Seminar on Sharing Experience on Best Practices and Services for People with Disabilities
Geneva, 17 September 2007

Document SIS-07/016-E
Original: English

Financing U.S. Public Radio's New Digital Services
Matching Federal Funds Have Made All The Difference

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Introduction

In October, 2002 the U.S. Federal Communications Commission (FCC) authorized In-Band, On-Channel (IBOC) digital transmissions for all AM and FM Broadcast stations. IBOC is commonly known as HD Radio™, the marketing term chosen by iBiquity Digital, Inc., the company formed by the merger of Lucent Digital Radio and USA Digital Radio in 1999 and which owns the underlying technology[1].

Public Radio in the United States had participated actively in the development of HD Radio, with stations WILL-AM and FM in Urbana, Illinois, WBJB in Princeton, New Jersey, and WETA-FM, Washington D.C. having served as early test-beds for the application and refinement of IBOC systems. WUSF-FM in Tampa, Florida became the first U.S. public radio broadcaster transmitting IBOC full time on February 13, 2003.

Federal Support for Spectrum and Funding

Public radio in the United States is comprised of over 800 FM radio stations along with several dozen AM stations as well. US public radio is typically found on the "non-commercial reserved" lower 20 channels of the FM band (88.1 – 91.9 MHz). The FCC originally declined to dedicate channels for the exclusive use of Noncommercial Education stations in 1934, but by the time the FM band was

[1] iBiquity Digital holds scores of domestic and international patents on the underlying technologies associated with HD Radio.

being readied for adoption in 1941 the FCC agreed with critics that a reservation of 20% of the available frequencies for noncommercial use would be an appropriate use of the public spectrum resource.

At that time few noncommercial stations existed, and despite the reservation of spectrum over the ensuing 20 years the noncommercial spectrum was still largely underutilized. Thus, in 1967 the U.S. Congress passed the Public Broadcasting Act to provide seed money for the establishment and operation of new noncommercial stations. The Act also suggested the need for a network to be known as National Public Radio and a Public Broadcasting System to serve educational television services as well. However, few people inside or outside of the United States realize that our public radio system is actually a loose federation of nearly 300 locally-governed, separate legal entities.

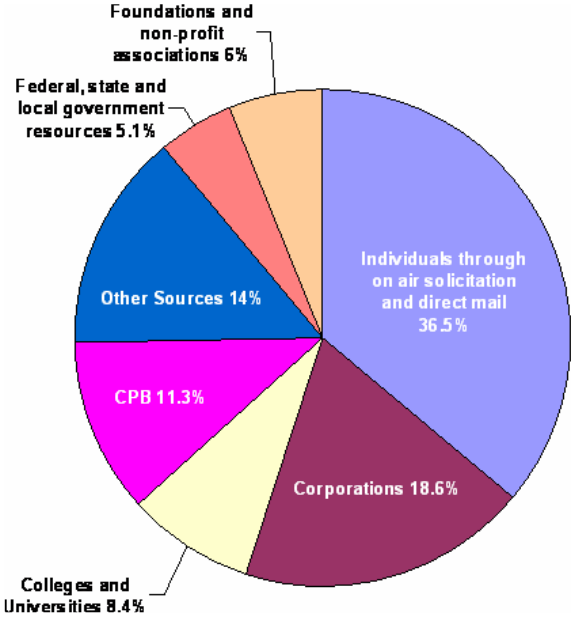
NPR was founded in 1971 with 90 stations carrying the inaugural broadcasts by AM fidelity telephone program circuits. Importantly, funding for the Public Telecommunications Facilities Program to help build and improve public radio and television stations, as well as funding for the Corporation for Public Broadcasting to support the programming services of public radio and television stations has continued for the past 35 years. Public radio today consists of approximately 825 radio stations, with 812 being members of National Public Radio.

Continuing Federal Seed Money Support for Public Radio

Support for public radio and television in the United States began in earnest with the passage of the Public Broadcasting Act of 1967, which established a "strong federal interest" in achieving "full national coverage" of public radio and public television stations.

