ACCESSIBLE DIGITAL RADIO BROADCAST SERVICES

AN IDEA WHOSE TECHNOLOGY IS ARRIVING

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ABSTRACT Approximately 10% of the global population, or 650 million people, suffer from moderate to serious vision or hearing loss. With the advent of digital radio transmission in the US, new public service features will be implemented to afford sensory impaired populations better access to radio's rich and diverse content, as well as life-saving emergency messaging.

Recent development activities have demonstrated the ability to provide (a) conditional access for reading service for the blind, and (b) closed captioned radio for the deaf and hard of hearing. The unique needs of sensory impaired consumers must be addressed with specialized services that employ universally designed, accessible interfaces and features. The technical and service requirements for adding these elements are now being analyzed by technology developers, public and commercial broadcasters, standards organizations and consumer equipment manufacturers. Recently a comprehensive companion effort has been launched to identify and develop the most appropriate technologies, service models and end-user requirements to guide the development of mass-market digital radio services. We will present the results of a comprehensive survey conducted by National Public Radio Laboratories focusing on the needs and desires of visually and hearing impaired consumers. Additionally, we will present consumer electronics prototype demonstrations applicable to the introduction of accessible digital radio systems.

INTRODUCTION All telecommunications are migrating to digital transmissions. Radio broadcasting, the original wireless medium, is no exception. Eureka DAB 147, Digital Radio Mondiale, DMB, HD Radio, and other digitally based radio transmissions are being successfully deployed in various countries around the world. With this transition, digital radio ushers in a multimedia format, complete with display devices that can support captioned radio services. In the United States, NPR Labs, and our partners at the WGBH National Center for Accessible Media, are conducting a research program on the development and implementation of accessible radio services, funded by the Department of Education National Institute for Disability Rehabilitation and Research. NPR Labs is currently focusing on integration within HD Radio, the mainstream digital radio broadcast system currently being deployed in America.

Although radio is the last electronic mass medium to be making the conversion to digital transmission, the conversion is well underway with HD Radio signals on-the-air in virtually every major market in the United States. Over 1,700 radio stations are currently broadcasting in HD Radio, including over 310 public radio stations. According to current estimates, by 2010, all 825 public radio stations should be broadcasting digitally. Digital Radio, especially at new band and in-band FM data rates, introduces a flexible service model which will greatly expand and improve radio's public service offerings. Multiple program channels from a single radio station, improved sound quality, and the addition of text, time-shifting, and targeted content are current or emerging features for the growing number of HD Radio stations.

There are several critical services that public radio will provide as radio migrates to digital transmission: (a) emergency notification; (b) radio reading services for the visually and print impaired, and (c) captioning for the hearing impaired. At the top of the list is emergency notification. Broadcast radio serves as a lifeline of communications during times of emergencies, especially when the power grid is down. NPR, on a voluntary public service basis, continuously monitors the nation's Primary Entry Point system (PEP) system, the backbone of the Emergency Alerting System. PEP stations have been provided with hardened facilities and secure telephone links from the Federal Emergency Management Agency (FEMA). NPR passes all national emergency messages directly to the over 800 stations that receive programming through the Public Radio Satellite System. The NPR system is tested weekly and staffed 7/24.

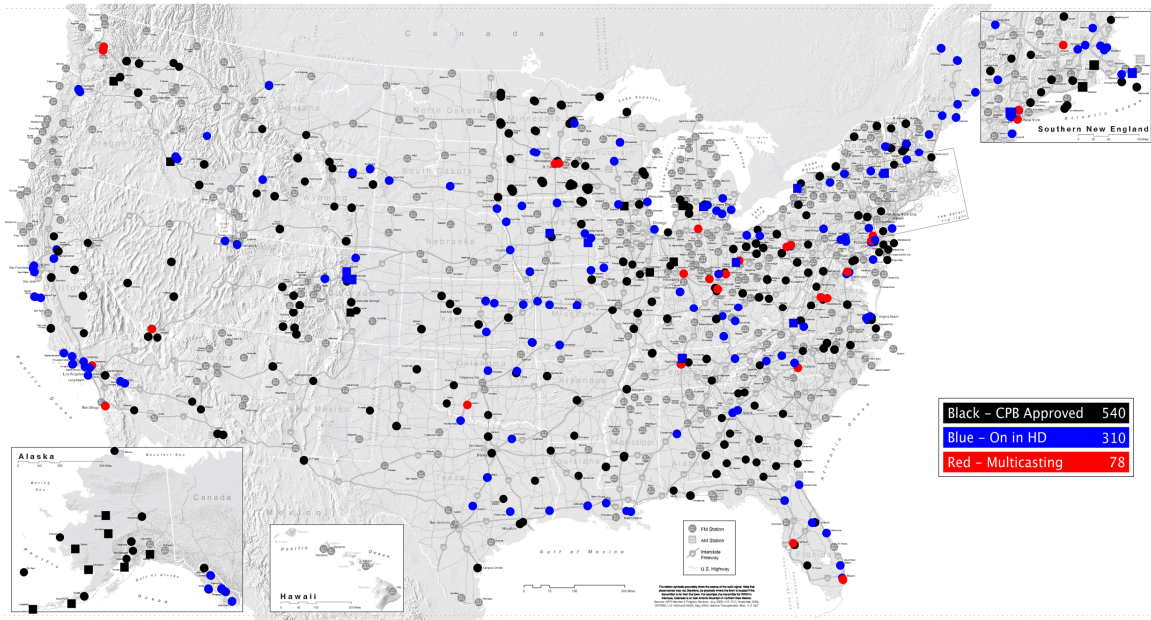See the map of public radio digital transition status shown on the next page in Figure 1.

