policymakers need to understand the fast-moving and rapidly evolving media landscape, and shape regulatory changes to provide a sustainable digital transformation for all. He stated that ITU is aware that almost a third of the world's population remains unconnected, with no access to either remote education or Internet-delivered entertainment. Quested remined attendees that much work lies ahead in this area.

Author Punchihewa presents information on green technology at the conference.

Currently, broadcasting services are able to reach and serve nearly everyone. However, rapid technological advancements and the use of a wider and wider range of media platforms by content providers are beginning to pose a wide range of threats to traditional broadcasting. This was also addressed at AMS2023, with presentations and discussions on the future of television and other media, along with the challenges that come with adopting streaming services.

AMS2023 speakers shared their views on both the opportunities and the threats that artificial intelligence may present, and also discussed the need for green technologies for sustainability, and technologies for addressing the needs of people with differing abilities.

Where Television May Be Heading

For some time now, the broadcast and media industry have been feeling the impact of "cord cutting," with this trend continuing to rise to record levels as more and more viewers move to on-demand video streaming. Warnings about "the death of traditional TV" have been around for quite a while. A two-day pre-summit workshop themed "The Future of TV" was organized to address this, and the conclusion reached by participants was that traditional television is not dead yet, but content distribution will be a mixture of multiple platforms. The Asia-Pacific region is quite diverse, so the proportions will depend on each country, audience, and infrastructure availability. AIBD members are already distributing content on multiple platforms and this content may be accessed on a variety of devices anytime and anywhere connectivity is available.

In the pre-summit proceedings, it was noted that regulations governing traditional broadcasters require them to provide a dependable signal to their viewers, as they have a crucial responsibility to keep the citizens in their areas of service informed, especially in times of emergencies.

Conference presenters stressed that the digital revolution has the potential to transform our economic and social model far more intensely than any previous technological revolution, and noted that this transformation differs from others, in that a new paradigm now exists that's based on decarbonization, sustainability and the circular economy.

Broadcasters Need To Act Both Locally And Globally

The speakers emphasized that digital and green transitions go hand in hand, and that digitization is a key enabler for many productive sectors on their way to a green transition. They noted additionally that the broadcasting and media sector has a key role to play in reducing carbon footprints. The combination of new digital applications that facilitate sustainability and lower carbon footprints, along with a high-capacity and energy-efficient distribution network architecture, can contribute decisively to limiting climate change potential.

Presenters noted that the digitization process requires reliable, resilient and efficient broadcast and media networks, and during the past decade, online media network traffic has increased exponentially, which has led to increased energy consumption and carbon emissions. They observed that deployment of more efficient technologies and use of renewable energies can help to reduce these negative impacts.

It was emphasized that the broadcast and media sector must take firm steps toward sustainability, and by moving to more efficient operations and promoting a transition to cleaner energy sources. The implementation of a circular and sustainable economy will allow a better use of resources, and such changes should not be seen as a risk, but rather as an opportunity to help manage climate change.

About The Author

***Dr. Amal Punchihewa** is a researcher, educator, advisor and consultant in ICT, Media, and Broadcasting with close to four decades of experience in the industry, academia, and research. Amal is a Chartered Professional Engineer and Fellow of IET(UK) and a senior member of IEEE(USA) He is also a distinguished lecturer of IEEE-Broadcast Technology Society. Amal facilitates and advocates technical guidelines and standards, and provides expertise related to the convergence of media, and evolving technology needs. He advocates, encourages, and manages member communities, and help them to understand the trends that shape the media, to empower media & ICT stakeholders to continue to take good strategic decisions. He is also the technical advisor of the AIBD and a member of the AIBD international advisory board.*

The Downward Path To Broadcast Engineering—No. 32

Some Basic Knowledge And A Little Sandpaper Finally Solved A Recurring Problem

By Eric Hoehn

For the older readers, I'm sure from time to time you look back at your positions over the years, and marvel at all the changes and what you had to learn to keep up with the technology. For those readers just joining the broadcast industry (and the IEEE), I can only wonder about what things will look like for you in the coming decades. My story concerns some of this broadcasting "ancient history," however, the lesson learned then is still as relevant now as it was decades ago.