Matching grants have been provided for the construction of hundreds of public radio and public television stations, and an annual "community service grant" is provided through the Corporation for Public Broadcasting (CPB) that supports local station operations through a detailed formula that provides basic support for station operations. Contrary to what many in the public believe, however, this support is fairly modest, comprising on average just 11% of station operating needs. The percentage is typically higher in smaller, rural communities, and lower in larger cities where stations raise substantial monies through corporate and private donations.

Chart 1 – Public Radio Station Funding Allocation



The United States Congress continues to provide substantial "seed funds" for public broadcasting activities, including the current transition to digital transmission technologies for both public tv and public radio. The grants administered for public television and radio digital conversion typically provide for 45% of the cost of basic transmission equipment, with an up to 70% CPB match available for qualified rural, hardship and minority stations.

Additional Congressional funding provided for the deployment of a satellite interconnection system, which now provides studio quality distribution of thousands of hours of programming weekly to virtually all public radio stations from the northern most tier of Alaska to Guam, Puerto Rico and all of the continental United States through the single Galaxy IV satellite at the 99 degrees West Longitude geostationary orbital slot.

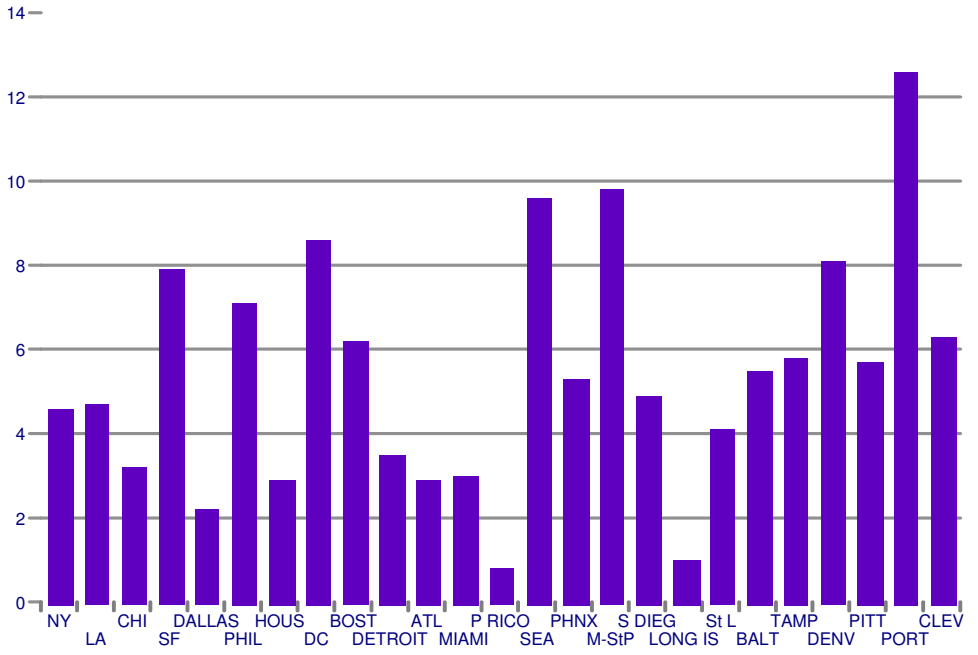
Public Radio, despite no centralized governance structure, has embraced sophisticated and sometimes complex business practices to further the use and satisfaction with public radio programming. Ongoing research about audience needs and preferences has been matched with in-depth analysis of business trends in operating practices and policies.

In 1989 the Public Radio Expansion Taskforce identified the need for more channels as acute. Since that time the number of stations has nearly doubled

and further research has shown that the greatest use of public radio programming is invariably found in communities with multiple public radio stations. The sheer diversity of public radio programming and transient nature of the American people combine to place ongoing pressure on local public radio stations to provide the "blockbuster" programs in every market that were favorites of listeners moving in from other communities.

This has often led to fragmented program services with "block programming" of different program types being made available throughout the day – News/Jazz/Classical and more are commonly available on individual stations at various times of the day and week. While this responsiveness to the needs of listeners with strong loyalty to different programming has been successful overall predictability of format appeal has suffered. Yet in markets with 3-7 public radio stations the overall use of public radio as measured by "listening share" is dramatically higher due to the natural focusing of formats with each station taking on an identified role as "the Classical", "the Jazz" or "the News/Talk" station. For these reasons public radio has internally adopted the slogan "More Channels, More Service".