FIGURE 1 – PUBLIC RADIO CONVERSION STATUS AS OF 29AUG07

However, emergency services do not currently extend to sensory disabled citizens - NPR believes it is essential to provide services to this rapidly growing population. It is estimated that 10% of the world's population, or 650 million consumers, are currently suffering from moderate to severe hearing or vision loss. The National Federation for the Blind projects that this number will double over the next three decades as "baby-boomers" reach retirement age. These adults may have mild to severe vision loss caused by untreatable disorders, such as macular degeneration, diabetic retinopathy, glaucoma, etc., or mild to severe hearing loss caused by excessive exposure to loud noise, aging, infection or injury. This population is accustomed to accessing information quickly and effortlessly from a variety of sources, but as their senses deteriorate, they will find themselves becoming increasingly helpless, relying on friends and family for assistance, and ultimately being forced to give up the technologies they once relied on. NPR believes consumers with disabilities should not be denied access to emergency and potentially life-saving information.

ACCESSIBLE EMERGENCY BROADCAST RADIO SUCCESS
In order to bring emergency broadcasting to sensory disabled consumers, service enhancements such as dedicated digital channels for radio reading services for the visually impaired and print handicapped, and captioned radio for the deaf and hard of hearing are being carefully planned and deployed over the next 3-5 years. These service enhancements will soon be available on long-life battery-operated digital radios. Next generation chipsets from SiPort, Samsung,

and Texas Instruments are being readied for mass deployment that will enable battery operations.

READING SERVICES FOR THE BLIND AND VISUALLY IMPAIRED
Radio reading services for the Blind were first established in the United States on analog subcarriers in 1969, providing daily glimpses of the world through readings of current newspapers, magazines, and popular books. These copyrighted materials were regulated by an exemption for such services in the Code of Federal Regulations by the U.S. Congress. Over 100 reading services exist today in the US and abroad, with many of these services broadcasting on subcarriers at 67 kHz or 92 kHz on FM public radio stations.

It is estimated by the International Association of Audio Information Services (IAAIS) that roughly one million out of an eligible population of 8-12 million have been provided a special purpose analog SCA radio. Over the last forty years roughly one million radios have been delivered in person or by mail to individual users. Not only is this a substantial commitment of time and money, but the audio quality of affordable SCA radios has been markedly inferior. Digital radio has the potential of providing blind and visually impaired consumers with access to reading services by way of "conditional access", a feature currently being implemented on HD Radio.

Conditional access allows a particular radio reading service channel to be turned on solely for reception by eligible users. For the visually impaired, proof of need can come from a doctor or eligible social service organization. Thus, it is possible that in the future perceptually impaired consumers can buy a mainstream digital radio receiver, verify their status with their local radio reading service through their radio's electronic serial number, and immediately gain access their local reading service. Conditional access has been successfully tested over the air at WUSF-FM in Tampa Florida. Encryption provisioning (CA) technology was provided by NDS, a major supplier of subscription entitlements and integrated by iBiquity Digital.

