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IEEE

Broadcast Technology Society Newsletter

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

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The Westin Alexandria Hotel will once again serve as the backdrop for the October IEEE Broadcast Symposium.

BTS Readies for Fall Broadcast Symposium

By James E. O'Neal

ALEXANDRIA, VA

The premier event for the Broadcast Technology Society event is the annual Fall IEEE Broadcast Symposium, and this year's show promises to be no exception. It brings together some of the top broadcast engineering people in the world for three days (Oct. 17–19) and provides exposure to the most cutting-edge developments in this sector.

The Symposium's organizers, co-chairs David Layer and Paul Schulins, have once again been working diligently for months to produce another top-drawer event. More than two dozen technical presentations are scheduled, along with panel discussions, tutorial sessions, and luncheon events. There are also opportunities for relaxing, socializing and networking at the end of the day, with receptions scheduled on Wednesday and Thursday evening.

"I am excited about this year's Symposium, which thanks to the hard work of our Virtual Events chair, Tom Gurley, and my co-chair Paul Shulins, will once again include an on-line "virtual" component, allowing Broadcast Technology Society members from around the world to benefit from this event," said Layer.

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President's Column

William Meintel, BTS President

As I've discussed in previous columns, the demand—or perceived demand—for spectrum is threatening the future of over-the-air television broadcasting (OTA-TV). We have been told that OTA-TV is no longer needed and that the TV spectrum should be reallocated for new and innovative technologies. I've previously given my opinion on that subject and won't repeat it here. However, this talk of spectrum requirements has gotten me to thinking about the subject of spectrum management and the relationship between spectrum management and the introduction of new technologies.

It seems that in recent years, spectrum management, at least in the United States, has come down to spectrum auctions. It's a simple concept—locate some unused or underused spectrum and auction it off to the highest bidder. This process may require relocating some incumbents to a different band and/or reducing their bandwidth requirements by using new technologies. This relocation typically is somehow paid for from the auction proceeds or possibly by the new users of the spectrum.

Spectrum auctions are politically popular as they are promoted as being a source of tremendous revenue for the government and will also allow the introduction of much needed new and innovative services to the public. In view of this, I have some questions that come to mind:

- Do spectrum auctions actually yield the advertised revenue or more importantly the actual long term value of the spectrum?
- Would a different revenue model actually yield more revenue over the long term?
- Are auctions the best path to new innovative services?
- Are auctions really spectrum management, or just a convenient way to avoid it?

As I address the first two points, let me be the first to say that spectrum auction design and results are not my area of expertise. However, from what I've read, it would seem that for various reasons previous auctions have fallen well short of expectations and future auctions may well meet the same fate. In today's economy, logic would imply that the current value of spectrum would be less than in better times.

The value to a bidder is based on their expected return on the investment, which in turn is based on the expectations of demand for the anticipated service being offered, and what customers are willing or able to pay for that service. In a down economy the customers will be fewer and their ability to pay will be less.

That said, perhaps a different model would produce more long term revenue. For example, a profit-sharing arrangement where the government/public would receive a percentage of the profit derived from the use of the spectrum. This profit sharing could take many different forms and not necessarily be just a direct cash payment to the government treasury. I expect some smart people could devise any number of acceptable concepts.

Such a scheme would lower the risk by removing the need for an initial outlay to purchase the spectrum, thereby allowing additional resources to be made available for deploying the service. Although, the initial profit to the public will be smaller, there is a potential for a steady stream of "income" that could ultimately far outstrip the one-time income from an auction.

Now to the third question—are auctions the best path to new innovative services? Given that large sums of money are required to win a spectrum auction, a reasonable assumption is that the winning bidder will be a large corporation. Since large corporations like to please their stockholders with large profits, they therefore are typically reluctant to embrace unproven technology even if it has the potential to reap a very large reward. The risk is just too great. Therefore, the likely answer to the question is no, auctions are probably not the best path to new innovative services.

The last, and I believe, most important question is—Are auctions really spectrum management or just a convenient way to avoid it?

In my opinion the answer is clear—auctions are a way to avoid the hard work of real spectrum management. Instead of auctioning off the spectrum to the highest bidder or attempting to rig it to satisfy some specific social need, it's time to do real spectrum management.

The government should be soliciting input on the important communications needs of the country, and in conjunction with all interested parties, should develop a long range plan of how to provide the needed services. This planning should consider new technology that will likely to be available when the plan is implemented. It should also challenge developers to push the limits to solve technical problems by setting a very high bar when making assumptions concerning future spectrum efficiency with the reward to the developers being product sales.

The technical planning must devise a methodology to integrate all of the various needs, avoid technical conflict while using the least amount of spectrum. This planning also needs to look not only at wireless spectrum, but must integrate it with the use of the wired services. Unlike wireless, where only a specific amount of spectrum will ever be available, the capacity of the wired infrastructure is only limited by the amount of "wire" that is deployed. Serious consideration needs to be given as to what services need to be wireless and what can be better

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From the Editor

Looking Back, Looking Forward

James E. O'Neal, BTS Newsletter Editor

Your editor attended a July ceremony at the Smithsonian's Air and Space Museum commemorating the 50th anniversary of the successful launch and activation of the Telstar One satellite. It was a joint venture between the Smithsonian and the French Embassy, as France was one of the three international players in this first effort to relay live video from one continent to another.

Part of the ceremony involved playback of a portion of the content the French sent from their Pleumeur-Bodou earth station. As it was after midnight Paris time July 12, 1962 when the demo took place, what was seen here was, in fact, not really live, but a recorded presentation. Regardless, it was a monumental occasion for communications and broadcasting people, as well as the world at large, with the planet shrinking perceptibly that evening/morning.

I was 15 years old in 1962 and just beginning a piano lesson when the historic transmission was scheduled to start. Somewhat reluctantly my teacher agreed to "pause" the lesson so that I could view the big event. We adjourned to her living room and soon had the big Emerson console warmed up. After a bit of U.S. network preamble, the scene shifted to the AT&T earth station in Andover, Maine, and within seconds we were witnessing the first video to make it across the Atlantic via satellite in real time. It was quite memorable—first a short address by a French government official advising us to relax and enjoy as we were in Paris for the nonce, and then singer Yves Montand belting out a beautiful French ballad half a world away.

The video clip shown at the Smithsonian included Montand's performance, and this was enough to immediately whisk me back to that exact moment in time 50 years ago.

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The memories from that event are still so strong it's very difficult to accept the fact that it took place half a century ago. However, one doesn't have to look far to realize that we are now living in a rather different world.

Communication via satellite is universal now—there are very few businesses, even tiny mom-and-pop gas stations in the smallest towns, that aren't linked somewhere via small aperture satellite terminals. Pass by apartment and townhouse complexes and try to find one without pizza pan-sized dishes on balconies and roof edges. For that matter, are there any new cars on the road these days that don't have telltale bumps on the roofline for concealing the very tiny antennas used for satellite-delivered radio and GPS devices?

For those who are still early in their careers—and even for persons such as myself who've been in broadcasting for decades—it's hard to imagine or think back to a time when we weren't dependent on a bank of transponders somewhere up in the sky for receiving very high quality video and audio from some distant point.

What makes the events that took place in Maine and France during the evening of July 11/12, 1962 even more significant is that it was only six years earlier that the first transatlantic undersea telephone circuits were established. Prior to that, all calls between here and Europe were carried by HF radio.

And prior to the era of communications satellites that began with Telstar, network radio and television affiliate feeds were hauled around the country via open line, coaxial cable, and microwave more or less exclusively by AT&T Long Lines (remember them?). By the early 1980s, satellite distribution completely overshadowed AT&T's operations and they petitioned the FCC to discontinue this tariffed delivery service, something that had begun more than 50 years earlier.

Satellite communications, of course, have been supplemented by fiber optic cables for some years now, but show no signs of going away.

Again, for those of us who have spent our careers in broadcasting, there have been a lot of other changes since the time that Telstar was first illuminated and that satellites made front page headlines.

In looking back, it seems that most of these changes were rather subtle in nature.

The vacuum tube was king when Telstar was placed into orbit, with many believing that transistors would never amount to much more than replacements for tubes in consumer AM radios. Speaking of AM, in 1962 it was king. Most people didn't own a set that could tune the FM band. There was little in the way of audio processing and a clear channel nighttime frequency meant no co-channel interference and listeners that frequently wrote in from halfway across the country and further.

VHF television slots were highly coveted; a UHF operation had an almost ironclad guarantee of hemorraging red ink.

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BroadcastAsia2012 Draws Record Crowd

BTS Booth Volunteers Stays Busy Throughout Show

By Yiyan Wu

BroadcastAsia2012 was held June 19–22, 2012 in Singapore. This year attendance was up by more than 10 percent from 2011, with 11,129 persons from the broadcasting, film and pro audio fields attending the event. The number of exhibitors increased also to a record breaking number of 739. This represents a 12 percent gain over the 2011 figure. The event showcased the latest developments in such areas as OTT, DVB-T2, digital media asset management and digital radio. BroadcastAsia2012 has grown to the extent that it is now firmly positioned as the leading regional event dedicated to digital multimedia and entertainment technology.

Above: The BroadcastAsia2012 BTS booth with volunteers Yuanyuan Xu, Yiyan Wu and Bo Liu

Left :The Suntec Singapore Convention Center hosted this year's BroadcastAsia event.

Below: BTS booth volunteer staffers were kept busy dispensing information and siging up new members.

The IEEE's Broadcast Technology Society was well represented at the show with a membership and information showcase run by volunteers from the BTS Shanghai chapter and local volunteers from Singapore. The BTS booth was active during the entire event, providing information, membership forms and literature about the IEEE and BTS. Seven international visitors signed up for membership at the booth, taking advantage of the special rate available for new members at trade shows. Many others took registration forms with them, indicating a strong interest in joining the IEEE and the BTS.

The show will return next year as BroadcastAsia2013 and will be located at a new venue, the Marina Bay Sands in Singapore. Event dates are June 18-21, 2012. To obtain complete information about BroadcastAsia'2013, please visit the official Website at *www.broadcast-asia.com*.

New BTS AdCom Members-at-Large Selected

In accordance with the IEEE BTS Constitution, the BTS Administrative Committee (AdCom) is composed of 15 elected voting members-at-large, five of whom are elected for three-year terms each year from the Society membership. The BTS welcomes and extends congratulations to the five members-at-large elected for the 2012–2014 term. They are David Bancroft, Tom Cox, Ralph Hogan, Marisabel Rodrigez, and Robert Surette.

David Bancroft is sole proprietor of Bancroft Technical Consulting, Reading, United Kingdom. He was previously with Thomson/Technicolor/Grass Valley, and specialized in high-speed studio interfaces, digital cinematography, digital movie postproduction and color management. His prior experience included positions in the BBC engineering group, as well as engineering and marketing positions with RCA, Ampex and BTS/Philips. In addition to being a member of the IEEE Broadcast Technology Society, he is also a Fellow of the Royal Television Society, of the SMPTE, and of the BKSTS, and is also a member of the IET. He is also an IEEE Distinguished Lecturer, specializing in professional reference monitors and in camera imaging, and is also active in these areas in SMPTE standardization work. He has produced several publications on television and movie production and postproduction. He is currently consulting to a major U.S. broadcaster on SMPTE studio reference monitor standardization, to a U.S. corporation on future technology projects, and to the U.S. government on consumer electronics techno-legal issues.

Tom Cox has been a member of the IEEE for more than 20 years and is senior vice president of engineering for Clear Channel Media and Entertainment

where he oversees the engineering and regulatory operations of more than 150 radio stations in 28 U.S. markets. Tom has worked in the radio broadcasting industry for some 35 years. He holds a Bachelor of Science in Electronics degree from Chapman College and is licensed as a registered professional electrical engineer. He is a member and past president of the Association of Federal Communications Consulting Engineers and a member of the Society of Broadcast Engineers.