Chart 2 – Public Radio Listening Share in the Top 25 Radio Markets

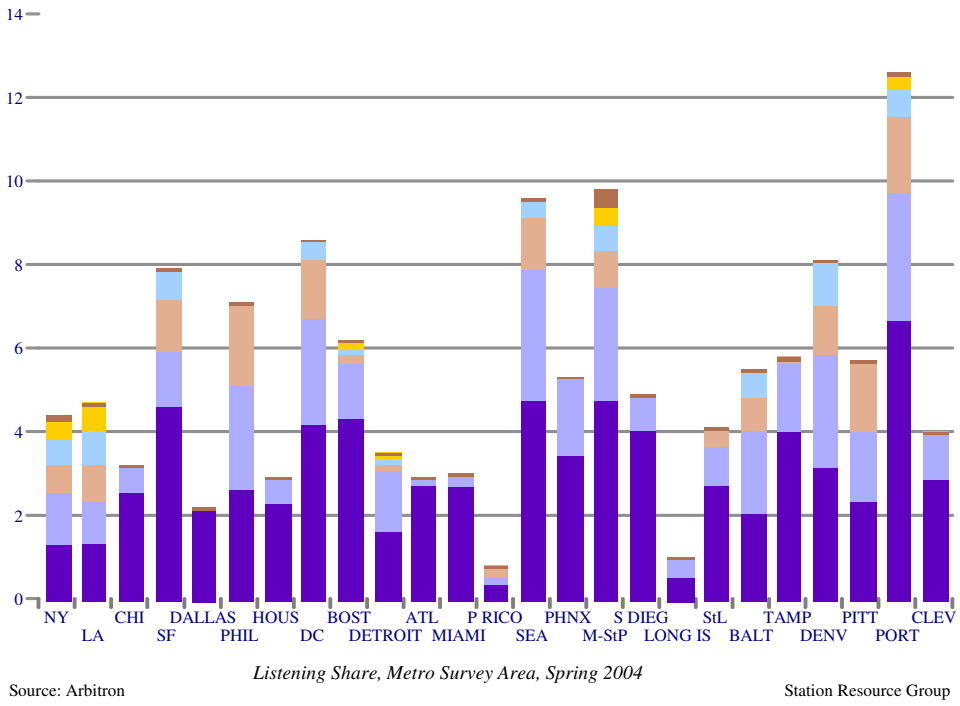


Listening Share, Metro Survey Area, Spring 2004

Source: Arbitron

Station Resource Group

Chart 3 – Public Radio Listening Share Showing Contribution of Individual Stations – Data Reveals Greater Listening Where More Stations Are Operating



Listening Share, Metro Survey Area, Spring 2004

Source: Arbitron Station Resource Group

- >$1 Billion would be needed to buy this many missing stations in top 100 markets alone
- At total system cost of ~$140 Million, all 800 FM public radio stations can offer *three program services*

Long Sought After Features – The Tomorrow Radio Project

Subsequent to the early demonstrations of Eureka 147 technology at ORB '88 and the report of the Public Radio Expansion Taskforce in 1989, public radio, led by NPR focused on the multiplexing attribute of all digital systems as a possible solution to the need for more public radio program channels.

The digital radio transition in the United States took much longer to deploy than in other nations due to market and spectrum scarcity that made the quest for a "no new spectrum needed" digital radio system to be the ideal solution. But early efforts to develop IBOC technology failed with public demonstrations in 1995 causing unacceptable interference on existing analog radios. The system

proponents went back to the labs and subsequent to the merger of USA Digital Radio and Lucent digital radio unveiled a system that required much less power due to improvements in coding gain, and spectral utilization.

Extensive testing by an ad hoc review board of top engineers judged the new IBOC system to be both compatible with analog transmissions as well as a "substantial enhancement" over analog broadcasting. At this time, the "substantial enhancement" attribute was based on extensive subjective audio quality assessments which judged the 96 kbps audio stream to be statistically indistinguishable with CD quality and substantially better than existing AM and FM analog broadcasts.