Based on this success, iBiquity has committed that all chipsets produced as soon as Q3 2007 will include CA functionality. The final step in this process will be the integration of a low bit rate audio coder to provide a substantially superior audio quality over analog SCAs. Results from studies conducted at NPR Labs comparing analog SCA quality (McMartin Light and Medium, and QEI) with very low bitrate digital coders show this can be readily achieved at a bitrate of 11.8 kbps using the best available very low bit rate codec tested (see Figure 2 on the next page).
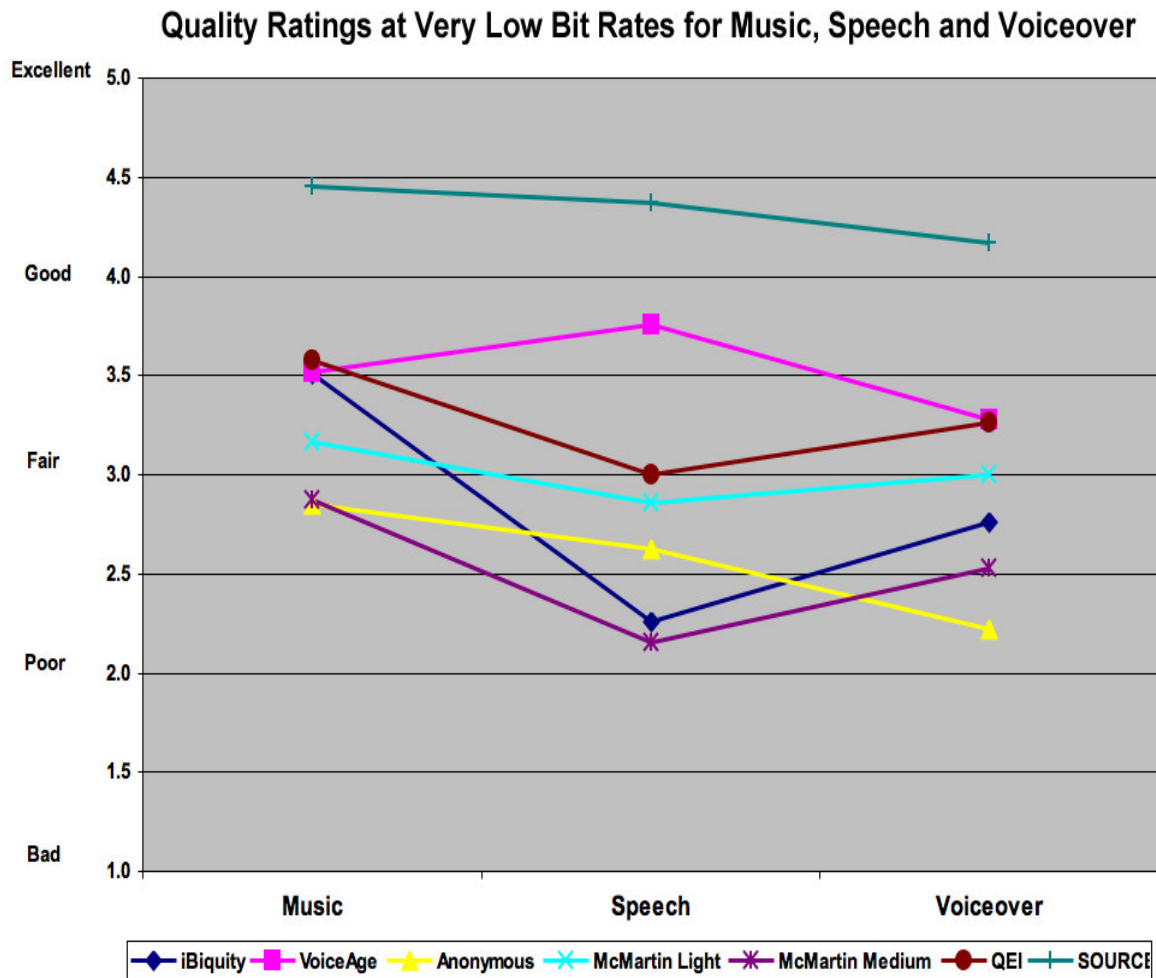
FIGURE 2 – AUDIO QUALITY RATINGS OF VERY LOW BIT RATE CODECS

iBiquity Digital has already developed supplemental audio channels for activation of voice grade service channels for radio reading services and conditional access support is under active development to maintain copyright exemption for these broadcasts. Only "sonalert" support and Live-Descriptive Video Service-trained describers would be needed for parallel emergency service access for the visually impaired.

CAPTIONED RADIO
For the first time in radio history, captioning of radio broadcasts for the hearing impaired is within reach due to flexible bandwidth provisioning of HD Radio through the Advanced Applications Services (AAS) data transport. There are

several issues that must be addressed before a successful captioned radio can be deployed.

