

HD RADIO TECHNOLOGY

A DESCRIPTION OF SERVICES AND APPLICATIONS

iBiquity Digital Corporation provides the following summary of HD Radio services and applications, in response to the request of the Technological Innovations of the Digital Radio Consulting Council.

A. A SUMMARY OF HD RADIO SERVICES AND APPLICATIONS:

The following chart lists the principal HD Radio services and the characteristics of each service:

Service Name	Description	Typical Bit rate	Band	Sharing Service with audio	Composite Connections	Trade-Offs	Carried by Carriers P1/P3/SIS	Middleware Required	Receiver Process
Multicasting	Transmission of up to three more program channels.	16-48 kbps	FM	Additional audio service.	Additional audio service.	Yes (bit for bit)	P1/P3	Yes/Audio server	Standard
PSD Data	Song Title and Artist /Commercial Title	Included in CODEC data	AM/FM	Yes	Yes	None	P1/P3	Yes/Studio Automation supporting ID3v2.3	Standard
Artist Experience	Cover Art/Station Logo/Commercial Image	~ 4kbps	FM	Synchronized to audio	Yes/trigger	Yes (bit for bit)	P1/P3/SIS	Yes/Studio Automation and MSAC	Advanced User Interface
Active Alert	Robust Digital Emergency Alert and Information Service	100bps	AM/FM	No	Independent	None	SIS	Yes/Emergency Alert Manager	Basic User Interface
Song Tagging	Integrated Music commerce	Included in CODEC data (PSD)	AM/FM	Only Sync	Yes	None	P1/P3	Yes/Studio Automation System supporting ID3v2.3	Basic User Interface
Traffic	Traffic Event and Traffic Map Flow Data	500bps - 5kbps	FM (Could be AM?)	No	Independent	Yes (bit for bit)	P1/P3	Yes/Proprietary 3rd party traffic server (CCME, BTC) and MSAC	Advanced User Interface
Journaline	Text services News/Weather/ Sports	~ 2kbps	FM (Could be AM?)	No	Independent	Yes (bit for bit)	P1/P3	Yes/3rd party license and server (FhG) and MSAC	Advanced User Interface
Electronic Program Guide	Textual listing of program schedules for all stations in an area.	Adjustable (2kbps – 11kbps)	FM	No	Independent	Yes (bit for bit)	P1/P3	Yes/Backend service bureau and MSAC	Advanced User Interface
Surround Sound	Data for Surround Sound decoding	Audio Watermark no data usage	FM	Yes	Embedded in audio	None	P1	No/Audio Content source watermarked	Advanced Audio Decoding
Tag Station	Interactive data services for smart phones with integrated digital radio.	typical 14kbps	FM	Yes, but may be independent	Yes, but may be independent	Yes (bit for bit)	P1/P3	Yes/Tag Station Server and MSAC	Advanced User Interface
Single Frequency Network	Synchronous repeater or “booster”	No data usage	FM	Only Sync	Yes	None	N/A. Embedded in Layer1 waveform	No, but manufacturer interface and transmission hardware integration	None

B. DESCRIPTION OF HD RADIO SERVICES:

The following is a more detailed description of each of the above services:

1. MULTICASTING

- a. **Concept:** Multicasting is the ability of an HD Radio FM station to transmit one, two or three audio channels (HD2, HD3, HD4)- and possibly more in the future - in addition to a digital version of the main analog program (HD1).
- b. **User Experience:** A listener with an HD Radio receiver will discover these new channels as he tunes his radio dial. For example, in addition to a station's conventional news and information program on 97.1-HD1, he can also find a classical music channel on 97.1-HD2, a jazz channel on 97.1-HD3, and weather information on 97.1-HD4. In some larger cities in the United States, more than twenty new multicasting channels are on the air—including 23 in New York City, 24 in Los Angeles and 25 in Chicago—offering a wide variety of complementary or specialized program formats.
- c. **Technical description:** All the digital programs are multiplexed together into a single wideband data stream that is transmitted on low-power digital sidebands adjacent to the station's analog signal. All signals fit entirely inside the station's authorized channel spectrum mask. Each FM station has 96-120 kbps of audio bandwidth available, which is divided among the HD1 to HD4 channels. The audio codec provides sufficient audio quality to support multiple, high-quality multicasts (See Section C, below).
- d. **Receiver requirements:** Multicasting is a standard feature of HD Radio technology, and so there are no special requirements for receivers. All HD Radio receivers are capable of receiving multicasting channels.
- e. **Transmitter requirements:** Stations that desire to broadcast multicasting channels must install an additional piece of transmission equipment called an "Importer". No other transmission system changes are needed.
- f. **State of commercial implementation:** Over 1,300 multicasting channels are on the air every day in the United States, and about 20 more channels are operating in Mexico and other countries. 1,140 stations are broadcasting HD2 services, 270 are broadcasting HD3 services and 20 (and growing) are broadcasting HD4 services. Public broadcasters have especially embraced multicasting because it offers them an opportunity to provide a greater range of program services to their communities. The 100+ commercially available receivers support multicast services.