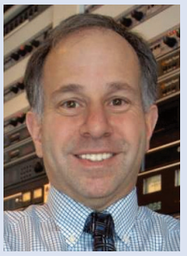
Ralph Hogan is associate general manager of engineering services at Rio Salado Colleges division of public service. He has held many nationally-recognized positions in the broadcasting field and is currently president of the Society of Broadcast Engineers. He is also the past founding president of the Association of Public Radio Engineers, a member of the National Public Radio (NPR) Distribution and Interconnect committee. He is an IEEE senior member, a member of the Society of Broadcast Engineers and that organization's national certification committee, and currently serves on the SBE's executive board. Ralph also serves as BTS education and membership chair, and in that position has overseen the development of the "Bridging the Gap" training course. He has more than 46 years in public broadcasting and received a B.S. degree in engineering science from Louisiana State University in New Orleans. He holds a FCC general class radiotelephone operator's license, and is an SBE Certified Professional Broadcast Engineer, Certified Broadcast Networking Technologist and Certified Digital Radio Broadcast Specialist.

Marisabel Rodriguez was born in Buenos Aires, Argentina and studied electronic engineering at the University of Buenos Aires, and specialized in telecommunications at the Instituto Tecnologico de Buenos Aires. She has been employed by Sun, IBM, the Buenos Aires city government, and the Ministry of Economy of Argentina, where she was in charge of networking administration and IT infrastructure. She has been with Turner Internacional Argentina since 2005, and currently serves there as senior manager of systems operation and administration for Latin America. She is also part of the Business Excellence group representing the Buenos Aires facility for Turner.

Robert Surette is director of sales engineering with Shively Labs, a division of Howell Laboratories, and has been with the company since 1981. He graduated from Lowell Technological Institute with a Bachelor of Science degree in electrical engineering. He has been directly involved with design and development of broadcast antennas, filter systems and RF transmission components since 1974, serving first as an RF engineer with the original Shively Labs in Raymond, Maine, and was later associated with Dielectric Communications. He is an IEEE senior member, an associate member of the AFCCE and a member of the SBE. He is the author of a chapter on filters and combining systems for the latest edition of the CRC Electronics Handbook and also for the ninth and tenth editions of the NAB Engineering Handbook.

Symposium continued from page 1

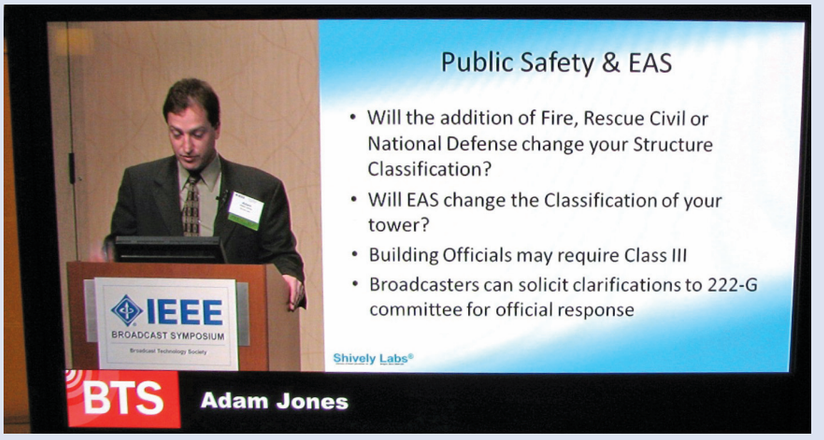
David Layer



Paul Schulins

"We have an extremely interesting and relevant three-day technical program this year and I hope to see a good turnout from the BTS membership."

"I am honored to work with David Layer and the entire symposium committee again this year to help put together an exciting and timely program that will include some of the brightest leaders in radio and television engineering," Schulins said. "I am especially proud to be able bring in some prominent presenters who will no doubt make a lasting impact on our industry, and share some important material during the symposium. I would highly encourage anybody in the radio or TV engineering field who wants to be on top of the latest advances in the state of the art to attend this year."



Last year's Symposium marked the first time the event was made available for off-site registrants. Plans are underway to stream the 2012 Symposium worldwide live via the Internet.

(A complete Symposium Schedule is located on p. 8 in this issue of the **BTS Newsletter**.)

SYMPOSIUM VENUE IS CONVENIENTLY LOCATED

The Symposium is being held again this year at the Westin Alexandria Hotel, in Alexandria, Va., and is very conveniently located for participants arriving by car, train or air. The hotel is located only minutes from the Washington Beltway (I-95 Telegraph Road North exit), and is just a short walk for those arriving via the D.C. Metro system from either Washington's National Airport or via Amtrak at Washington's Union Station. (Limited Amtrak service is available directly in Alexandria too, with the Amtrak train station also an equally short walk from the event hotel.)

Complete registration, hotel, and other information is available at the Symposium Website, *http://bts.ieee.org/broadcastsymposium.*

From the Editor continued from page 3

(For that matter most receivers couldn't tune UHF frequencies.) Another loss leader was color—just a few hours per week—mainly from NBC—and very few people wanting to spend the extra money to view these infrequent offerings.

In 1962, another comparatively new kid on the block—videotape—was also gaining ground and beginning to give film (kinescope/telecine) a run for its money. (Of course the machines were enormous, costs tens of thousands of dollars and consumed head drums at an alarming rate. Station automation was almost unheard of and computers were monstrous things that only the federal government and companies such as GM owned. On-air graphics were created in-house by artists with paint brushes and lettering sets and were rendered to air in the form of 35 mm slides and art cards. Ditto crawls and rolls—all via photographic film—no one had ever heard of a c.g.

Somewhere along the line though, the transistor gained favored status, the integrated circuit entered the workplace and the microprocessor was born and quickly became indispensable. Tape video storage was pushed out by solid-state memory. Tubes—even camera tubes and transmitter types—began to vanish.

I could go on and on, but I'm sure you get the picture.

The broadcasting industry book has been completely rewritten since Telstar was launched. We've witnessed the advent of some really marvelous technology—and it's not over by a long shot; I imagine that the next 50 years will be even more interesting and have more to offer.

I feel privileged to have been a part of this evolution and look forward to seeing what happens next in this wonderful thing called broadcasting.

IBC Show Is Not To Be Missed

By Mike Bennet

In an industry that is constantly changing and evolving, IBC provides an essential guide to the latest technologies, business models and innovations at the forefront of electronic media and entertainment. From mobile video to automated playout, stereo 3D to cloud production—whatever your interest—IBC has it covered.

Exhibits

There are 14 themed halls to browse containing the latest innovations from more than 1,300 leading manufacturers along with a wealth of free-to-attend activities and events designed to enrich your business, your knowledge, and your one-to-one relationships. Interact with more than 50,000 attendees from 160 countries who are attracted by the wealth of technological advances and strategic thinking that the IBC show uniquely offers.

Conference

Stimulating debate and sharpening strategy, the IBC conference attracts the industry's most influential and authoritative speakers. Join in this six-day program that's packed with headline-grabbing keynotes, master classes, revered technical papers, question and answer sessions, panel discussions and more. Nowhere else you can network with representatives of Microsoft, the Walt Disney Studios, Facebook, Sony, the BBC, Google and the European Commission. Only IBC combines such invigorating debate and definitive overview of the roadmaps that will govern the future of electronic media and entertainment.

IBC Connected World

The light speed penetration of Internet-connected devices and the services that run on them have huge implications for traditional media. Smart phones, games consoles, netbooks, connected TVs and tablets are making content available on-demand anywhere, and with an unprecedented degree of personalization.

Anyone looking to make sense of these changes should head for the IBC Connected World, a special area of IBC that encapsulates the very latest developments in mobile TV, 3G and 4G services with the pioneering applications and technologies that are driving content over-the-top into the home and into our future.

The Fall 2012 issue of the **BTS Newsletter** will feature highlights of this year's IBC Show.

President's Column continued from page 2

satisfied with a wired connection, including the use of hybrid systems involving both.

This should lead us to good management of a scarce resource, and improve existing services, while creating an environment for creating new and innovative solutions and services.

At the same time the technical side of the spectrum planning is moving forward, an appropriate model also needs to be developed to implement the technical plan. It needs to consider the best method to allow the public to profit from the use of the public spectrum, while at the same time allowing those who invest in the technology infrastructure to be appropriately rewarded for their investment. The model also needs to devise a licensing methodology that can allow for competition, while at the same time eliminating the use of proprietary hardware. Competition should be based on the quality of service using common devices that can be software modified. This would allow competitors to offer better or different services while at the same time using compatible equipment.

Most of this article has been devoted to the consideration of services that are directed to a large group of users. However, there are also niche needs that will require solutions as well, and these must also not be overlooked. Some may be satisfied within the context of the larger services, while other will require their own unique solution.

The process of developing and implementing this long range plan will not be easy. The guiding principle must be that it is for the overall good of the public and grounded in sound science. It will require vision as to what is technically possible, given the time frame in which it is to be implemented and strong leadership to see it through. I believe that the technical minds and other resources are available to make this happen. All it takes is the will to not take the easy, but convenient, way out and to do the right thing for the long term good.

Let the debate begin!

As society president, I welcome your input about this or any other issues affecting BTS.

Bill Meintel
President
wmeintel@ieee.org

Symposium Program

2012 IEEE BROADCAST SYMPOSIUM TECHNICAL PROGAM

WEDNESDAY, 17 OCTOBER

9 AM Tutorial – IP in Broadcasting
Session Chairs:
Rich Chernock – Triveni Digital, USA
Bob Surette – Shively Labs, USA

1) ***IP's Acronym Soup & Network Architecture: Things You Need to Know***
Pat Waddell, Joel Wilhite – Harmonic, USA
2) ***Overview of SMPTE 2022 Family of Standards***
John Mailhot – Harris, USA
3) ***Audio Distribution in an IP-based Multiplatform Broadcast Plant***
Guy Bouchard – CBC, CANADA

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4) ***IP Control in the Broadcast Facility***
Troy English – Ross Video, CANADA
5) ***Media Streaming to Small Screen Devices***
Pat Waddell, Joel Wilhite – Harmonic, USA

Video presentation – "Cell Tower Deaths"
Frontline and ProPublica (aired 5/22/12)

12:45 PM Box Lunch
Tutorial – Broadcast Towers and Protecting Your Station in an Era of Broadband Expansion
Moderator: Bill Hayes (Iowa Public TV)
Presenters: Tom Silliman and Kathy Stiler (ERI)

2 PM Tutorial – Computer Simulation Tools for Broadcast Engineering
Session Chair: Eric Wandel – Wavepoint Research, USA

1) ***Overview of Computer Simulation Tools Used in Broadcasting***
Eric Wandel – Wavepoint Research, USA
2) ***Allocation Analysis***
Bill Meintel –Meintel, Sgrignoli & Wallace, USA
3) ***Propagation Analysis***
Sid Shumate – Givens & Bell, Inc., USA
4) ***Antenna and RF Component Modeling / Optimization***
Eric Wandel – Wavepoint Research, USA

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5) ***Medium Frequency Simulation Methods***
Ben Dawson – Hatfield & Dawson Consulting Engineers, USA
6) ***Intermodulation and Other Interference Studies***
Greg Best – GB Consulting, USA
7) ***RF Radiation Hazard Predictions***
FCC Staff

6–9 PM Welcome Reception
Entertainment provided by Da Vinci Strings

THURSDAY, 18 OCTOBER

8:30 AM Welcome and Opening Remarks
Symposium Co-Chairs: David Layer – NAB, USA
Paul Shulins – Greater Media, USA