Public radio supported and participated actively in the engineering reviews and sought specific assurances concerning lack of interference to 67 and 92 kHz FM subcarriers which are utilized to transmit radio reading services for the blind in many American cities. iBiquity agreed to fund further testing which upon completion the following summer of 2001 showed the interference potential to be minimal.[2]

Although the HD Radio system was primarily designed to provide a technological improvement over FM transmission in terms of better audio fidelity, full frequency response, and lack of multipath impairments, it also supported a feature originally known simply as "logical channels" and later as "supplemental audio channels." These supplemental audio channels held the promise of providing the additional program services that public radio had documented as the key to greatest audience use and satisfaction.

Several unknowns about the potential digital coverage in the absence of "analog blend" and the audio quality that could be achieved within a subset of the 96 kbps stream required documentation. NPR launched the Tomorrow Radio Project to document these unknowns in January of 2003 with partners Kenwood Corporation and Harris Communications. The Corporation for Public Broadcasting, at the urging of leaders in the "Digital Transition Consultancy" group agreed to fund the Tomorrow Radio Project.

iBiquity agreed to provide a special code load to partition the datastream into an arbitrary 64 kbps main program channel and 32 kbps supplemental audio channel. The field test work then proceeded, supervised by the consulting engineering firm of Hammet and Edison. Four public radio stations volunteered to host IBOC transmissions in San Francisco, Los Angeles, Washington, D.C. and New York city (KALW-FM, KJZZ-FM, WETA-FM, and WNYC-FM, respectively).

[2] Less than 2.8% interference impact was projected for the worst case studied.

These tests were completed in December of 2003 and showed that greater than 95% digital coverage was experienced between the 60 dBu and 70 dBu contours.

Chart 4 – Test Coverage on WETA-FM, Washington, D.C. Green Indicates HD Radio Coding, Red is Absence of Digital Radio Reception

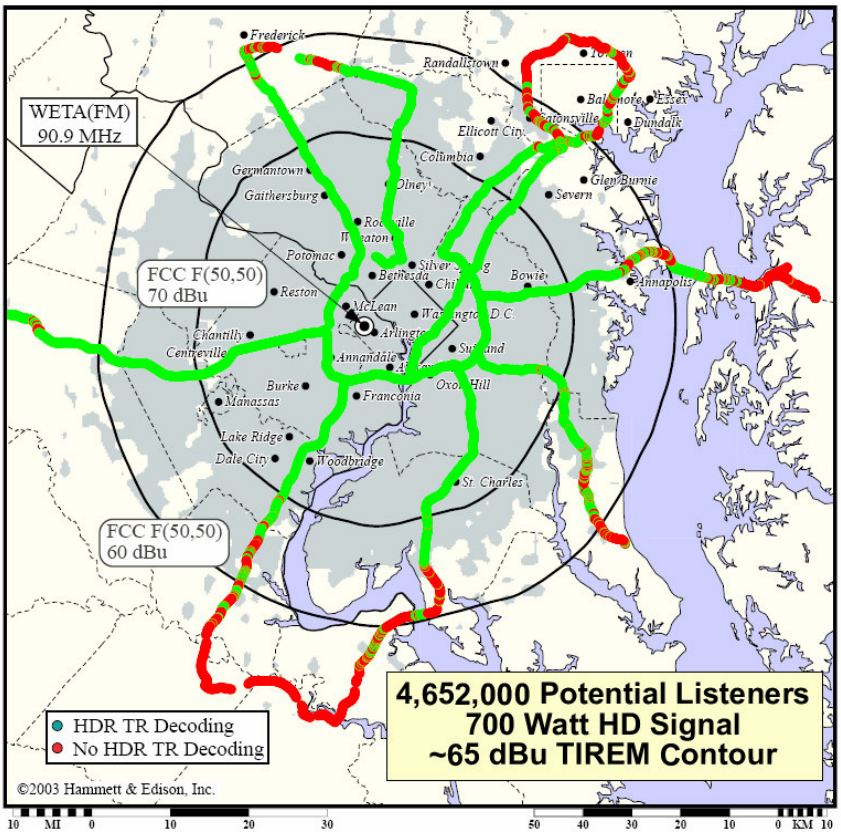


Chart 5 - WNYC-FM, New York [3]