Like a lot of us in the broadcast profession, I started working at a radio station while I was in high school. I continued my "radio education" during college, helping to keep the student station there on the air.

This lesson that I'm going to describe is from the late 1980s when I began my first job with a broadcasting group after graduating from college. I should note that I'd served as an assistant to a station engineer at a major market radio station while I was in high school. I also worked at the student station at my college, which was an engineering school, and a number of us students pitched in to keep things going at the radio station.

After graduation from engineering school, I got my first full-time radio station engineering job. This was at a small established FM station, and I was the *only* engineer, with no one to lean on to help me solve a problem in real time.

'Other Duties As Required'

In addition to helping to keeping everything up to par at this station, my duties also included maintenance of a new FM that was partly owned by the established FM's owner, and located about an hour-and-a-half away from my home base in Missouri. This startup FM operation, while doing well, did not have a lot of spare equipment. If it's remotely-controlled CCA 3 kW transmitter failed for any length of time, the only recourse was to use a kit that had been purchased that allowed the unit's low-power exciter to be connected directly to the antenna to completely bypass the IP and power amplifier stages. Fortunately, during the time I was there, I never had to resort to using this bypass kit, but I'm getting ahead of myself.

This main (and only) transmitter initially seemed to be very reliable with its very straightforward grounded-grid design, which made it stable and easy to service. (For those of you younger readers who are unfamiliar with the grounded-grid circuit, the "tradeoff" for the simplicity and stability it afforded was a somewhat reduced efficiency, but back then, no one was worried that much about power bills.)

The CCA 3 KW FM transmitter came with a very troublesome intermittent loss of power.

Dealing With A Very Pesky 'Intermittent'

Of course, nothing is 100 percent reliable, and I got calls on several occasions during my first summer of this new job informing me that the FM was off the air. The bothersome thing was that in almost all of these outage situations, by the time I got to the transmitter site, the big rig was back on the air without any clue as to what had happened. On at least one of these "ghost in the machine" episodes, I did observe (via the remote metering in the studio control location) that the power amplifier's plate and other voltages were normal—just no RF output!

These "dry runs," in addition to wasting a lot of time , were very perplexing and frustrating, as one thing I'd learned about working with tube-type devices, is that there's usually a good problem "reporting and logging system" associated with them, such as an open tube filament, a blown fuse, or maybe a very visible burned-out plate load

resistor. But this was not one of those "hard failures," just a very annoying intermittent.

I was determined to get to the root of the problem, and finally, on one of my trouble calls, luck was with me, with the transmitter remaining off the air after I'd arrived at the site.

Thank Goodness For The 'Add-On' Metering

During my initial observation, all meter readings (except the power output) seemed normal, save for one thing. This was the filament voltage of the final amplifier tube, which, according to the log that was kept, was slightly higher than normal. (In recalling this episode after more than some four decades, I find it interesting—and very fortunate for me back then—that a filament voltmeter had been added to the transmitter after it was delivered. This was not a "stock" item on that particular CCA rig.)

The young Eric Hoehn is a happy man indeed after finally solving the mystery of the CCA transmitter's occasional power loss.

This higher than normal voltage reading was my real clue as to what might be going on. After shutting things down, I reached in to pull the single RF amplifier tube from its socket, and immediately noticed that the tube was stone cold. Upon removing it from the socket, I couldn't help but notice the corrosion on the filament collet. It didn't take long to figure out that the corrosion created a high resistance condition that kept the filament from drawing its rated current, and with no load on the filament transformer, the filament voltage was reading high.

A little time spent in applying some fine sandpaper to the corroded area got things back in business. I ordered a new socket and after replacing the original unit, there was never another one of these "mystery" problems.

Document, Document, Document!

My "lesson learned" was that's it's important to document and keep a record of "normal" operating voltages, currents and other parameters for equipment. When you're armed with such information, it's easy to notice when something is even just a little bit off and this can be a useful starting point in the troubleshooting process. In the case of the CCA transmitter, the physical condition causing the problem was not obvious unless the tube was removed. However, the higher-than-normal filament voltage was a definite clue in indicating that the tube's filament was not being powered. (I should add that one's eyes are also a valuable troubleshooting instrument, but in this case the corroded socket was not visible until the tube was removed.)