8:45 AM RF Issues and Technology
Session Chair: Greg Best – GB Consulting, USA

1) ***Facilitating Live TV in Different Scenarios Using Cellular Bonding Technology***
Natalie Chouraq – LiveU, USA
2) ***Efficient Codec Design, Internet Anomaly Correction and Embedded Cellular Technology Make Single Modem ENG Practical***
Joe Giardina – DSI/RF Systems, USA
3) ***An Update to the All-pass Diplexer: Imperfect Conditions and How to Account For Them***
Nick Paulin – ERI, USA

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4) ***FM Transmitter Considerations for Improved FM Analog/Digital Combining Systems***
Kerry Cozad – Continental Electronics, USA
5) ***Interference from Passive Intermodulation (PIM) – Keeping the Red Flag Flying***
S. Merrill Weiss – Merrill Weiss Group, USA
6) ***Spectrum Update***
Bill Meintel –Meintel, Sgrignoli & Wallace, USA

Noon Joint BTS/AFCCE Luncheon
Speaker – Kevin Gage, EVP & CTO, NAB

2 PM Mobile DTV
Session Chair: Lynn Claudy – NAB, USA

1) ***Field Evaluation of Mobile Receiver for Legacy ATSC***
Tomoaki Iwai – Pioneer America, USA
2) ***Mobile Emergency Alert System: A New Means of Alerting the Public***
Wayne Luplow – Zenith**, USA**
3) ***Conditional Access in Mobile DTV***
Art Allison – NAB, USA

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4) ***Mobile DTV Repeater Testing Results***
Victor Tawil – NAB, USA
5) ***New Audio Considerations for Mobile DTV***
Tim Carroll – Linear Acoustic, USA

6–9 PM Manufacturers Reception
Sponsored by DSI, ERI, Harris, Jampro, Myat, Nautel, Shively Labs, SPX, Stainless

FRIDAY, 19 OCTOBER

8:30 AM Audio for Radio and TV
Session Chair: James O'Neal – NewBay Media, USA

1) ***FM Stereo Transmission Using Single Sideband Suppressed Carrier (SSBSC) Modulation***
Frank Foti – Telos/Omnia, USA
2) ***Introducing IEEE 802.1 AVB for Professional Audio and Video over IP Networks***
Al Salci – Sierra, USA
3) ***Network Considerations When Implementing an Audio over IP Console/Routing System***
Kelly Parker – Wheatstone, USA

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4) ***Using the ITU BS.1770-2 and CBS Loudness Meters to Measure Loudness Controller Performance***
Bob Orban – Orban, USA
5) ***Audio Compression Codecs: Are We Squeezing the Life Out of Radio?***
Mary Ann Seidler and Herb Squire – Elenos, USA
6) ***Audio Panel***
Moderated by Paul Shulins – Greater Media, USA
Panelists: Bob Orban, Frank Foti, Tim Carroll

Noon - IEEE/BTS Awards Luncheon
Speaker – Sam Matheny, VP Policy & Innovation, Capitol Broadcasting
Sponsored by NewTek

2 PM Future of Broadcasting
Session Chair: S. Merrill Weiss, MWG, USA

1) ***FoBTV Overview***
Mark Richer – ATSC, USA
2) ***FoBTV Scenario/Use Cases***
Presenter TBD
3) ***Progress in "ATSC 3.0" the Next Generation Broadcast Television***
Jim Kutzner – PBS, USA

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4) ***Technologies for the Next Generation of Digital Terrestrial Television Broadcasting***
Shingo Asakura – NHK, JAPAN
5) ***Design of the China Digital Radio System in FM Band***
Gao Peng – SARFT, CHINA

Notes

LUNCHEONS & RECEPTIONS

WEDNESDAY, 17 OCTOBER

Box lunch

6–9 PM
Welcome Reception
Entertainment provided by Da Vinci Strings

THURSDAY, 18 OCTOBER

Joint luncheon with the Association of Federal Communications Consulting Engineers (AFCCE)

Thursday 6–9 PM
Manufacturers Reception
Sponsored by
DSI, ERI, Harris, Jampro, Myat, Nautel, Shively Labs, SPX, Stainless

FRIDAY, 19 OCTOBER

IEEE BTS awards luncheon
Sponsored by
NewTek
BE EMPOWERED.

Coffee Breaks - 15 minutes
At about 10:15 am and 3:00 pm

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Thursday and Friday:

WiFi PROVIDED BY

duTreil, Lundin & Rackley, Inc.

PUBLICITY BY

TVTechnology

RADIOWORLD

ARCHIVED SESSION AVAILABLE

Please visit the registration desk for information on how to access recordings of the sessions at this year's Broadcast Symposium online.

ERI ELECTRONICS RESEARCH, INC.

HARRIS

Plan to attend the 2013 IEEE Broadcast Symposium October __, 2013

Symposium Program Committee:

BTS IEEE Broadcast Technology Society

BROADCAST SYMPOSIUM

The 2012 IEEE Broadcast Symposium, presented by the IEEE Broadcast Technology Society (BTS), features technical presentations of significant, recent, and important technical topics of interest to engineers, scientists, consultants, educators, regulators, and others in the field of radio and television broadcast technology. In addition to the high quality technical papers, the Broadcast Symposium provides an excellent opportunity for attendees to discuss broadcast technology issues, ideas, and problems with their peers, manufacturers, broadcasters, and academic representatives.

REGISTRATION

Registration is required for admission to all sessions and is open to IEEE members and non-members. Those registered in advance may pick up their registration packets at the registration desk located in the lobby outside the Edison Ballroom. Paid conference registrants will receive a USB flash drive containing the conference record.

IEEE

IEEE Broadcast Technology Society

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Technical Program

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Remembering Telstar

Television went global 50 years ago

By James E. O'Neal

WASHINGTON

In today's world where pizza pan-sized satellite antennas delivering hundreds of television channels are as common as starlings on rooftops of homes, businesses, and even RVs, few recall a time when receiving video from space was just a dream.

Fifty years ago—July 11/12, 1962—that dream became a reality in a big way with the successful launch and activation of Telstar 1 and people from all nations of the earth taking notice as the United States, France and England exchanged television programs in real time for the first time.

Golden Anniversary Neglected?

Half a century tends to dull memories and little is planned in the way of commemorating this once momentous event. The French embassy, in conjunction with the Smithsonian's Air and Space Museum is planning an afternoon program, the Coalition for American Solar Manufacturing [photovoltaics powered this first transatlantic satellite video relay] sent out a commemorative press release, and the Governor of South Dakota issued an executive proclamation declaring July 23rd as "Telstar 1 Anniversary Day" [scenes from Mt. Rushmore and Custer State Park were transmitted via the new satellite 11 days after it went into service]. Aside from this, there's not much else planned to commemorate that day in 1962 when the world became a great deal smaller.

Telstar's launch was a giant news event in its day—it served as the vanguard for all wideband satellite communications that came later. The event even inspired a song that made it to the top of the pop music charts in both England and America. However, on its 50th anniversary, the bird and its launch seem to have been all but forgotten.

People working in television in the 1960s and '70s will certainly remember the significance of satellite-delivered television—the long lead-time booking of transponder access, the coordination process and setup time with the commercial carriers and the few uplink/downlink facilities in operation then (in the beginning, these were not co-located with television stations, or even network facilities), and also the great costs associated with satellite video. And when the technology was in its infancy, broadcasters used supers and announcements to make sure that viewers knew when programming was being relayed by spacecraft.

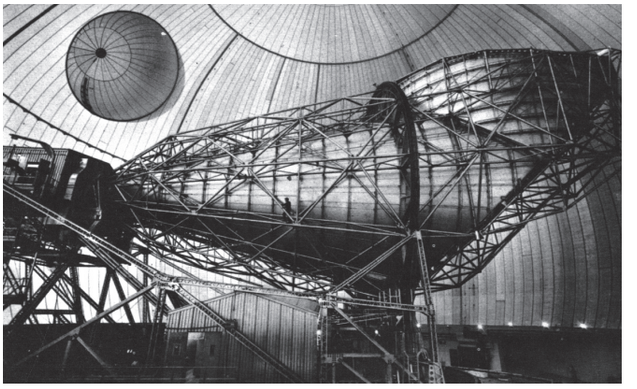
"Satellite television is just something taken for granted now," said Hal Wallace, curator of the electricity collections at the Smithsonian. "I remember watching signs on TV in the 1960s that said 'live via satellite,' and that's just not done now."

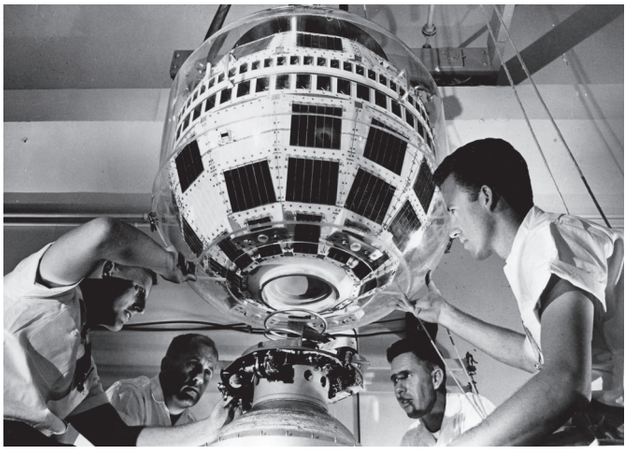
Wallace acknowledged that the Telstar 50th anniversary had even slipped by him and his department.

"We did an objects-out-of-storage exhibit recently—the theme was 1950s and '60s—and I pulled out some transistors for it," said Wallace. "There was a display board from Bell Labs showing the variety of transistors used in Telstar I, but I really wasn't aware of the anniversary coming up."

Setting the Scene

For those who don't remember, or weren't there, Telstar really was the big news item of the day. Even President





Kennedy, speaking during a scheduled press conference, lauded the efforts of thousands of scientists, engineers, and factory workers in turning a dream into reality.

"I understand that part of today's press conference is being relayed by the Telstar communications satellite to viewers across the Atlantic, and this is another indication of the extraordinary world in which we live," President Kennedy said. "This satellite must be high enough to carry messages from both sides of the world, which is, of course, a very essential requirement for peace, and I think this understanding, which will inevitably come from the speedier communications, is bound to increase the well-being and security of all people—here and those across the oceans."

At precisely 6:35 p.m. EST, all three U.S. television networks interrupted scheduled programming for a live cut-in demonstrating this incredible new capability for sending moving images across 3,500 miles of the Atlantic Ocean. France initiated the relay with an eight-minute program transmitted from its Pleumeur-Bodou earth station and featuring a musical performance by Yves Montand and Michele Arnaund, along with remarks from France's post and telecommunications minister, Jacques Tarette. (Rather ironically, the French satellite salute came via videotape, as the transmission occurred after midnight Paris time.)

"Relax, you are in Paris, I invite you to spend a few pleasant moments with me," advised Tarette, who used the event to praise French-American cooperation.

Several hours later—the French program, soon after it began, ended with loss of acquisition of Telstar—England was next to go up with a 12-minute program uplinked from its own Goonhilly Downs satellite facility. Unfortunately, a behind-the-scenes squabble mired the beginnings of this new era in communications, with the British accusing the French of breaking an EBU agreement that specified that the first Europe-to-America feed was to be a joint venture.

Regardless of the politics, millions of Americans that evening were astounded to see and hear television programming originating from across the big pond. The satellite had been launched from Cape Canaveral on July 10, with initial activation and testing of its wideband transponder capability taking place some 15 hours later on July 11. Engineers at Goonhilly Downs and Pleumeur-Bodou got their first glimpse of American video with a shot of the Stars and Stripes flying outside the U.S. earth station, accompanied by "The Star Spangled Banner."

Satellite Details

The U.S. earth station forming the nucleus of this historic relay was located in Andover, Maine, and as in the case of the U.K. and French facilities, was selected primarily for its proximity to the Atlantic in order to shorten the distance between stations and thus maximize the amount of time available for transmissions during the satellite's availability every 2.6 hours. (Telstar was not a geosynchronous bird; that didn't happen for another two years and the launch of Syncom II.)