Just as importantly, in this same timeframe, the broadcast industry sought from iBiquity an upgrade in the audio coder specification to provide best in class audio performance for AM stations operating at 36 kbps and which would also provide improved performance for supplemental audio channels as well. iBiquity responded and unveiled a well-received HD Coder which was quickly implemented in the overall HD Radio system design. The upgrade was finalized in the fall of 2003 and was able to be upgraded in the small number of HD Radio receivers in the field at that time.

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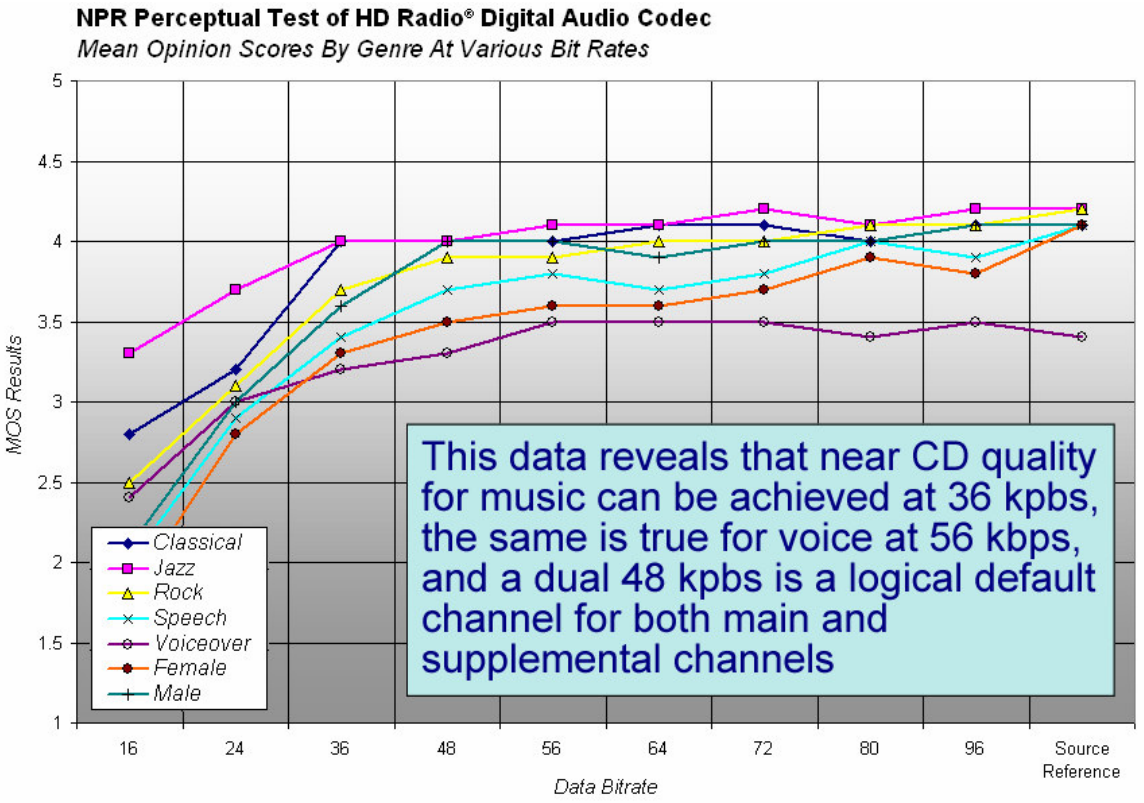
3 – Note the "false positive" west of the transmitter site on the Empire State Building – this resulted from acquisition of GPS lock prior to HD Radio lock when emerging from the Lincoln tunnel. Other red ticks are believed to be the loss of signal under bridge overpasses – an overall remarkable service area given the transmitted power of only 57 watts.

Coverage and Quality

Athough the quality was generally felt to be quite good with HDC no comprehensive tests had been conducted, so following on the heels of the successful Tomorrow Radio Field Tests which documented seamless digital radio coverage in urban grade signals NPR set out to document the quality associated with various HDC bitrates. CPB again agreed to fund the follow-on study.