This episode with the CCA transmitter was my first "eureka" moment in troubleshooting and restoring to service a piece of broadcast gear, and one that I remember after all the years I worked in broadcast engineering. Certainly, there were plenty of others, but this one sticks out.

Another "plus" on my side in this first engineering job, was that I had been privileged to work with others at my high school radio job and learned a lot about the practical side of things from my observations and experiences. There is a lot of knowledge that isn't available in textbooks. I would admonish those just starting out in the field of broadcast engineering to have a lot of interaction with other technical people and to have curiosity about what you are doing. So many times in my career, I was saved not by a particular tool or piece of test gear, but by the conversations with all the other engineers I worked with along the way.

Even in these days when equipment is far more reliable and comes with a lot of diagnostic aids, hands-on experience and lessons learned from others are still vital. Also, with stations having smaller technical staffs nowadays, it's also very important to interface with equipment manufacturers who are now able to remotely probe your gear and help you isolate problems.

Continue to educate yourself in factory schools and through professional societies such as the BTS. Be more than a member. Attend the gatherings of your colleagues and keep learning. I know that my transmitter story will sound simple to us old-timers, and may not be directly relevant to the younger generation (tubes?), but it's important to learn from the previous generations. Gain as much knowledge in this way as you can, and use it in your carrier, and in mentoring the generations who will come after you. This is the way to keep our industry vibrant.

About The Author

J. Eric Hoehn began *his broadcasting career at a high school radio station in 1976 and has worked for large and small broadcast groups. He earned a BSEE degree from the University of Missouri-Rolla and an MIS degree from George Washington University. He recently retired after 23 years with Sirius XM satellite radio.*

ITU Report

By David Guerra Pereda, BTS Member

This Is End (Almost)!

Usually everything that has a beginning has an ending. This is the case with this "ITU Report" column—or at least of my being the writer of the column—by the end of this year. With the publication of the Q4 issue in 2023 of **Broadcast Technology**, I will have written more than 40 columns since I started back in 2013. I would like to use these last two issues to provide an overview of the most significant of these columns, or at least the ones I enjoyed the most writing.

The first column was published in the third quarter of 2013, and began by describing the ITU 2013 statistics on global ICT developments about mobile-cellular subscriptions and Internet usage, both in developed and developing countries, with multimedia distribution in progressively higher demand. It also showed that broadcasting remained significant, despite the rise of web-based technologies, as the best technology available to cater to global audiences. Although TV broadcast is progressively losing its role, only two years ago, it remained the only window to the outside world for almost one third of the world's population. In that first column, I also advertised the ITU remote participation in meetings was available through webcasting, allowing delegates to save on travel expenses. While full remote activity was not yet available, efforts were ongoing to create an international meeting point for telecommunications discussions. This platform is now a fully functional reality, although the most refined virtual reality can't fully and successfully substitute face-to-face meetings.

The next issue posed a real challenge, with more than 100 source documents involved. The topic was not an easy one either: the coexistence of terrestrial broadcasting services with PLCs (power line communications). It was the first of a kind involving interference study and spectrum sharing. As several Study Groups of ITU-R are involved in interference analysis, that issue of the magazine provided a good opportunity to introduce the structure of the ITU-R as regards technical affairs. Finally, the column illustrated how resolution of a tricky question can be hampered by politics and secondary interests in global standardization organization standardization. Other issues in this area were included in some of my other columns (Q3 2014, EMC; Q3 2015, RF noise; Q3 2016, interference caused by LED lighting; Q4 2016, PLC reloaded; and in Q1 2022, an update on interference.

The second-quarter issue of 2014 also inaugurated columns related to work presented by the research group with which I'm associated. In that issue, the topic was the study of the potential interference to radio communication services by wind turbines. This is a topic that—far from being a matter of historical interest—has gained increasing relevance during the past decade.