Telstar's transponder capacity was extremely limited by today's standards—about 500 voice telephone circuits, or one TV channel, and its power output was in the neighborhood of 4 Watts, requiring huge antennas and liquid-cooled amplifiers to pull the received signal out of the noise. Once acquired, its transponder capability was only useful for about 20 minutes at a time, with signals fading into a sea of noise as the 16,000 mph satellite traveled out of range and could no longer be tracked by the earth stations.

The Telstar Legacy

AT&T put more than $50 million [close to $400 million in today's currency] into the development of the Telstar communications satellites and paid NASA an additional $4 million to launch it. Telstar was a small satellite by today's standards—less than three feet in diameter and weighing only about 170 pounds. And the first Telstar placed in orbit had an unexpectedly short life.

The day before Telstar's launch—and in an apparently uncoordinated effort—a couple of U.S. government agencies had placed a 1.4 megaton nuclear warhead into low earth orbit and detonated it as part of an experiment known as "Starfish Prime." In addition to frying street lighting systems and an inter-island telephone microwave relay in Hawaii, the resulting radiation also burned out transistors on Telstar I, taking it

Transatlantic Video Before Telstar

Once television established itself in the late '40s and early '50s, carriage of news and other special events programming quickly became a common desire of the networks. [In 1953, CBS went to great efforts to get kinescope recordings of the coronation of Queen Elizabeth II back from London and on air in the States the same day it happened, going to the extreme of chartering an airliner and stripping out most of the seats to make room for flatbed film editing stations. The program was assembled as the aircraft crossed the Atlantic.]

Prior to the launch and activation of Telstar I, the only way to get full bandwidth video across the Atlantic had been via airline delivery of videotape. Slowscan television images could be sent via existing submarine telephone circuits (which themselves were only about six years old at the time of Telstar's launch), but these left a lot to be desired in terms of entertainment value.

In the pre-satellite era, one proposal for exchanging live video back from Europe called for "orbiting" a number of aircraft at fixed stations over the Atlantic for microwave relay purposes. As one aircraft returned to base for refueling and a fresh crew, another was inserted into its position, providing an almost continuous video transmission path. Fortunately, perhaps, this idea was never put into practice. From an historical perspective, John L. Baird had succeeded in sending low-resolution video via shortwave radio from England to America in 1927. And in 1938, BBC "high definition" 405-line low-band VHF broadcasts were received in New York; however, this was due to a propagation "freak" and could not be counted upon for any sort of regular service.

The Telstar venture was the natural culmination of man's desire to view unfolding events at great distances.

James O'Neal

temporarily out of service five months after its launch, and permanently disabling it in February 1963. However, Telstar did fulfill the dream of its Bell Labs designers, ushering into existence the era of live television from anywhere on the planet (and later from the moon and other parts of the solar system).

*This article was reprinted with permission from **TV Technology** magazine

Upcoming Events

of Interest to BTS Members

- **Oct. 17–19, 2012** – IEEE BTS Annual Broadcast Symposium; Alexandria, Va.
- **Oct. 22–25, 2012** – SMPTE Annual Technical Conference and Exhibition; Hollywood, Calif.
- **Oct. 23, 2012** – Society of Broadcast Engineers National Meeting; Denver, Colo.
- **Oct. 26–29, 2012** – Audio Engineering Society Conference and Exhibition; San Francisco, Calif.
- **Jan. 8–11, 2013** – Consumer Electronics Show (CES); Las Vegas, Nev.
- **Feb. 18–22, 2013** – Hollywood Post Alliance (HPA) Technology Retreat; Indian Wells, Calif.
- **Apr. 6–11, 2013** – NAB Show and Exhibition; Las Vegas, Nev.
- **June 13–15, 2013** – AES Convention; Denver, Colo.
- **June 18–21, 2013** – BroadcastAsia; Singapore
- **Sept. 12–17, 2013** – IBC 2013 conference and exhibition; Amsterdam, Netherlands

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 **BTS Newsletter** editor at *BTSeditor@ieee.org*.

Maximizing Payload Efficiency of Digital Television Broadcasting

By Oded Bendov

Introduction

For broadcast DTV, payload efficiency should relate the available and potential payloads throughout the designated service area. Ideally, the same high payload would be available to all viewers regardless of location. However, delivery of high and equal payload to everyone is not possible with a single transmitter[6]. In addition to multiple transmitters, maximizing the payload requires hierarchical modulation and diversity reception.

This paper has two objectives: First, to provide a definition of payload efficiency and second, to show how payload can be maximized. Hierarchical modulation that supports a variable payload rather than a modulation that supports only one fixed payload attains the highest payload efficiency which can be further maximized with diversity transmission and a single receive antenna.

Payload (Net Channel Capacity) Limits for a Single-Transmitter/Single-Receiver Link

A digital channel's payload is the net deliverable information data rate, exclusive of channel coding and overhead. For an errorless channel, the maximum rate is a constant that depends on the modulation format and is independent of the CNR at the receiver. In Fig. 1, the maximum data rates for errorless channels with M-ary modulation are the straight lines at the right of the plot area. For example, the maximum rate [equation (3) below] for 16-PAM [256 QAM] modulation is 48 Mbps for a 6 MHz-wide channel.

For an AWGN channel, the maximum theoretical payload is limited by the available SNR at the output of the decoder. Shannon's payload limit for a single-receiver/single-transmitter link (Fig. 1) is independent of any modulation and channel coding. It is the maximum theoretical payload reachable by some optimum combination of modulation and channel coding. No known combination of modulation and channel coding reaches Shannon's payload limit. The gap between the available payload and Shannon's limit is the Modulation Efficiency Gap (MEG). The gap, about 5 dB in an AWGN channel, represents the difference between the Threshold SNR (TSNR) required for DTV decoding with BER not exceeding a fixed limit, and Shannon's SNR for the same payload. The maximum available SNR for a 6 MHz DTV broadcast channel is the SNR at the output of the DTV transmitter, typically about 30 dB.

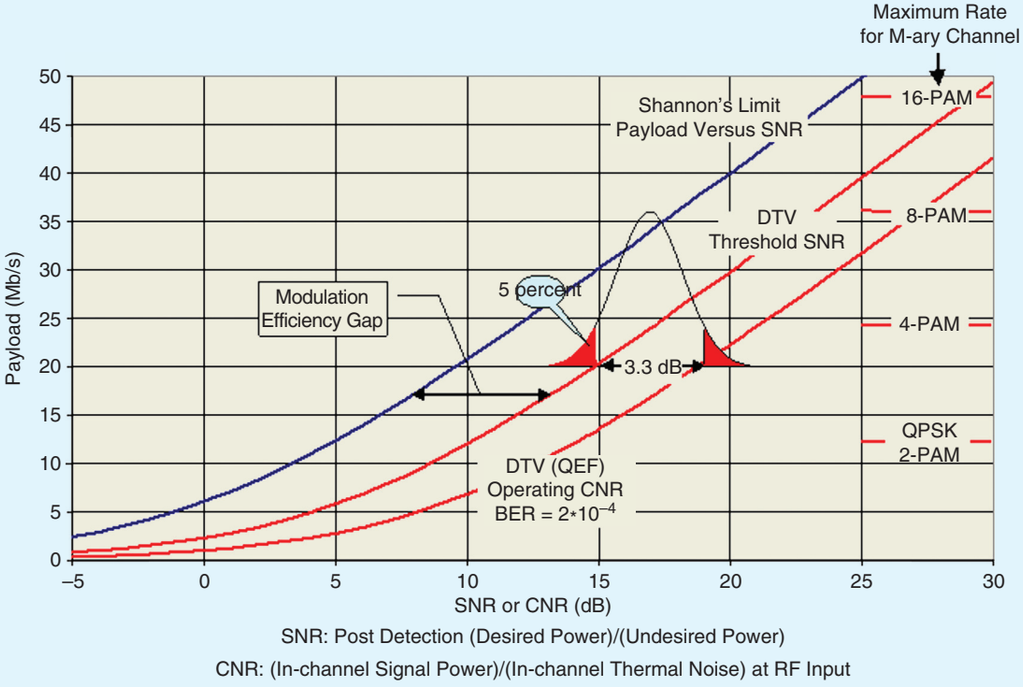


Figure 1. DTV and Shannon Payloads for 6 MHz Channel DTV Operating: Static Rayleigh channel with CNR Std. Dev = 1 dB Shannon and DTV Threshold: AWGN channel.

The MEG of the TSNR and the operating CNR of DTV (Fig. 1) are compliant with ATSC 8-VSB, DVB-T, DVB-T2. The TSNR for AWGN channel, 6 MHz wide, can be derived from:

$$\text{Payload} = 6\,\text{Log}_2(1 + SNR * K) \quad K \leq 1 \tag{1}$$

where K = the power penalty due to modulation and channel coding. For $K = 1$ the payload is Shannon's limit which holds for Payloads < Maximum rate. With diversity configuration using multiple antennas, $K > 1$ is possible and the payload limit would exceed Shannon's, which is strictly for a single-transmitter/single-receiver link. (Transmission/reception diversity for DTV broadcasting is introduced below.)

Estimating the operating CNR depends on the propagation model and field measurements. In practice, DTV channels are not AWGN. For a static Rayleigh channel without 0 dB echoes, the operating CNR (Fig. 1) plotted from DVB-T/T2 measured data[1,2] for BER $= 2 * 10^{-4}$ [Quasi-Error-Free (QEF)] scaled to 6 MHz channel. This CNR is consistent with field measurements of ATSC-8VSB. Assuming Normal distribution of CNR and a standard deviation of 1 dB, 90 percent of the operating CNR will be within 3.3 dB of the Threshold CNR.

Payload Efficiency of DTV Broadcasting

The average Shannon payload over the range $\Delta SNR = SNR_{max} - SNR_{min}$ (SNR not in dBs) in an AWGN channel is:

$$\langle P_S \rangle = \frac{W/\text{Log}_{10}2}{\Delta SNR} \int_{\Delta SNR} \text{Log}_{10}(1 + SNR)\, d(SNR)$$

$$= \frac{W}{\Delta SNR}\left[\frac{1 + SNR}{\text{Log}_{10}2}\text{Log}_{10}(1 + SNR) - \frac{SNR}{Ln2}\right]_{\Delta SNR} \tag{2}$$

where W is the channel's bandwidth and $W * \log_{10}(1 + SNR)/\text{Log}_{10}2$ is Shannon's maximum payload. Shannon's limit holds as long as $P_S < R$, where R is the maximum data rate possible for an M-ary errorless channel:

$$R \leq (2W/\text{Log}_2 10)\,\text{Log}_{10}M \tag{3}$$

The payload efficiency of DTV, at a specified or lower BER, is the fraction of the available average DTV payload relative to maximum average available payload, over a common SNR range within service area:

$$\eta = \frac{< P_{DTV} >}{< P_S >} \leq 1 \text{ for } SNR \leq \left[10^{\frac{R * \text{Log}_{10}2}{W}} - 1\right]$$

$$\eta = \frac{< P_{DTV} >}{R} \leq 1 \text{ for } SNR > \left[10^{\frac{R * \text{Log}_{10}2}{W}} - 1\right] \tag{4}$$

Payload Efficiency of Fixed Payload Modulation

Consider a 20 Mbps fixed payload delivered by 8-PAM modulation (64-QAM, Fig. 2). If the SNR of the decoded DTV is above its 15 dB TSNR, the payload would be delivered with BER at or below the maximum specified BER.