NPR hired noted audio expert and cognitive behavioral researcher Dr. Ellyn Sheffield of Salisbury University to test the HD coder at datarates from 16 kbps to 96kbps. The results showed that ordinary listeners were unable to perceive the difference in CD sources and in some tested program material at rates as low as 36 kbps (Jazz and Classical).

Chart 6 – Multiple Bit Rate HDC Subjective Audio Performance, 2004



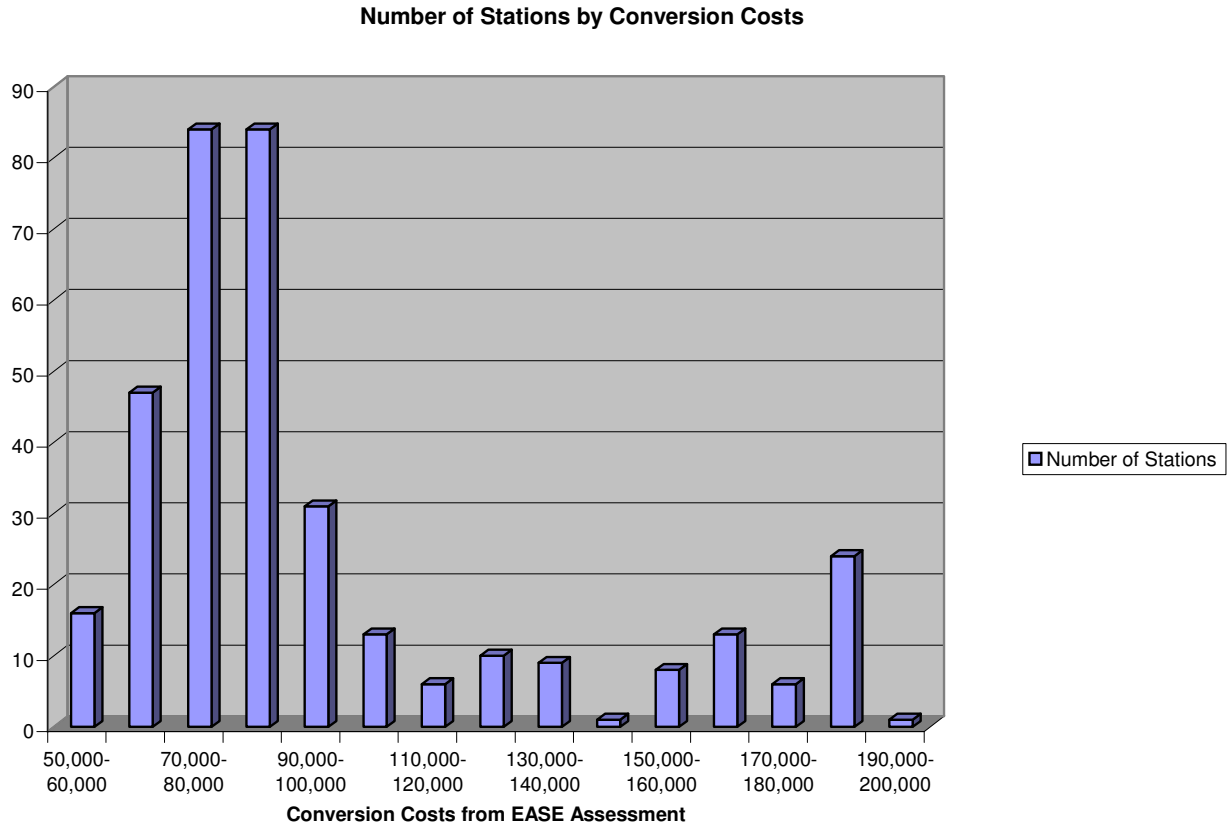
An overall logical default of 48/48 kbps yielded very good audio quality, with full frequency response, and an absence of multipath artifacts. Today, most radio stations that are operating "multicast" channels are doing so at the 48/48 rate with good results.