Remembering 150 Years Of The ITU

The issue of Q1 2015 was the first to commemorate an anniversary, with 150 years of the ITU's existence honored by means of a review of the organization's history from its beginnings as the UIT (Union Télégraphique Internationale), long before the United Nations was conceived. Along the same historical lines, the previous column to that one focused on analog TV switch-off, from the beginning of the process to its current status in 2015 in different regions of the world. A key question then was that of staying with the established deadline, or moving it forward, as a rushed switch-off would result in the loss of TV reception without the deployment of digital alternative, while a delayed analog shutdown would cause significant issues with regard to cross-border interference.

There was another historical column in Q2 2017, where I described how a revision of suppressed ITU-R Recommendations and Reports was the guiding thread of a more specific retrospective of broadcasting. The first 90 years of CCIR/ITU-R Study Groups were described in the 2018 Q1 column. Finally, I produced a sort of "archaeological" column in Q4 of 2022, in which I explored the dawn of TV channel bandwidth.

Green broadcasting topics were initiated in Q2 2015, where several groundbreaking examples of good practices in this area, including three key aspects for the future of our home planet or, more accurately, for our future *on* the planet. These included the promotion of utilization of renewable energy sources in broadcast station power systems, improving power efficiency in both transmitter and receiver components, and fostering waste reduction and recycling.

WRC Outcomes

The final acts and decisions of World Radio Conferences have also been in the spotlight of two columns, with first of these appearing in the Q4 2015 issue. There I described the "digital dividend" with regards to the 700-MHz frequency

band, which was a "star" among the resolutions. In addition, Asia (with the exception of the Arab states and North America supported a co-primary allocation to the mobile service as far down as 470 MHz. A pre-conference analysis of WRC 2019 was also undertaken in 2018, with some hot topics on the table being the impact of Wireless Power Transfer for electric vehicles on radio communication services, potential revisions to frequency allocations to support systems such as the amateur radio service in Region 1, the meteorological satellite service, Earth exploration satellites, railway radio communication systems, and International Mobile Telecommunications in frequency band 1 (452 to 1,492 MHz in Regions 1 and 3).

Other topics that have been dealt with in the columns over the years have included cognitive radio systems in Q4 2014; SSB in HF broadcasting in Q2 2016; high-power medium wave broadcasting in Q3 2018 (this was another complex one, as far as sources were concerned); and there was a kind of continuation of this with my Q4 2018 column, which discussed high-power FM (VHF) broadcasting. Last, but certainly not least in terms of significance, was my Q3 2021 column, which was devoted to radio astronomy.

Upcoming Events

of Interest to BTS Members

- **Sept. 15–18, 2023** – IBC Show 2023 - Amsterdam RAI; Amsterdam, Netherlands
- **Oct. 16–19, 2023** – SMPTE Media Technology Summit – Loews Hollywood Hotel; Hollywood, California
- **Oct. 25–26, 2023** – NAB NY Show (co-located with AES convention) – Jacob Javits Center; New York City, New York
- **Jan. 9–12, 2024** – CES Show and Exhibition – Las Vegas Convention Center; Las Vegas, Nevada
- **Feb. 19–22, 2024** – HPA Tech Retreat – The Westin Mission Hills; Rancho Mirage, California
- **April 14–17, 2024** – NAB Show – Las Vegas Convention Center; Las Vegas, Nevada
- **May 17–19, 2024** – Dayton Hamvention – Green County Fair and Expo Center; Xenia, Ohio
- **June 19–21, 2024** – IEEE International Symposium on Broadband Multimedia Systems and Broadcasting; Toronto, Canada
- **June 26–28, 2024** – Communications & Broadcasting Week – Koto-Tokyo Big Sight International Exposition Center; Tokyo, Japan

(IMPORTANT NOTE: Event dates and locations listed above are subject to change. When making plans to attend any of these trade shows, conferences, or meetings, *always* confirm details with event organizers first.)

If you have information on broadcast-related events that may be of interest to other Broadcast Technology Society members, please submit them at least three months in advance to the Broadcast Technology editor at BTSeditor@ieee.org.