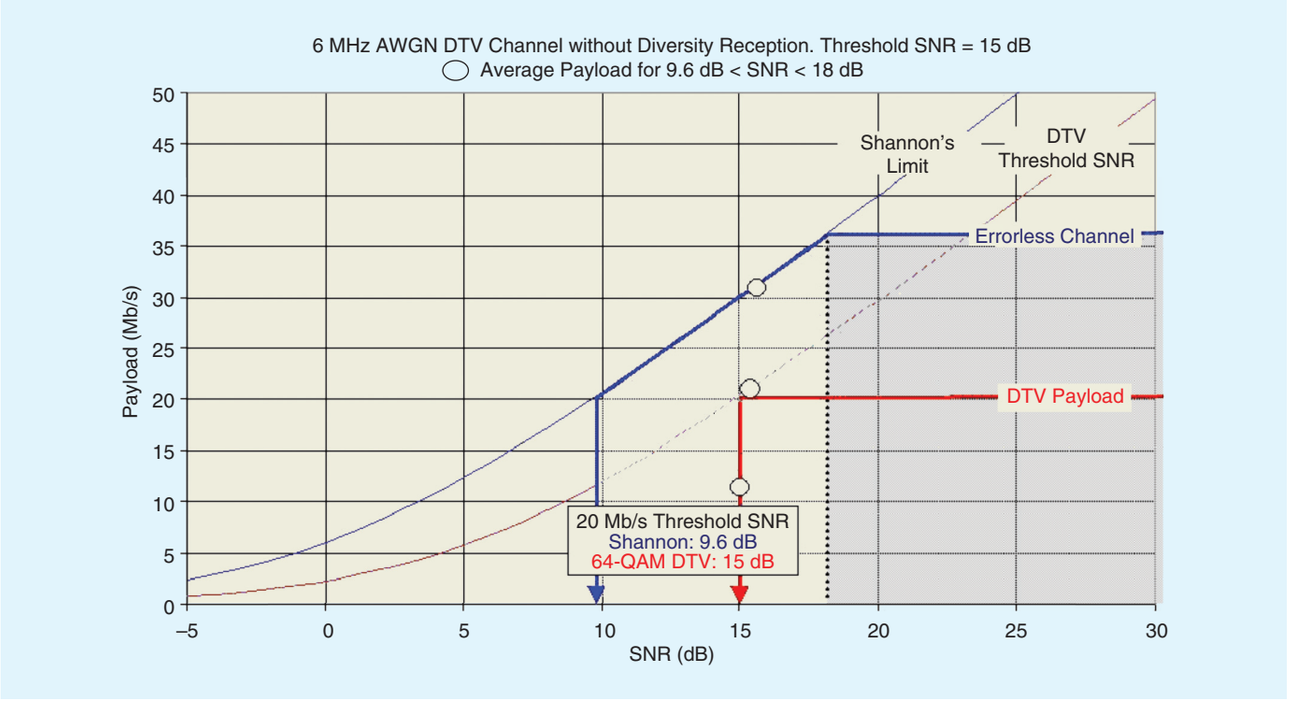


Figure 2. Calculation of Payload Efficiency of Fixed 20 Mbits/sec 8-PAM Modulation.

There are two regions of payload efficiencies, separated by $SNR = 18$ dB. Where $SNR > 18$ dB, the maximum payload for 8-PAM, errorless 6 MHz channel, is 36 Mbits/sec. Thus, where $SNR > 18$ dB the payload efficiency is $\eta = 20/36 = 0.56$. The regions where $SNR > 18$ dB typically encompass suburban areas whereas locations with $SNR \leq 18$ dB typically encompass indoors, hand-held devices and rural areas. However, low SNR due to interference and multipath is common everywhere.

The lower bound SNR = 9.6 dB is Shannon's minimum SNR for the desired 20 Mbps payload. For the fixed payload of 20 Mbps, the average payloads and their efficiencies, evaluated with equation (2) and (4), are:

$$\langle P_S \rangle = 30.4 \text{ Mbps} \quad \langle P_{DTV} \rangle = 11.7 \text{ Mbps}$$
$$\eta = 0.38 \quad 9.6 \text{ dB} < SNR \leq 18 \text{ dB}$$
$$R = 36 \text{ Mbps} \quad \langle P_{DTV} \rangle = 20 \text{ Mbps}$$
$$\eta = 0.56 \quad 18 \text{ dB} < SNR \leq SNR_{Tx}$$

The average payload over the SNR range from 9.6–18 dB is 30.4 for Shannon's limit, and 20.6 Mbps TSNR. For a hypothetical DTV with continuous variable modulation and $SNR_{min} = 9.6$ dB that follows the TSNR curve, the payload efficiency would increase from $\eta = 0.38$ to $\eta = 0.68$. In the region $18 < SNR \leq 30$ the efficiency would increase from $\eta = 0.56$ to $\eta = 25.6/36 = 0.72$. This higher efficiency shows that hierarchical modulation results in higher payload efficiency.

Practical Low SNR Limit for DTV in 6 MHz Channel

As shown in Fig. 2, a fixed 20 Mbps DTV payload with TSNR = 15 dB exhibits low efficiency over a limited service area. With hierarchical modulation and lower TSNR, a robust service to wider segment of the public is possible. There are practical limits to the lowest TSNR for DTV.

Fig. 3 (adapted from Fig. 1) shows that negative operating CNR or SNR for payloads above 1 Mbps is impractical. Further, increasing the DTV payload through ideal diversity is difficult at low operating SNR (see Sec. VII). This assessment contradicts a prediction[3] that 2.5 to 3 Mbps can be delivered at SNRs of –2 to –4 dB. In reality, delivery of 2.5 to 3 Mbps with subpar diversity would require operating SNR > 4 dB. Thus, Shannon's law cannot be used as a measure of payload vs. SNR because it is unattainable for all known DTV modulations with error correction schemes.

In addition to setting a practical limit for the lowest operating CNR/SNR, the maximum allowable BER must also be set. An acceptable level for DTV is $BER = 2 * 10^{-4}$ (Fig. 4). The four curves in show the upper bounds[4] of BER of uncoded MQAM in an AWGN channel, given by:

$$BER \leq 0.2e^{-1.5SNR/(M-1)} \tag{5}$$

With channel coding, improved SNR (coding gain) is possible when the allowable BER is sufficiently low. As shown in Fig. 4, the higher the SNR, the higher the potential for coding gain of up to 10 dB. However, codes designed for high-SNR can have negative gains at low SNRs[5]. In Fig. 4, each vertical line, capped at $BER = 10^{-1}$ above which no gain is expected, represents the maximum potential coding gain for each MQAM.

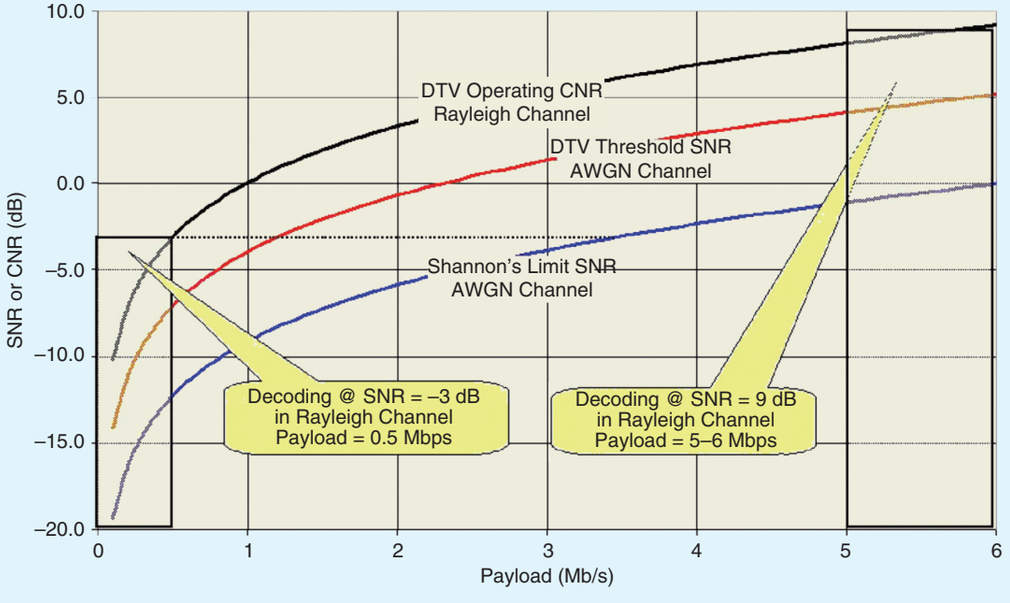


Figure 3. Payload with Low SNR in Noisy Channels.

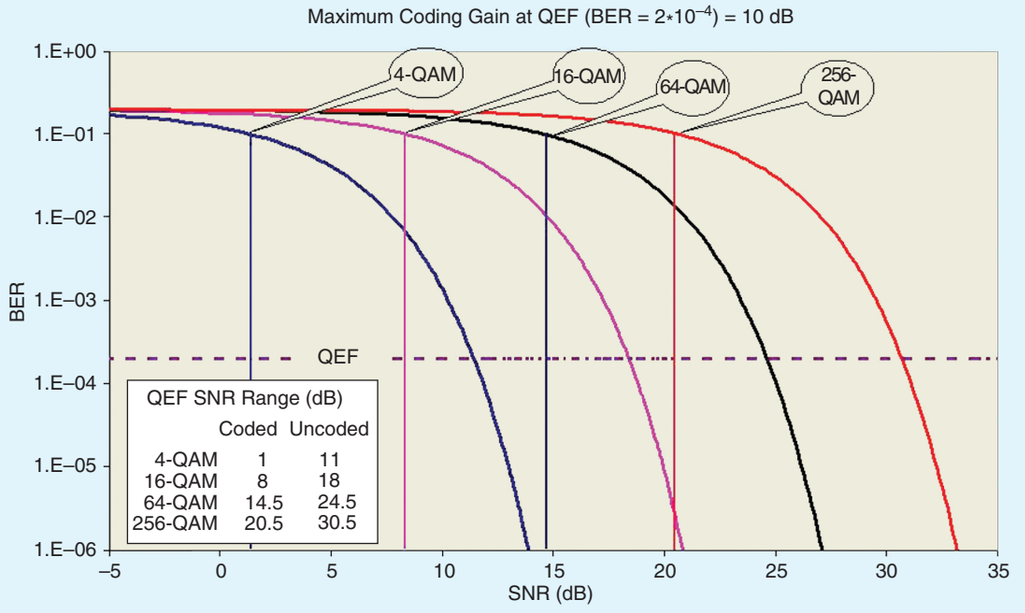


Figure 4. Upper/Lower BER Bounds for Uncoded/Coded QAM.

Payload Efficiency of 4-QAM to 256-QAM Hierarchical Modulation

A conceptual example of a four-level hierarchical modulation with payloads from 5 Mbps to 37 Mbps at an estimated QEF performance is shown in Fig. 5.