These requirements include (a) a fast text channel (FTC) to carry captions, (b) a suitable sized display screen, (c) user adjustment of font size, contrast and backlighting, (d) a buffer for controlling the scrolling speed, (e) a designated data burst to signal an emergency alert, (f) captioning providers on 7/24 standby, (g) validated design requirements, (h) manufacturing partners, and (i) funding partner(s). Most of the technical underpinnings for the captioning displays are available through receiver partners identified by NPR.

Moreover, iBiquity Digital Corporation has pledged their support to activate a "Fast Text Channel" for carrying live captioning through the HD Radio transport within the AAS data channel, as well as a burst data protocol designated to act as an alert notification trigger. For the Deaf and Hard of Hearing, a compliant Emergency HD Radio would support a bed-shaker connection, as well as strobe activation upon receipt of an alert. These ancillary devices can be readily triggered by connection to the receiver's output relays when an emergency alert is received. This functionality exists within the core iBiquity HD Radio code.

Finally, and perhaps most importantly, designated content providers would need to assume round-the-clock responsibilities to immediately activate captioning and described video services as needed. Although integration of these technologies and operating processes are complex, there do not appear to be fundamental obstacles that would preclude development over the next few years. In fact, most requirements are already met or are under active development.

THE NEEDS OF THE SENSORY IMPAIRED COMMUNITY
The unique needs of sensory impaired consumers must be addressed with specialized services that employ universally designed, accessible interfaces and features. Since the technical and service requirements for adding these elements are now in development by technology developers, public and commercial broadcasters, standards organizations and consumer equipment manufacturers, the remaining effort needs to identify the most appropriate technologies, services models and end-user requirements to guide the development of mass-market digital radios. NPR Labs and WGBH-NCAM have begun to prototype, field test and assess appropriate technologies and service models specifically designed for perceptually impaired consumers. As a first effort in determining consumer needs, an extensive survey was conducted with members of both sensory disabled communities.

Description of Survey
Our goal was to compile as many ideas and opinions about future radio technology as possible. We designed two questionnaires – one geared to vision

and one geared to hearing – including open-ended questions about technologies and features that could be included in future radios. Questionnaires were collected over the internet, over e-mail and by telephone, depending on the needs of the disabled respondents, and explored a variety of topics including closed captioning and display features, emergency notification, voice command and audible feedback, look-and-feel and ergonomic design.

Participants
Surveys were conducted with over 300 sensory impaired, technology users, ranging in age from 20 to over 70. Surveys were distributed to a number of organizations, selected to represent a wide range of consumers with disabilities. Respondents came from all over the US, Canada and the UK. Both males and females responded, over 130 were deaf or heard of hearing, and 170 were blind or visually impaired. It should be noted that our respondents were not homogenous in their impairments, abilities, background knowledge and motivation to use technology.

Their comments were far ranging, creative, and thoughtful. We were continually struck by our participants' willingness and ability to compensate for poorly designed and inadequate technology. Despite this, participants articulated excitement and enthusiasm for newly designed, accessible radios. Most of the consumers we surveyed registered both fear of slipping further behind the "technology curve" and a sincere desire to help shape the future of radio technology. They viewed themselves as consumers with purchasing power, and they saw radio as an important technology to which they had not had enough access.

Survey results
Survey results are divided between two fundamentally different groups of sensory disabled consumers. The first group, visually impaired and blind, can take full advantage of the output of radio, but cannot use complicated and/or opaque interfaces often found in mainstream radios. In contrast, the hearing impaired and deaf consumers are equipped to navigate complicated visual displays, but cannot take advantage of the auditory output. Although the needs of these two groups are different, we believe that both can be addressed with well thought out, universal radio design.

All respondents
Prior to conducting these surveys, we believed (and the wisdom of the day suggested) that perceptually disabled consumers would desire products manufactured with their specific disabilities in mind. We found out that nothing was farther from the truth. Both the hearing and visually impaired communities were overwhelmingly in favour of integrating assistive technology into mainstream products. The majority of respondents saw enormous advantage in

being able to purchase mainstream products, including lowered cost, greater personal choice, access to the most current technologies, and reducing their reliance on after-market, clumsily engineered assistive technologies. Being able to receive emergency notification and information was of paramount importance.

Both the hearing-impaired and visually-impaired communities expressed deep dismay that they did not have equal access to emergency information. They described emergencies as including weather and natural disasters, but also major traffic problems, road closings, and weather/disaster-related building and service closings (i.e., schools, churches, social services, etc.). Respondents felt that redundant alerting systems would be most helpful, and were particularly interested in receivers that could be turned on remotely to broadcast emergency messages. Additionally, they were interested in accessing messages from several areas or regions, not from just their local community.