What's New

Broadcast Technology presents new product releases from broadcast equipment manufacturers

LED Virtual Production Displays

LG Electronics' new LED video displays for virtual production applications include the LBAE026 tiles, which are based on DVLED (direct-view light emitting diode) technology. The display tiles provide brightness levels as great as 1,500 nits, and have a 2.6 mm pixel pitch.

The tile displays are easy to assemble and maintain, and may be assembled either as a flat or curved video screen. They feature accurate color rendition, low-latency video processing, an HDR capability, as well as an adjustable color gamut to allow precise matching of individual tiles and to achieve desired color renditions.

For additional information, please visit LG Electronic at *www.lgsolutions.com.*

Live Production System Enhancement

Chyron's latest version—4.7—of its Prime live production platform includes new tools and provides enhanced workflows to accelerate the design of and playout of electronic graphics for live sports and other fast-paced television production applications.

New features include a powerful datable resource advanced audio-following for complex scenes, refinement of design interfaces, and expanded control panel toolbox and more. This latest edition of Prime facilitates the automatic driving via real-time data sources such as a web API from a provider of sports data. Its control panel creation toolbox includes a new series of shortcut keys for common sports operations such as the transfer or clearing of graphics from program to preview to aid playout operations.

For additional information, please visit Chyron at *https://chyron.com.*

JPEG XS Stream Monitoring

Leader Instruments is now offering a JPEG XS stream monitoring option for its LV5600 television waveform monitor and LV7600 rasterizer without the need for an external decoding device. The new option—SER33—allows users to perform quality checks of JPEG XS compressed video, as well as allowing a direct comparison of these streams with uncompressed video sources.

The SER33 option may be activated in both new or existing Leader waveform monitors and rasterizers. It also includes a JPEG XS test pattern signal generator. The new capability afforded by the option adds to the versatility available in the LV5600 and LV7600 in the quality assessment of both video-over-IP and conventional SDI signals.

For additional information, please visit Leader Instruments at *www.leader.co.*

Compact 64 X 64 Signal Router

Cobalt Digital's new WAVE RTR-64x64 router supports a range of video signals up to 12G-SDI within a compact 4RU

frame. The high-density router provides easy integration within an existing facility, as well as a great deal of flexibility and ease of use. It includes an Ethernet port for IP-based control, as well as RS-422 and RS-232 serial communication ports.

The WAVE RTR 64x64 features a web-based control system that provides setup functionality, as well as monitoring, and the creation of pre-set configurations and salvos. It is specifically optimized for use with 12G-SDI signals, but it also easily handles lower rate SDI video, along with ASI and MADI.

For additional information, please visit Cobalt Digital at *www.cobaltdigital.com.*

IP Streaming Appliance

DTV Innovations' OX-1 streaming appliance is ideally suited for transport of ATSC 3.0 signals from studio to transmitter, as well as other applications involving transmission of broadcast signals via the Internet. It may be used to convert a standard ATSC 3.0 STLTP (Studio to Transmitter Link Transport Protocol) signal for RIST (Reliable Internet Stream Transport) transmission protocol, and then convert the RIST protocol back to STLTP over multicast at the receiving site. It's suitable for both ATSC 1.0 and 3.0, and SRT (Secure Reliable Transport), as well as RIST protocols and any combination of SRT, RIST, ZIXI and SMPTE 2022 TSoIP (Transport Stream over Internet Protocol) streaming formats.

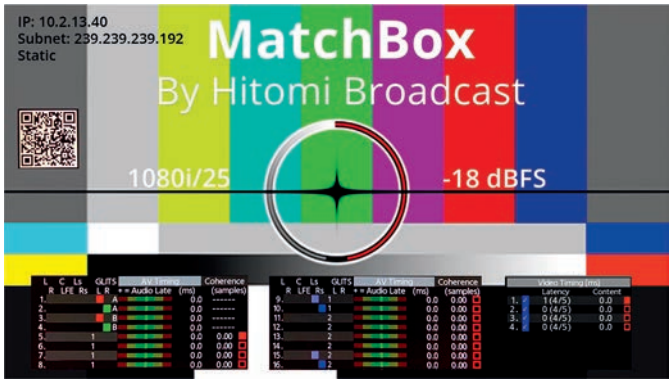
The OX-1 device is also available in a 1RU frame version (the OX-R) with a dual redundant power supply for enhanced reliability.