Following the methodology developed in Section IV, the payload efficiency is

$$\langle P_S \rangle = 39.7 \text{ Mbps} \quad \langle P_{DTV} \rangle = 21.8 \text{ Mbps}$$
$$\eta = 0.55 \quad 4.0 \text{ dB} < SNR \leq 24 \text{ dB}$$
$$R = 48 \text{ Mbps} \quad \langle P_{DTV} \rangle = 37 \text{ Mbps}$$
$$\eta = 0.77 \quad 24 \text{ dB} < SNR \leq SNR_{Tx}$$

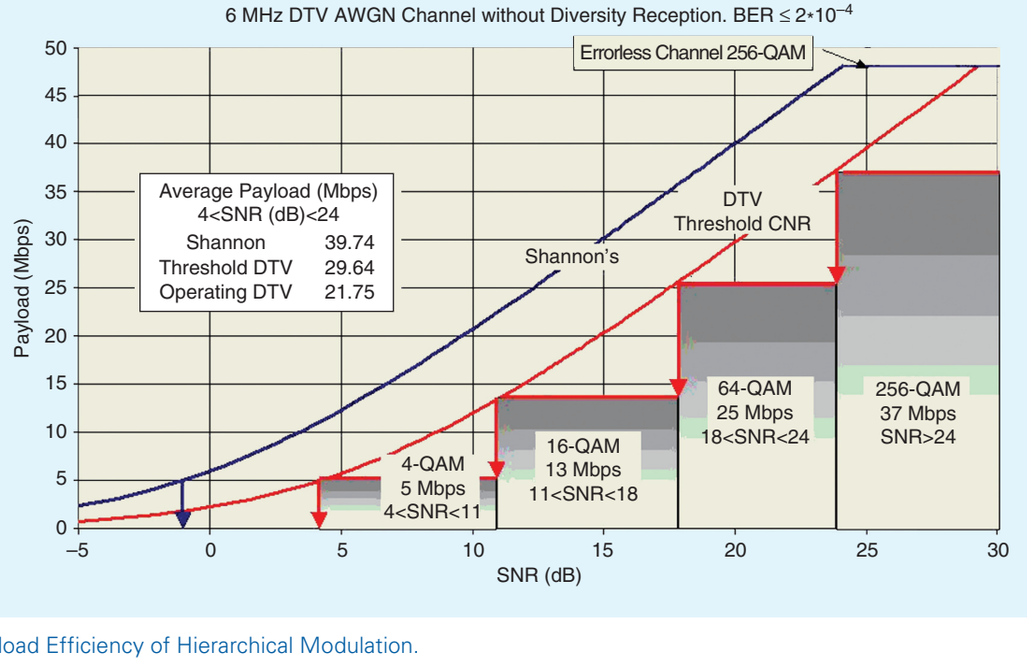


Figure 5. Payload Efficiency of Hierarchical Modulation.

The payload efficiency of hierarchical modulation is much higher than that of a single-level modulation with fixed payload. The range of SNR over which decoding is possible is also much wider, starting as low as TSNR = 4 dB. Consequently, DTV service would become available to far more receivers.

The highest post-detection SNR cannot exceed the transmitter's SNR. For high-power DTV transmitters, that radiated SNR is about 30 dB. Increasing the transmitter's radiated power increases the CNR, providing a higher power margin for signal processing, and thus raising the likelihood that the post-detection SNR will be above threshold. Nevertheless, the transmitted power is limited by the authorized Effective Radiated Power (ERP). Therefore, improving the payload and robustness of DTV links must rely on multiple transmitter network[6] and diversity transmission.

Maximizing the Payload Through Diversity in AWGN Channels

Numerous diversity transmission and reception schemes[7,8] have been proposed to improve the payload and reception reliability via multiple and independent (decorrelated) receiving antennas. Notable are spatial multiplexing of two independent data streams (MIMO) and maximal SNR combining of two identical data streams from two independent receivers (MRC). Both techniques require that the receiver's antennas be sufficiently separated, typically by $\geq 0.5\ \lambda$.

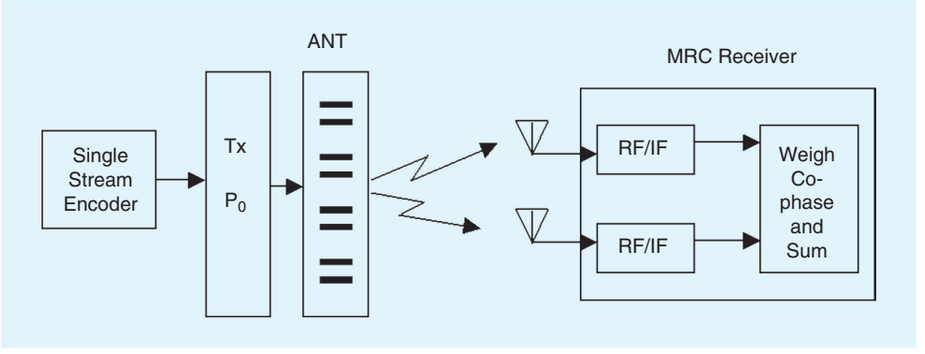


Figure 6. Maximal SNR Combing: Single Stream; One TX Antenna; Two Rx Antennas.

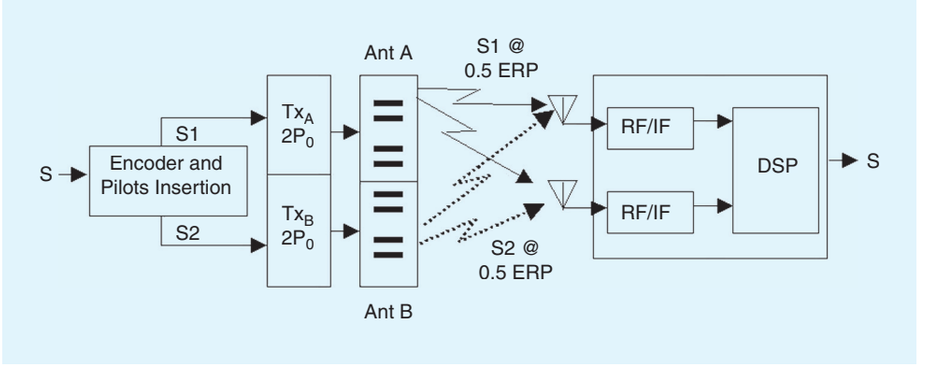


Figure 7. Spatial Multiplexing of Two Independent Streams S1 & S2.

Theoretically, and assuming an AWGN DTV channel, MRC has the advantage at low SNR and MIMO at high SNR. But for consumer-grade DTV receivers, a two-receive antenna system, with the antennas separated by ≥10-inches for UHF reception and ≥30-inches for Hi-VHF (174–216 MHz), is impractical. Fortunately, a recent diversity scheme using a single receive antenna[9] has been proposed (see part **c**).

a. MRC

Fig. 6 shows a typical 1 × 2 MRC configuration. Ideally, the two received signals, A_1 and A_2, are co-phased and weighted by b_1 and b_2 such that:

$$SNR = \left[\sum_{i=1}^{2} b_i A_i\right]^2 \Big/ N\sum_{i=1}^{2} b_i^2 \qquad (6)$$

where N is the noise power.

When $b_1A_1 = b_2A_2$ the SNR doubles (+3 dB) and the payload relative to equation (1) is:

$$\text{Payload}_{MRC} = 6\text{Log}_2(1 + 2 * SNR * K) \qquad (7)$$

where the SNR is given by (6).

b. MIMO

Fig. 7 shows a typical 2 × 2 MIMO configuration. The data stream S is split into two, S1 and S2. Each stream is separately encoded with unique ID and pilots, and then transmitted from independent transmitters and antennas. At the receiver, the digital signal processor combines the two streams. In essence, this scheme is a two-channel, four-port, (space) multiplexer, with each channel's payload maximized subject to Shannon's law.

Assuming that the transmitting antenna, being aperture/gain limited, is split into two halves, each transmitter's output power must double ($2P_0$) in order to maintain the maximum allowable ERP.

Assuming the same SNR for all branches of the multiplexer, the payload relative to equation (1) is:

$$\text{Payload}_{MRC} = 2 * 6\text{Log}_2(1 + SNR * K/2) \qquad (8)$$

Fig. 8 shows the improved payloads of the 1 × 2 MRC and 2 × 2 MIMO diversity schemes relative to the single-transmitter/single-receiver (1 × 1) DTV and Shannon links and b) that below

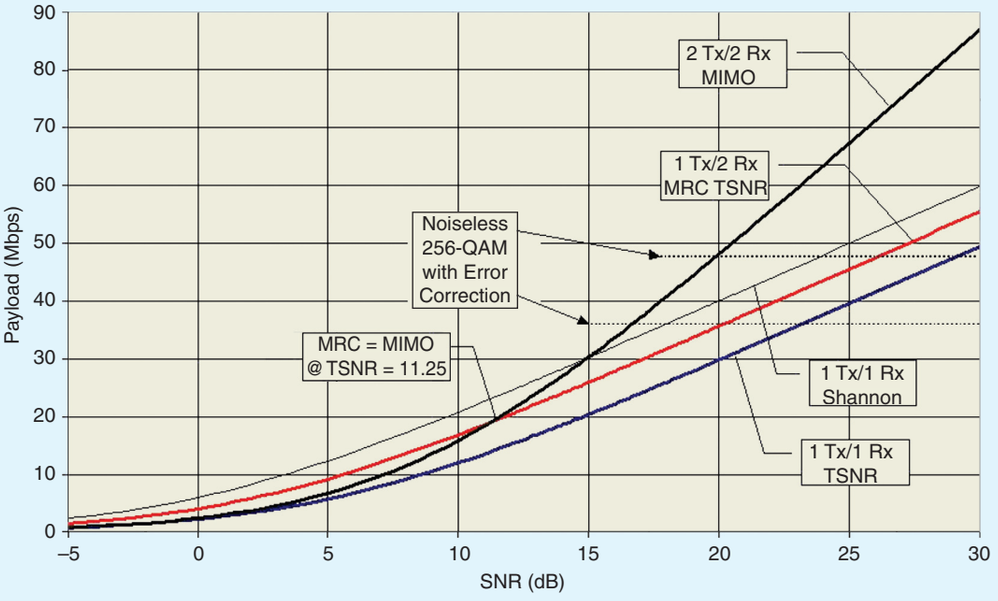


Figure 8. Maximizing the Payload of DTV Through Diversity.

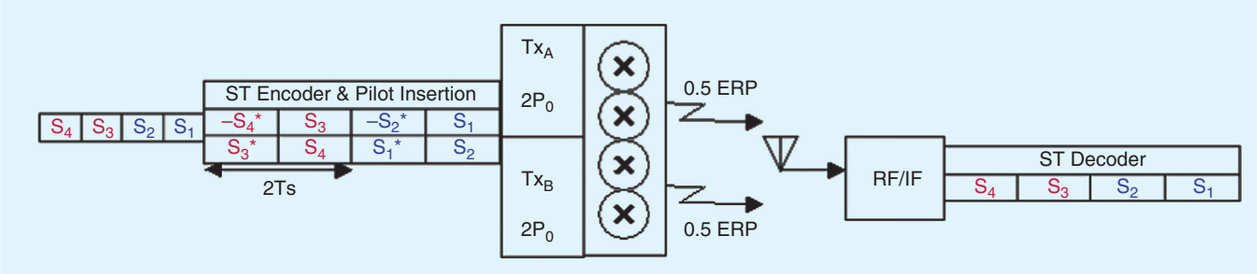


Figure 9. Alamouti's Diversity Scheme.

SNR = 11.25 dB the 2 × 2 MIMO is inferior to the 1 × 2 MRC. Thus MIMO is useless for DTV broadcasting with hierarchical modulation or low TSNR. In any case, diversity based on two independent receive antennas is impractical for consumer-grade DTV receivers. Fig. 8 also indicates that a payload as low as 8 Mbps at SNR = 4 and up to 37 Mbps where SNR ≥ 18 dB would be possible with 1 × 2 MRC ideal diversity reception and 256 QAM hierarchical modulation.

c. Alamouti's Scheme[9]

Fig. 9 shows the two-transmitters/single-receiver diversity scheme (aka Alamouti's). It is based on space-time (ST) encoding two successive symbol periods ($2T_S$). During the first of two symbol periods, two successive symbols, s_1 and s_2, are transmitted, from antennas A and B. During the next symbol period, **s2*** is transmitted from antenna A and **–s2*** from antenna B[1].

[1]s* is the complex conjugate of s.

The suggested separation between the centers of the two transmitting antennas is ≥10 λ, eminently feasible for DTV broadcasting. The 2 × 1 Alamouti's scheme exhibits the same diversity enhancement as that of the 1 × 2 MRC scheme shown in Fig. 8. It is the best diversity scheme for broadcast DTV.