NPR additionally tested low bit rate (24 kbps) and very low bit rate (12 kbps) audio coders against the audio quality achieved with existing analog SCA technology. At 24 kbps the HD coder performed substantially better than best analog SCA technology. At 12 kbps only one coder among the 12 submitted for testing performed better than existing analog SCA audio quality – the Voice Age coder.

Current Deployment Status

In February of 2003 NPR completed a study of "Public Radio First Generation HD Radio Cost Projections". Those projections, which have proven remarkably accurate, tallied basic station transmission costs at an average of $140,000US per station. As of this writing, CPB has funded nearly 640 of the 825 eligible public radio stations for digital conversion matching grants, which typically provide between 45-50% of station transmission purchasing costs. Higher levels of CPB matching support of up to 70% are provided for stations meeting demonstrated hardship criteria (which typically serve economically disadvantaged markets).

Chart Three – 2003 Cost Projection



It is readily seen that a wide range of HD Radio transition costs were projected in the 2003 study. This study was completed before the cost savings of dual antenna installations were approved for higher power stations, and before the development of the novel "mid-level" or "split-level" combining technique that enabled the use of more efficient digital architecture instead of the higher cost and relatively less efficient "high level combining" approach. This study was also completed before any significant broadcast manufacturing was actually underway. Actual transmitter costs were somewhat higher than predicted, but offset by the system savings of dual antenna and high level combining approaches. Over the ensuing years, the average costs of implementation have been remarkably close to the projected $140,000 U.S. figure from the 2003 study.[4] Individual costs did vary considerably as was expected with the limited field data on the 859 stations studied in the assessement.

Good News - What We've Accomplished

Thanks to iBiquity's responsiveness to numerous requests for system upgrades in

[4] CPB has recently indicated that average station eligible costs have been estimated as $130,000US per station – but that this number does not include all costs typically incurred, only the core "digital transmission" hardware costs.

the original architecture, major redesigns of the original digital radio system are now standard features. Most important of those is the full embrace for multicasting, which any FM station can now transmit with an informal authorization to the FCC. Most significantly, the attribute we felt would take the longest to accomplish, defacto standardization of multicast receivers in all new HD Radio receivers, became a reality in 2005.

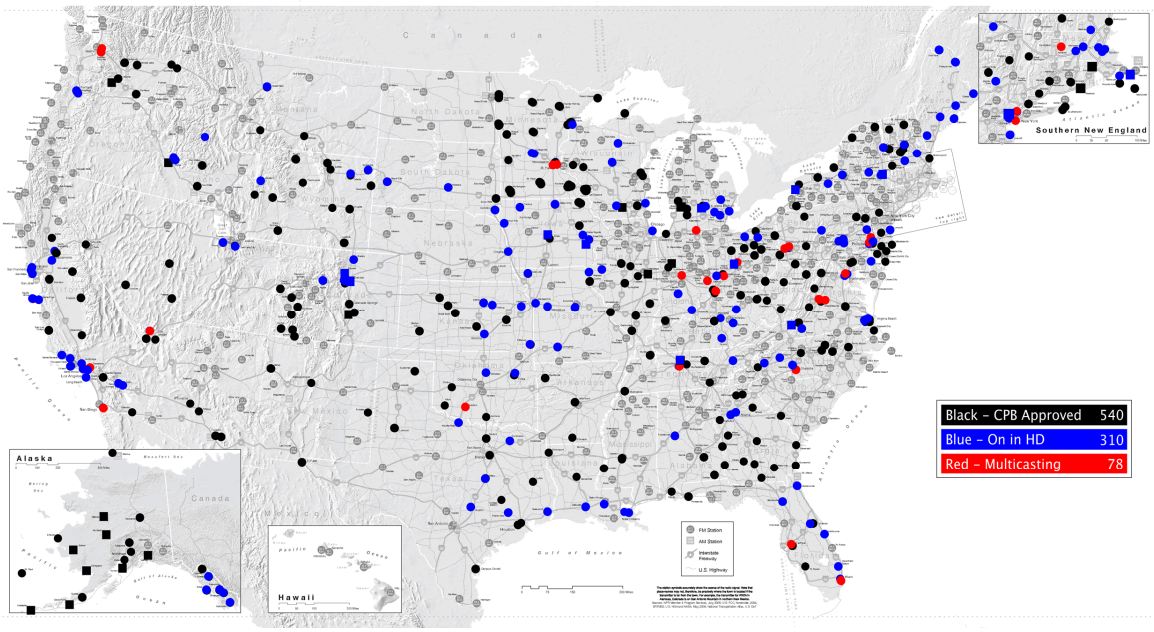
With a digital radio multicasting future assured nearly $1 BillionUS in savings will be seen by not having to purchase additional FM stations to assure three public radio signals in each of the in top 100 markets. Thanks to the cost effectiveness of digital radio, for a total system cost of ~$140 MillionUS, each of the over 800 FM public radio stations can offer a *minimum* of three program services, and additioinal new digital public services, including accessibile radio channels.