For additional information, please visit DTV Innovations at *www.dtvinnovations.com.*

Lip Sync Measurement/Correction Tool

Hitomi's MatchBox provided end-to-end assessment of disparities between delivery of audio and video signals, eliminating the need for guesswork by using objective data to ascertain signal path latencies. The tool is available as a free-to-download iPhone app, and greatly streamlines the synchronization of signals in a control room environment.

MatchBox provides a precise analysis of latency and lip-sync shifts to ensure optimal alignment of signal paths and delay compensation devices, as its operation is based on analytical data, rather than intuitive matching of A/V signals by operators. The company will be offering both file-based and cloud-based versions of this lip-sync measurement tool.



For additional information, please visit Hitomi at *www.hitomi-broadcast.tv.*

Video/Audio Signal Test And Measurement

The Rx series of rasterizers from Phabrix provide both 2K/3G/HD/SD signal generation, and analysis and monitoring for compliance testing and diagnosis of issues with both video and audio signals. The Rx instruments are available in three form factors, with a choice of 2-channel or 4-channels of measuring capability.

The rasterizers feature advanced real-time eye and jitter physical layer analysis, as well as closed captioning, loudness and Dolby monitoring capabilities, with as many as 16 measurement tools available simultaneously. In addition, they also have the ability to capture A/V signals to aid in diagnosing intermittent faults, with capture triggered automatically according to user-defined criteria.

For additional information, please visit Phabrix at *https://www.phabrix.com*

Video Production Switcher

For-A's latest introduction in its HVS production switcher product lineup is the model HVS-190. The new one M/E switcher supports high-bandwidth NDI (network device interface) and NDI HX video sources, and comes equipped with built-in 3G/HD-SDI and HDMI interfaces. Its compact size makes it ideal for use in OB vans, live events, and similar applications

The switcher features both adjustable signal processing and frame synchronization on all inputs, a multiviewer, still store with a clip memory, remote control capability for offsite event management, built-in chroma keying, easy configuration via a web server and tablet or PC, and more. It's available in two versions: the HVS-190I with an integrated control panel and electronics unit, and the HVS190S with separate control panel and support electronics package.

For additional information, please visit For-A at *www.for-a.com*.

Hard Drive Docking Station

The Echo 20 Thunderbolt 4 SuperDock is Sonnet Technologies' latest addition to their line of hard drive docking stations. It's compatible with Apple M series Mac computers; Thunderbolt 3 Intel Mac computers; Thunderbolt 4 and USB4 Windows computers; late-model Thunderbolt 3 Windows computers; Thunderbolt 4 and USB4 Chromebook computers; as well as M series iPad Pro tablets.

The new Echo 20 provides enhanced connectivity for most peripheral devices, with three Thunderbolt 4 ports, an internal M.2 NVMe SSD socket, an HDMI 2,1 port, a 2.5 Gb Ethernet port (RJ45), a 3.5 mm audio jack, a 3.5 mm microphone jack, two analog line-level audio output jacks, an SD 4.0 card slot, and four USB 3.2 Gen 2 (10Gbps) Type-C charging ports. It also supports the connection of one 8K or two 4K computer displays.

For additional information, please visit Sonnet Technologies at *www.sonnettech.com*.

Editorial Deadlines

Broadcast Technology *welcomes contributions from its members. Please forward materials you would like included to the editor at* BTSeditor@IEEE.org. *Here are our editorial deadlines for upcoming issues:*

Issue	Due Date
Quarter 4	Oct. 31, 2023
Quarter 1	Jan. 10, 2024
Quarter 2	Apr. 3, 2024
Quarter 3	June 28, 2024

Calling all Chapter Chairs

The IEEE Broadcast Technology is interested in your chapter activities, but have you ever wondered how to write a chapter report. Below are some directions that can help you get your chapter noticed.