Conclusions

Future DTV broadcasting will have to be spectrally efficient, payload efficient, and provide robust reception to hand-held devices indoors. An earlier paper[6] demonstrated that a network of transmitters is required to deliver high payload throughout the service area. In this paper payload efficiency is defined and it is shown that the highest efficiency is attained with hierarchical modulation. Lastly, this paper shows that MIMO technology is impractical for TV channels and that the best diversity scheme for DTV reception is Alamouti's, with a single receiving antenna.

Ideally, the diversity transmitting antennas would be circularly polarized, as the total ERP would double for circular

continued on page 21

Chronicling HDTV's History

An IEEE associate member dedicates his time to documenting the history of high-definition television

By Philip J. Cianci

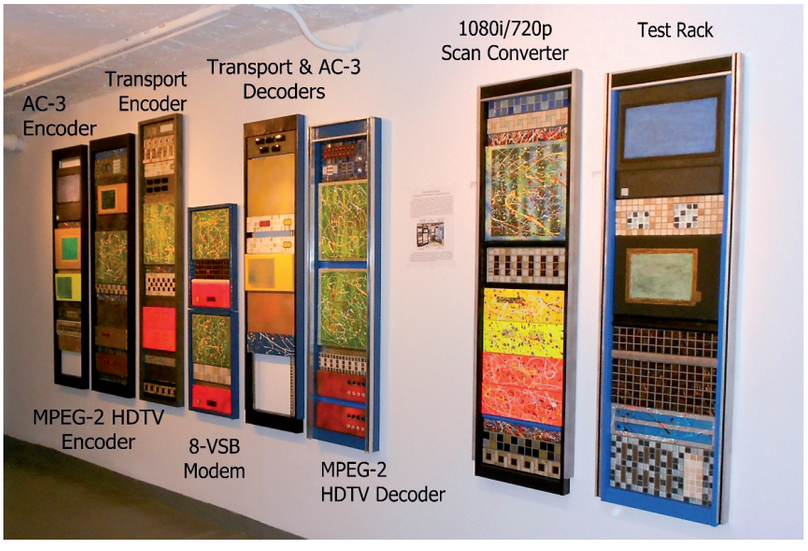
This is the first in a series of guest blog posts submitted by IEEE members about their technical interests, career experiences, and personal stories. Philip J. Cianci is an IEEE associate member who has spent more than two decades documenting the evolution of HDTV through photographs, paintings, and stories. If you're interested in submitting your story, e-mail the editors at institute@ieee.org.

On a sunny June day in 1984, I found paradise in Briarcliff Manor, N.Y., 30 miles up the Hudson River from the Big Apple, when I arrived for an interview at the Holland-based Philips' U.S. research laboratory. Within a year of my hiring, I found myself at the center of the rapidly intensifying HDTV storm. Philips' U.S. Labs had just begun work on Advanced Television Systems (ATV) and in 1985 our first high definition prototype was designed and fabricated. My contribution to this augmentation channel, NTSC-compatible system, was developing code for the Intel 8088 microprocessor-based image processing circuits.

In the late 1980s I began to photograph everyday activities at the labs—equipment racks, my colleagues at work, and the country club-like grounds. The photos became the subject matter for creative experiments—using oil paint and multiple mediums applied to various surfaces, including printed circuit boards—chronicling daily activity in HDTV R&D. These were among the first systems designed and built in the United States, shortly before the Advisory Committee on Advanced Television Services was created by the FCC and the ATV standardization process began. My first painting, done on a surplus PCB, was of our next HDTV prototype. In time I began to write paragraphs and short stories, recording what I considered interesting and noteworthy observations and events about the HDTV saga as it unfolded.

As Philips Labs' efforts to develop the next generation of television technology intensified, so did my creative output. While designing digital matrix and tri-level sync circuits, my painting became more ambitious, my writing more elaborate, and now covered not only Philips Labs' efforts, but also our collaboration with other companies whose efforts culminated in the design, construction, and delivery of the Grand Alliance digital HDTV prototype to the Advanced Television Technology Center (ATTC), in Alexandria, Va. It was at that moment that I resolved to write an eye-witness account, and memorialize what it was like to participate in the HDTV engineering effort that digitally melded broadcast engineering with computer science and information technology.

Not content with leaving my paintings about HDTV history in storage, my next newsletter sent to my art patrons featured a painting of the Grand Alliance HDTV prototype strategically placed on the outside of the mailer, and it was also sent to Sarnoff Research Institute. The flyer eventually wound up in the hands of Dr. Alex Magoun, curator of the David Sarnoff Library at SRI who arranged the purchase of a number of my HDTV history paintings for the company's library. A short time later, I was referred to Dr. Bernard Finn, then curator of the Smithsonian Institution's electricity collections, and I began to contribute materials relating to the development of HDTV. These included written personal recollections, technical reports, system drawings, and a T-shirt commemorating the shipment of the Advanced Television Research Consortium's AD-HDTV system to the ATTC for testing. (The rest of this tale is told in Dr. Finn's forward in my book)



As fate would have it, I joined the engineering effort at the sports channel ESPN in 2003 during construction of the 120 000 square foot all-HD Digital Center, then (and possibly still) the most ambitious file-based HD television production facility in the world. While working there as a broadcast media technology engineer, in 2006 I made an effort to find a publisher for my manuscript detailing the history of HDTV technology. Focal Press passed on the proposal, but I did author

continued on page 23

Adcom Group Selects Symposium Papers

CHICAGO

Twelve BTS Adcom members met on Tuesday, June 12 at the Hilton Chicago O'Hare hotel to evaluate abstracts received during the call for papers for the IEEE BTS annual Fall Broadcast Symposium. Three other group members participated in the proceedings via telephone.

Prior to the all-day paper selection meeting, Adcom members assembled for a group dinner held at the hotel on Monday evening and were presented with an opportunity to socialize and also meet the new BTS administrator, Amy Reeder, who helped organize the Chicago meeting.

Symposium co-chairs, David Layer and Paul Schulins, presented the group with a large number of abstracts which were finally narrowed down to 24 by the end of the day. In addition, plans were made for the two half-day tutorial sessions to be held in conjunction with the Symposium

Other items of business included the naming of tentative candidates for Symposium luncheon, event sponsorship opportunities, and a discussion of plans for making the Symposium proceedings available via the Internet to both IEEE members and non-members who are unable to attend the Alexandria, Va. event in person.

In addition to Messrs. Layer and Schulins, the following Adcom members also participated in the paper selection session: Greg Best, Tom Gurley, Bill Hayes, Bill Meintel, James O'Neal, Tom Silliman, Bob Surette, Eric Wandell, Merrill Weiss, and Ed Williams. Telephone participants included Rich Chernock, Ben Dawson, and James Fang.

A complete listing of the papers selected and information on the half-day tutorials is presented elsewhere in this Newsletter.

IEEE BTS Adcom members (l-r) James O'Neal, Bill Hayes, Ed Williams, Tom Silliman, Merrill Weiss, Bob Surette, David Layer, Paul Schulins, Tom Gurley, Eric Wandell, Bill Meintel, and Greg Best

Maximizing Payload continued from page 19

polarization thus providing stronger signal with fewer multipath-induced notches in its spectrum.

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Chapter Reports

Dr. Hsiao-Chun Wu Addresses PCJS BT Chapter on Digital Image Watermarking

BTS Distinguished Lecturer, Hsiao-Chun Wu, visited the PCJS BT chapter on May 30, 2012 and presented a lecture on "New Optimal Signal Embedding Techniques for Digital Images and Digital Television Identification. The meeting was held at Bell Labs in Murray Hill, N.J. with 17 IEEE members present, along with guests and Bell Labs employees.

In his presentation, Dr. Wu explained that copyrighted digital media can be watermarked so that the ownership of a particular piece of work can be easily traced. He explained, however, there are trade-offs in watermarking an image or program. The ultimate watermark is one that can't be seen by ordinary viewers, but is robust enough to survive transmission through a storage medium, over the Internet or via a digital broadcast. He said that digital watermarking techniques had been investigated and an optimal scheme was proposed—one that maintains a high signal-to-noise ratio for both the subject program material and the watermark itself. Simulations were presented that demonstrated the effectiveness of these new proposed watermarks and showed the results of various watermark embedding techniques. Some of these were not noticeable at all.

Later in his presentation, Dr. Wu discussed "Steganalysis," the analysis technique used to determine the presence of watermarks.

A lengthy discussion followed the presentation, focusing on the watermarking capacity in an image. Questions were raised on appropriate constraints to be use and what video parameters are the most important to maximize. It was noted that images are not the only objects that can be embedded as watermarking material; data can also be embedded. For example, embedding a data watermark could allow a video file to be automatically routed to a storage server across the Internet as a means for achieving seamless automatic file distribution.

The lecturer observed that continuing research in digital watermarking will zero in on computing the watermarking capacity of an image and increasing the effectiveness of the watermark detector on the decoding end to make it is more immune to statistical variations in the images.

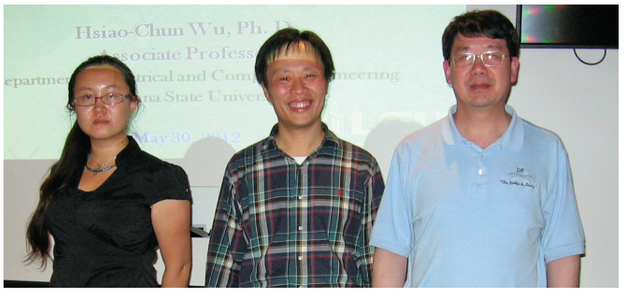
The IEEE PCJS BT chapter wished to once again extend its thanks to Bell Labs for hosting this meeting and offers special thanks to Dr. Hsaio-Chun Wu for traveling to New Jersey from Louisiana under the BTS distinguished lecturer program.

Submitted by Joe Stack, BT Chapter Chair

As part of his presentation on signal embedding techniques for digital images, BTS Distinguished Lecturer Dr. Hsiao-Chun Wu asks his audience to try and find the watermark.

Some17 IEEE members, Bell Labs employees, and invited guests attended the May 30 PCJS BT chapter meeting.

Dr. Wu invited audience participation and interaction during his presentation.



Graduate student and Intern Hongting Zhang and Dr. Hsiao-Chun Wu pose with Hong Jiang of Bell Labs after Dr. Wu's presentation.

Argentina BTS Activities

BUENOS AIRES

Dr. Tapan K. Sarkar, a professor at the College of Engineering and Computer Science at Syracuse University, visited the University of Buenos Aires May 14–16 to present several talks and seminars for BTS members and others at the school. His first seminar, conducted on May 14, was entitled "Who Is the Father of Electrical Engineering?" Another presentation took place on May 16 at the school and dealt with "smart antennas." This session—"An Exposition of the Choice of the Proper S-Parameters in Characterizing Devices, Including Transmission Lines with Complex Reference Impedances and a General Methodology to Compute Them"—provided credits to University doctoral program students attending. Dr. Sarkar has previously presented programs on antenna and transmission line theory.

Another May BTS program featured Javier Bonini, a telecommunications engineer and lecturer at the University of Buenos Aires. He spoke at an Argentine Chamber of Information Systems and Communications event on May 30, 2012 about the customer expectations with regard to IP delivery of video. His presentation—"Measurements of Quality of Experience in Video IP Networks—Assuring the Customer Experience," covered the challenges involved in IP video delivery, as well as metrics used to assess quality.

Submitted by Marisabel Rodríguez

Chronicling HDTV's History continued from page 20

two books for them about television technology. In the first book, *HDTV and the Transition to Digital Broadcasting,* an entire chapter—"A Compressed History of HDTV"—was related to HDTV history. Undeterred, I continued to work on the manuscript and also started a website called the HDTV Archive Project, where I invited technical participants in the Saga to contribute their experiences for inclusion in the archive and my book, should one ever come to be published.