Respondents talked about "choice" and "flexibility". They wanted to choose the size, ergonomic design and "look and feel" of the product they purchased. They hoped that new offerings with assistive technology would mirror currently available mainstream products, such as walkman-style units, tabletop units and stereo component units. Portable, small units with headphones seemed most desirable to suit participants' active lifestyles. Respondents felt that durability, tamper-proof features and robust, rechargeable batteries were necessary for portable use. Additionally, respondents called for presentation features to be user-adjustable (e.g., text colours, background contrast, speed of text presentation). They hoped for simple-to-operate, affordable units with universal design features.

Respondents were interested in pause/rewind/catch-up technology (e.g., TiVo® style functionality) but were concerned about the cost and receiver manufacturer's ability to make the features easy to use.

Survey results specific to the hearing impaired
For the hearing impaired, captioning radio broadcasts was principally important. Respondents felt that captioning should be accurate and synchronized with speech, sound effects and music. Residual hearing is extremely common in both profoundly deaf adults and adults deafened with age. Caption synchronization would allow participants to enjoy programming at the same time as do their friends and family, promoting both cognitive congruency and good social exchange.

Finally, participants wanted captioning to provide emotional content, identification and intention of the talk show hosts, song titles, subtitles and musical lyrics. Respondents mentioned often that receivers supporting captioning should have large displays so that the elderly could read information without glasses. Older

participants mentioned contrast, glare, and large print as crucial elements to ensure that their reading speed was maximized[1]. A number of respondents agreed that multiple block lines of text would be more desirable than scrolling text. Additionally, they felt the ability to slow down, speed up or completely repeat text was desirable.

There was mixed reaction when respondents were asked about visual displays, avatars and emoticons. Many respondents did not see visual helpers as important and were concerned that they would be overused or poorly placed on the display. As one respondent claimed "avatars are cute, but ultimately visual clutter when you're trying to read – especially if they are moving – very distracting." Nevertheless, other respondents reported instances when visuals could be useful, particularly if they assisted people in reading more quickly. These visuals could identify talkers, simple objects such as logos, tone of voice, related information and most importantly emergency alerts.

Survey results specific to the visually impaired
Audible feedback was considered the most important feature for the visually impaired user. Although respondents thought that beeps and tones may satisfy feedback needs for verification of menu selections, they believed that only audible feedback would provide enough information to be useful under all circumstances. Voice output to navigate menu selection was considered the "gold standard" by which other technologies should be measured. Respondents mentioned that audible feedback should include clear and concise instructions and be under user control, allowing the user to set playback conditions (i.e., speed of speech, volume). They also mentioned that it was important to be able to disable the feature, particularly in public situations.

A few respondents mentioned that Braille would be useful, particularly for labelling connections in the back of the receiver; however they were resolute that Braille should not take the place of audible feedback. With regard to voice command, many respondents were wary of its usefulness. They were concerned that it would not work properly, particularly in noisy situations, and that it would require too much training of the unit. As one respondent replied "The problem isn't that blind people can't enter information into devices using their fingers, it is that they can't see what the screen on the device reads, and what the buttons on the device say."

In contrast, other respondents were familiar with voice command technology on their cell phones, and thought that it would be a welcomed addition, especially for mobility impaired and aging [1] This comment was raised often within the deaf community, but also in the visually impaired community, particularly by older respondents who had some residual, functional vision. Finally, visually impaired respondents were asked about sonalert, which they described as an extremely

important component of receivers. They stated that it was critical to make alarm clock functionality as accessible as main functions.

Conclusion

Results from our survey indicate that consumers with disabilities are ready and willing to use mainstream products if they are equipped with features that provide appropriate assistance. They are particularly interested in products that provide personal choice and direct access to mainstream technologies. For the visually impaired, auditory feedback is essential. For the hearing impaired, captioning is essential. For both, access to emergency information is crucial. Assistive technology does not have to be prohibitively expensive, but it does have to be designed with the consumer in mind. For example, this may mean designing buttons and knobs that take into consideration older citizens' manual dexterity, designing displays that can "talk" for the visually impaired, or displays that are large enough for presentation of captioning for the hearing impaired.

All of these features appear achievable, given today's technology and products. In the US, testing, demonstration and integration on the transmission side is proceeding at a rapid pace. Over the next 2 years the emphasis will shift to achieving best operating practice service integration in consumer electronics products. NPR Labs, WGBH, and our technology partners are working hard to assure inclusive, accessible services in digital radio services. We are convinced that good accessible design is synonymous with great mainstream design. Given the alignment between government regulators, user communities, and manufacturing interest expressed to date, we expect to see initial field deployments of Accessible Radio Services in 2008.

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