Information for submitting Chapter Reports:

• Chapter Reports ideally should run approximately 200 to 500 words. (If a really newsworthy or unusual event is being described, we can accept slightly longer Reports, but nothing greater than 800 words.) We are looking for a summary of the event program or presentation. Please keep Reports straightforward and focused on the event. When someone is mentioned in a Report, it is very important that we receive the person's full name, title or position, organization they are affiliated with, and their connection with the story.

- Please identify all recognizable persons in your photos. We need their names, with title or position and affiliation. (Example: Mr. John Smith, vice president of consumer electronics production, Ajax Corporation.) If there is more than one person in a photo, please clearly identify everyone from left-to-right; please do not assume that we know persons depicted and will be able to fill in this blanks.

•This need for complete identification also applies to place and building names. Please make sure to provide the complete location of the event. (Don't just say the meeting took place in Smith Hall, as readers will likely not know that Smith Hall of part of the School of Engineering at Jones University.) Provide complete information about meeting venues.

• Very important—submit your Report as a straight Word file with no embedded logos, pictures, etc. Please do not send PDFs.

• Pictures are a very important part of every Report; however, they need to be good quality and tell a story; i.e., if a presentation is made at your meeting, your photograph should show the presenter standing at a podium, or at a chalkboard, etc. Group photographs are nice, but we really need at least one good photo of the lecturer making his/her presentation. Image size is very important too. An image that is acceptable on a Website is not necessarily large enough for publication in a printed magazine. Images must be at least 250 kb in size (one to two MB preferred). These must be sent as .jpg file attachments—no PDF— and PLEASE DO NOT EMBED IMAGES IN REPORTS.

• Please include answers to all of the following questions in your first paragraph: **Who** was involved? **What** happened? **Where** did it take place? **When** did it happen? **Why** (what was the reason?). Further, if the event you are describing was facilitated by an institution (university, company, etc.) that provided a meeting room, refreshments, etc.. Please include this information in every Report.

• Also, when submitting a Report, please provide complete identification about yourself, including your title or position and the name of the organization that you are affiliated with.

• Lastly, Reports must be timely. They need to be received by the **Broadcast Technology** staff no later than two to three weeks after the meeting or event took place.

If these items are not received in the required order, the Editorial Assistant will contact you for a revision. The **Broadcast Technology** editorial staff thanks you for your cooperation. We look forward to receiving and publishing your Reports. If you have any questions please send an email to btseditor@ieee.org

Visit the BTS Resource Center

BTS PULSE Events Now Available for download

IEEE Broadcast Technology Society now offers a comprehensive on line Resource Center, providing a single location to access all available virtual content. The Resource Center is located on the home page of the BTS website, *resourcecenter.bts.ieee.org*. New content is added everyday.

The Resource Center houses the following virtual products by top industry experts, educators, innovators and influencer's;

- Webinars
- Podcasts
- On-demand videos
- Event presentations
- Publications
- Technical articles
- Society newsletters

Visit today resourcecenter.bts.ieee.org

IEEE Broadcast Technology Society Administrative Committee

Society Officers

President: Paul Shulins

Vice President: Samina Husain

Treasurer: Jon Montalban

Secretary: Guy Bouchard

Past President: Ralph R. Hogan Jr.

Excom Liason Jim Stenberg

Administrative Committee Members-at-Large (elected by membership for 3 year term)