Deciding that a book on the history of HDTV technology would benefit from publication by an established company, rather than being self-published, I e-mailed a series of author's queries to potential publishers in early 2009, which led to the acceptance of my book proposal by McFarland & Company. With this vote of validity, call for contributions were graciously run in publications by IEEE, the Society of Motion Picture and Television Engineers, and the Society of Broadcast Engineers. The result of all my labors, *High Definition Television: the Creation, Development, and Implementation of HDTV Technology*, was published last January.

The book is available at online booksellers. IEEE members can order a signed copy at a 20 percent discount at my website.

My HDTV-related artwork can be seen at the Art Angler Gallery book launch and techno-artifact exhibit video.

In Memoriam

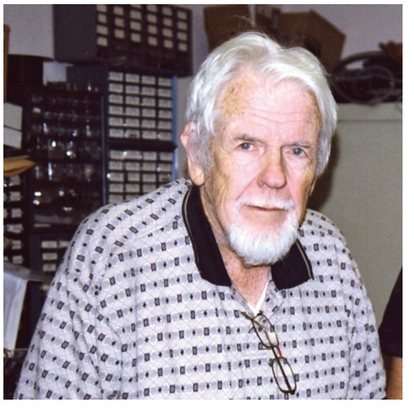
By James E. O'Neal

The broadcast engineering community lost two of its longtime and very significant members this summer with the passing of Charles E. Anderson and John H. Battison.

Charles (Charlie) Anderson died in Sparks, Nev. on July 12, 2012 at the age of 88. He spent more than 60 years in the field of broadcast engineering and will be most remembered for his contributions leading to the development of the world's first practical system for recording video in 1956. Anderson was part of the six-person Ampex Corporation team that overcame the then very significant difficulties in capturing and reproducing the very wide bandwidth video signal on magnetic tape.

Prior to the introduction of Ampex's video recorder, the only means available for preserving television images was via kinescope recordings in which a specially modified motion picture camera filmed video directly from the screen of a television monitor. Such recording technology left much to be desired due to motion artifacts, limited contrast range, film emulsion granularity, the time required for film developing, operating costs, and numerous other problems. When Ampex launched its small scale and underfunded effort to perfect a video recorder, several other groups including the BBC, RCA, and Bing Crosby Enterprises were already working on the development of such a device. However, the Ampex team's approach to capturing the 18-octave video signal differed significantly from the others with the use of a rotating head assembly to attain the necessary head-to-tape writing speed. (The other groups simply increased the linear speed of the magnetic tape relative to a fixed head, requiring very large quantities of tape for even short duration recordings.)

When Anderson joined the Ampex video recorder development team, a major unsolved problem existed in signal differences from each of the four



Charles E. Anderson

individual heads used to reproduce the magnetic tracks. Due to mechanical and electrical differences, no two heads yielded exactly the same output level or frequency response. The result was a very noticeable "banding" in the reproduced images as one head completed its scan and another began its pass across the tape. Team leader Charles Ginsburg assigned Anderson the task of developing automatic gain circuitry to cope with the signal differences. Anderson soon realized that this was not a perfect solution and suggested that an FM modulator/demodulator system be employed to replace the AM system being used at the time. Ginsburg rejected the idea, as conventional FM teachings required a fairly wide separation between the uppermost frequencies transmitted and the FM carrier frequency. Also, it was generally thought that both upper and lower sidebands created in the FM process had to be preserved. Due to the limited frequency response available then from both recording heads and tape oxide formulations, the carrier frequency and recorded spectrum would be very close together (much less than the 10:1 ratio thought necessary) and the upper FM sidebands would be lost. Nevertheless, Anderson persisted in his push to try FM and finally won out. Anderson's "voodoo" FM system worked and helped the team overcome one of the last remaining hurdles in perfecting a practical video recorder. The machine proved an instant success when it was first introduced at the 1956 National Association of Radio and Television Broadcasters (now NAB) convention in Chicago and the Ampex technology served as the foundation for all other videotape recorders developed.

Anderson remained with Ampex for some 30 years, retiring in 1984. He continued work as an engineering consultant for a number of years before joining the engineering staff at the Reno, Nev. PBS station, KNPB. Anderson assisted in conversion of the station to digital operations and remained there until 2009, scheduling his departure to coincide with the originally planned February 2009 nationwide switchover to digital television broadcasting.

John Battison died at his home in Loudonville, Ohio on Aug. 28, 2012, just days shy of his 97th birthday. He spent his boyhood in London, England and was one of many young people who became fascinated with broadcasting when radio first entered households in the early 1920s. Battison recalled taking his radio receiver to bed, listening to distant stations far into the night instead of sleeping in preparation for school the next day. Fear of being reprimanded inspired him to devise an "early warning" system to inform him that his parents were ascending the stairway to his bed chamber, thus allowing him to silence the radio and burrow under the covers.

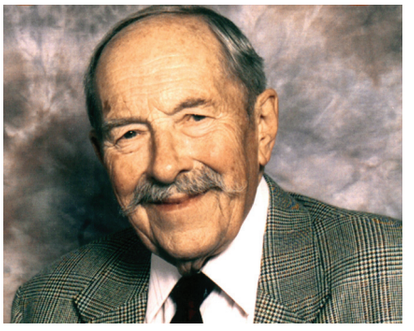
Battison also admitted to feigning illness on more than one occasion in order to stay home from school to experiment with a receiver he'd constructed to view the 30-line images then being transmitted via apparatus developed by John Logie Baird.

Upon completing his formal education, Battison was employed by Ecko, a pioneer U.K. radio and television receiver manufacturer. The BBC launched the world's first regular television service in 1936 and television was beginning to catch on with the British public; however, political events in Berlin soon spelled an end to both normalcy in Europe and

the BBC's television broadcasts. However, political events in Berlin soon spelled an end to both normalcy in Europe and BBC television broadcasting. Battison was soon to follow up another of his interests—aviation—and enlisted in the Royal Air Force. He spent the next six-and-a-half years in defending his homeland, performing flight training duties, as well as flying both Spitfire fighter aircraft and Lancaster bombers into combat.

At the end of hostilities in 1945, Battison decided to make the move to America and post-war broadcasting opportunities opening up there. His initial employment was with KMBC in Kansas City, Mo. He left this position to join the fledgling CBS television network in New York. There he worked with CBS's Peter Goldmark in developing the first color television system to receive FCC approval for over-the-air transmissions. Battison recalled that as part of this color television developmental work, he performed field strength measurements in connection with the world's first UHF television transmitter, a one kilowatt experimental model commissioned by CBS.

In mid-1950s, Battison decided to try out television broadcasting on a personal basis and established one of New Mexico's early television stations. In addition to engineering duties, Battison also appeared on camera in connection with two staples of early live small market television, studio wrestling matches and a daily children's show. He introduced wrestling contenders and provided ringside commentary as they went about their body slams and head locks. At other times of the day, he assumed the persona of another engineering type—a locomotive driver—hosting station's kiddie show as "Engineer Dan."



John H. Battison

Battison later moved from station ownership to consulting engineering work on a global basis, establishing television operations in several countries around the world. When he returned to the United States in the early 1960s, Battison became concerned that the interests of the men and women who operate broadcast facilities were not well represented and took it upon himself to launch a professional organization for this purpose, the Society of Broadcast Engineers. In enlisting support for the proposed organization, Battison personally sent out thousands of letters and forms to engineering staffs at U.S. radio and television stations. The SBE has now grown into a worldwide organization with more than 5,500 members.

Later in his career, Battison served as director of broadcast engineering operations at Ohio State University in Columbus.

Battison was a prolific author, producing some 15 books on broadcast engineering topics and writing more than 500 technical articles. He was a regular contributor to **Broadcast Engineering** magazine and at one point served as editor of that publication.

Another of Battison's interests was religion and he served more than two decades as an ordained priest in the Anglican Church. He conducted regular services at a Church in Columbus, Ohio until just a few weeks before his death.

A memorial service for Battison was conducted in Columbus, Ohio on Sept. 8, 2012.

Letters to the Editor

Dear Editor,

I enjoyed reading and was impressed by the Spring 2012 **BTS Newsletter** which reflects some major changes that you made—especially going to full color. This issue is much more interesting and inviting to the readers as a result of your new layout design, front page, headline style, high quality photographs, and larger type font. I know that the enhanced, new style **BTS Newsletter** reflects many hours of hard editorial work, and creative skills.

Also, you have provided an interesting time line of television history and future development with two articles side-by-side on pages six and seven. The page seven article, "Early Television Conference Celebrates 10th Anniversary" honors television's past technology and on page six, the "Future of Broadcast Television (FoBTV) Initiative" article explains what's going in today's world, with broadcasting leaders cooperating through a Memorandum of Understanding framework to chart the future course of terrestrial television broadcasting. In this **BTS Newsletter** issue, the reader receives both an overview of television's history and also a look at the way industry is now organizing to plan the future of global terrestrial television technology.

I look forward to reading future issues of the **BTS Newsletter**, as you continue to improve and apply new ideas making it become a premier publication for providing broadcast technology news and information to our members worldwide.

Ted Kuligowski,
IEEE BTS Member

IEEE International Symposium on Broadband Multimedia Systems and Broadcasting

June 4th – 7th, 2013 • Brunel University, Uxbridge, West London

http://www.bts.ieee.org

The IEEE International Symposium on Broadband Multimedia Systems and Broadcasting 2013, the 8th in the series, will be held at Brunel University in Uxbridge, West London. The symposium is the premier forum for the presentation and exchange of technical advances in the rapidly converging areas of multimedia broadcasting, telecommunications, consumer electronics, and networking technologies.

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The symposium seeks technical papers on the following topics:

1. Multimedia systems and services
1.1 Mobile TV
1.2 IPTV & Internet TV
1.3 DTV and broadband multimedia systems
1.4 VoD, interactivity, datacasting
1.5 Field trials and test results
1.6 Content management
1.7 Service deployments
1.8 Future of Broadcasting

2. Multimedia devices
2.1 Display technology
2.2 Acquisition technology
2.3 Set-top box and home networking
2.4 Mobile, portable, and handheld devices
2.5 Program guides and navigation

3. Multimedia quality: Performance evaluation

3.1 Performance evaluation
3.2 Objective evaluation techniques
3.3 Subjective evaluation techniques

4. Multimedia processing
4.1 Audio technology
4.2 Video coding and processing
4.3 Content adaptation and scaling
4.4 Error resilient and concealment
4.5 Rate control
4.6 Retrieval and indexing
4.7 3-D and multi-view video
4.8 Content protection and watermarking

5. Transmission and networking
5.1 Channel modeling and simulation
5.2 Channel coding, modulation, multiplexing
5.3 Signal processing for transmission
5.4 Propagation and coverage
5.5 Congestion control
5.6 Traffic and performance monitoring
5.7 Networking and QoS

Call for Tutorials: Proposals for half-day tutorials on 3D TV are also solicited

Call for Panels: Proposals are solicited for panels on technology, applications, business, and policy-related issues and opportunities for multimedia and broadcasting industry.

Prospective authors are invited to submit extended abstracts of about 1000 words by e-mail to btsbmsb@ieee.org. Each abstract must include at least two key words chosen from the topics mentioned above.

Please indicate that the abstract is submitted to the IEEE International Symposium on Broadband Multimedia Systems and Broadcasting 2013, and include the corresponding author's full name and contact information including: Affiliation, address, e-mail and phone number.

Important dates:
Submission of extended abstracts: December 16th, 2012
Notification of acceptance: February 28th, 2013
Submission of camera-ready paper: May 1st, 2013

All inquiries to ***john.cosmas@brunel.ac.uk***

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Please visit our new Website at **http://bts.ieee.org/** to see all the changes that have been made. If you have any suggestion for our Website, please send an e-mail to: *bts@ieee.org*.

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