Challenges Ahead

Getting all public radio stations converted to digital transmissions is our primary focus. Although good progress is being made, some issues are being encountered in timely completion of planned conversions due to local bidding requirements, additional site construction issues, while stations take advantage of the opportunity to refresh studio systems as well, and the receipt of committed local matching funds.

The factor that now lies before us – and under less direct control is the one that has caused many a new technology offering to stumble, plentiful and affordable radio receivers. As has been shown by the DAB roll-out in the United Kingdom it is the conjoining of both inexpensive, good quality receivers and the availability of compelling new program services. Public radio has now executed two modest HD Radio group receiver buys for use as promotional premiums by our stations totaling well over $1 million in product value. Yet, this is a tiny fraction of the estimated 750 million radio receivers in use in the United States. This sobering reality assures us of steady work towards the all digital future and analog shut-off for many years into the future.

Chart 7 – Public Radio HD Radio Transition Status – August 29, 2007



As is readily evident, public radio's digital radio transition has begun in earnest, and we are committed to exploiting the multiplexing capacity that can multiply the use and satisfaction with our new public services as rapidly as is humanly possible.

For accessible services, such as digital radio reading services for the Blind and Print Handicapped, as well as Captioned Radio for the Deaf and Hard of Hearing, timing is important as inclusion of needed features is essential to accomplish as early as possible in the digital radio equipment transmission. Fortunately, the Department of Education's National Institute on Disability and Rehabilitation Research has funded the NPR Accessible Digital Radio Broadcast Services project through a three year field-initiated grant. We believe excellent progress has been made to date as conditional access to protect copyrighted readings of books and newspapers, as well as bandwidth requirements and larger displays for Captioned Radio are rapidly becoming mainstream.

Yet, as Napoleon reportedly told a messenger, "I can grant you anything you may require, except more time for the completion of your journey."

Acronyms:
AAS – Advanced Applications Services – the data gateway within the HD Radio system
CAP – Common Alerting Protocol – an extensible format for emergency messages
DVS- Descriptive Video Services
EOC – Emergency Operations Center
ERS- Emergency Radio Service
FTC – Fast Text Channel
HD Radio – the digital radio system for the U.S. created by iBiquity Digital Corporation
IAAIS – International Association of Audio Information Services
NIDRR – National Institute on Disability and Rehabilitation Research
NPR – National Public Radio
RFI & RFP – Request for Information and Request for Proposal

Mike Starling is Vice President and Chief Technology Officer for NPR, and Executive Director of NPR Labs. In the 1970's Starling founded, built and managed commercial and noncommercial stations in Virginia. Starling is a board member of the North American Broadcasters Association, the Richardson Maritime Museum in Cambridge, and a past Board member of the International Association of Audio Information Services. He has consulted for radio stations across the United States and Southern Africa (the Swaziland Broadcasting and Information Service) and has been a U.S. delegate to the ITU. Starling joined NPR in 1989 as senior engineer, was named director of engineering in 1991 and a vice president in 1998. He is the 2004 recipient of the IAAIS's C. Stanley Potter Award for his work on making radio reading services accessible in digital radio and was named Radio World's "Engineer of the Year" for 2005, for his work on digital radio multicasting. Starling is also a lawyer, being a member of the California and DC bars. Contact information: mstarling@npr.org