2021–2023

Marta Fernandez
Wayne Luplow
James O'Neal
Marisabel Rodriguez
Robert Welle

2022–2024

C. DiLapi
P. Siebert
T. Silliman
P. Symes
Y. Wu

2023-2025

Greg Best
Guy Bouchard
David Gomez-Barquero
Jim Stenberg
Liang Zhang

Standing Committees and Representatives

5G Mag Representative
David Gomez-Barquero

Advanced Television Systems Committee (ATSC)
Yiyan Wu

AFFCE/BTS Scholarship Representative
Thomas Silliman

Awards
Peter Symes

2022 Broadband Multimedia Symposium Chair
Jon Montalban

BroadcastAsia Representative
Yiyan Wu

BTS Open Access EiC
Jian Song

Broadband Multimedia Symposium Advisor
Yiyan Wu

Committee on Man and Radiation Liason Robert Weller

Committee on Communications Policy Representative (CCP)
Wayne Luplow

VP of Conferences
Peter Siebert

Chapter Development Chair
Jim Stenberg

Distinguished Lecturer Chair
Maurizio Murroni

Education Chair
Rafael Sotelo

Future Directions Representative
Samina Husain

Fellows Chair
Dr. Liang Zhang

Young Professionals Committee Chairs
Marta Fernandez

Historian
James E. O'Neal

IEEE International Committee on Electromagnetic Safety (ICE) Rep
Robert Weller

Nominations and Appointments Chair
Ralph R. Hogan Jr.

Marketing Chair
Samina Husain

ITU Standards Rep
Shuji Hirakawa

IBC Representatives Board
William. T. Hayes

Membership Chair
Christine DiLapi

VP of Publications
Pablo Angueira

RadioDNS Representative
Ralph Hogan

Sensors Council
Paul Shulins

Standards Committee Chair
S. Merrill Weiss

Strategic Planning
Greg Best

IEEE Transactions on Broadcasting Editor
Yiyan Wu

Women in Engineering Representative (WiE)
Marisabel Rodriguez-Bilardo

Broadcast Technology Publication
Editor James O'Neal

Best, Greg
gbconsulting54@gmail.com

Bouchard, Guy
Guy_Bouchard@ieee.org

DiLapi, Christine
cdilapi@allonscience.com

Fernandez, Marta
marta.fernandez@ehu.eus

Gomez_Barquero, David
dagobar@iteam.upv.es

Hayes, William T.
wt_hayes@ieee.org

Hirakawa, Shuji
shuji.hirakawa@ieee.org

Hogan, Ralph R.
rhogan@ieee.org

Husain, Samina
samina.h.husain@ieee.org

Luplow, Wayne
w.luplow@ieee.org

Murroni, Maurizio
murroni@diee.unica.it

O'Neal, James E.
BTSeditor@ieee.org
scm114@aol.com

Shulins, Paul
paulshulins@gmail.com

Siegler, Dave
david.siegler@outlook.com

Siebert, Peter
peter_siebert@ieee.org

Silliman, Thomas
tom@eriinc.com

Song, Jian
jsong@tsinghua.edu.cn

Stenberg, Jim
jim@jsengineer.com

Symes, Peter
p.d.symes@ieee.org

Weiss, S. Merrill
merrill@mwgrp.com

Weller, Robert
rweller@ieee.org

Wu, Yiyan
yiyan.wu@ieee.org

Zhang, Liang
liang.zhang.dr@ieee.org

Technical Community Program Specialist
Jennifer Barbato
Broadcast Technology Society
445 Hoes Lane
Piscataway, NJ USA 08854
tel: 732 562 3905
j.barbato@ieee.org
bt-pubs@ieee.org

Society Promotions & Marketing Program Manager
Margaux Toral
445 Hoes Lane
Piscataway, NJ 08854
tel: 732-981-3455
m.toral@ieee.org

Institute of Electrical and Electronics Engineers, Inc.
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08854-1331

BTS Business

Web Site

http://bts.ieee.org/ If you have any suggestions for our web site, please send an e-mail to: *bts@ieee.org*.

Phone Number

We have a telephone number that's dedicated for IEEE BTS business: **732-562-6061**.

IEEE Broadcast Technology, Volume 1, Number 1 (ISSN 23794682) is published quarterly by the Broadcast Technology Society of the Institute of Electrical and Electronics Engineers, Inc. Headquarters address: 3 Park Avenue, 17th Floor New York, NY 10016-5997. It is sent at a cost of $1.00 per year to each member of the Broadcast Technology Society and printed in USA. Periodicals postage paid at New York, NY and at additional mailing offices. Postmaster: Send address changes to: IEEE Broadcast Technology, IEEE, 445 Hoes Lane, Piscataway, NJ 08854.