2. PROGRAM SERVICE DATA (PSD):

- a. **Concept:** Program Service Data (PSD) is an important component of the HD Radio technology. It consists of textual information that is transmitted by an HD Radio station and displayed on the consumer's digital radio receiver. This can be "Fixed PSD Data" (a single text message that is continuously displayed on the listener's receiver) or "Dynamic PSD Data" (text information that changes dynamically with every song or program element). PSD Data is a standard HD Radio feature enabled for all AM and FM stations, including multicasting channels.
- b. **User Experience:** When fully implemented by an HD Radio station, the listener will see text on his radio's display that changes continuously and relates to the program he is hearing. This information can include a song title and the name of the artist, the station name or slogan, weather information, the phone number or web site of a commercial sponsor, or any other useful information that the station chooses to transmit.
- c. **Technical description:** There are several PSD fields which are populated with metadata by the station. These are:
 - Artist
 - Title
 - Album
 - Genre
 - Comment
 - Commercial
 - Unique File Identifier (UFID)

The Commercial field can be used to transmit information related to the merchandise such as a text description, a web site address, etc. The UFID contains a unique identifier for each song.
- d. **Receiver requirements:** The receiver requires a display to show the textual information. All HD Radio receiver products support the display of PSD data. Because PSD is a fundamental feature of the HD Radio system, no special application software is required in the receiver.
- e. **Transmitter requirements:** PSD data is delivered to the HD Radio encoding equipment ("Exporter" or "Importer") via a standard Ethernet connection. The applications that generate the actual PSD data are not a part of the HD Radio system. There are several studio automation vendors that provide commercial software products for the creation of dynamic PSD, including ENCO Systems, Broadcast Electronics TRE, Arctic Palm and WireReady.
- f. **State of commercial implementation:** The majority of the 2,200+ HD Radio AM and FM stations have successfully implemented PSD Data. A great majority of the 100+ commercially available receivers support PSD services.



3. ARTIST EXPERIENCE

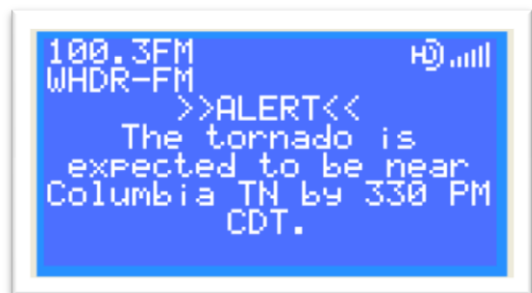
- a. **Concept:** Artist Experience is the synchronous transmission, delivery and display of images on a receiver that relate to a specific audio segment. This can be the cover of a CD, artist photos, other images related to the song or audio being played, or commercial information. The image is synchronized with the song or audio being played. If an image is unavailable or is not received, the station logo or other default image is displayed on the receiver.
- b. **User experience:** The user will observe images on his radio screen that change in relationship to the program content. The kinds of images that can be displayed include album covers, images of music artist or the radio station's air talent, station logos, weather maps, contest or promotional images or commercial images.
- c. **Technical description:** Images have a maximum resolution of 200x200 pixels with a maximum file size of 24 Kbytes, and can be formatted as either JPEG or PNG files. The image support data client is optimized to make use of the available bandwidth based on the following factors.
 - Size of image
 - Image repeat rate
 - Image data transfer rate

The images are transmitted in advance of the corresponding audio segment, and then a trigger is transmitted at the start of the audio segment to display the image. PSD messages must also be synchronized with the start of each new segment or song so that the image and message can be displayed together at the beginning of the song.
- d. **Receiver requirements:** Receivers require a color screen and the appropriate software interface.
- e. **Transmitter requirements:**
 - Importers must use software v. 4.3.1P1 or later. The Importer must be configured to the requirements of the artist experience data client vendor.
 - Exciters/Exporters must use software v. 4.3.2 or later
- f. **Studio requirements:**
 - The use of image Support Client/studio automation software based on MSAC v. 1.0.8 or higher
 - Automation systems must incorporate HD Radio HDP PSD SDK v4.7 or later
 - Studio automation software that supports Artist Experience is commercial available from the following software suppliers: Broadcast Electronics, Emmis Interactive, Jump2Go.
- g. **State of commercial implementation:** Over 100 FM radio stations in the United States are now broadcasting Artist Experience images. Automakers Volkswagen, Chevrolet, Buick, GMC and BMW are offering receivers that support Artist Experience services, and many additional automakers, including Lexus and Toyota, have radios in development which will support Artist Experience services.



4. ACTIVE ALERTS

- a. **Concept:** Active Alerts is a comprehensive emergency notification system that government agencies can use to warn the public in the event of national or local security threats, child kidnappings, weather or earthquake hazards, or any other situation requiring immediate public notification. It provides enhanced emergency audio, text, and data information that is delivered via HD Radio digital channels. iBiquity has worked in cooperation with Global Security Systems (GSS), Sage Alerting Systems, and other industry emergency notification system manufacturers to integrate this technology into commercial systems. iBiquity also worked with National Public Radio (NPR) to incorporate special accessible messaging capabilities designed for the deaf or people with other sensory disabilities.
- b. **User Experience:** If there is an emergency requiring public notification, the user's Active Alert radio will sound an alarm and provide audio announcements, text alerts and image information. Among the many possible receiver capabilities, radios can quietly monitor the designated alerting stations in the background 24 hours a day, and will "wake-up" from a sleep state if an alert is received.
- c. **Technical description:** The HD Radio Emergency Alert broadcast protocol is compliant with the Common Alerting Protocol (CAP) message definition and Integrated Public Alert and Warning System (IPAWS) technology adopted by FEMA and other United States emergency organizations. The Active Alerts feature is compliant with any CAP message definitions. Multi-channel HD Radio technology also permits the transmission of alert messages in different languages simultaneously by using different audio channels. Because the messages are delivered digitally, Active Alerts provides faster and more detailed information than traditional emergency alert systems.
- d. **Receiver requirements:** The receiver must incorporate Active Alerts command, control and display functions in the radio software. As conceived, not all radios would have this function, but specialized Active Alerts radios would be made available for use in homes, offices, schools and other environments.
- e. **Transmitter requirements:** Requires an ENDEC encoding system with compatible firmware to interface with the Active Alert communication protocol in the Exporter.
- f. **State of commercial implementation:** Active Alert was first demonstrated in 2010 on WAMU in Washington, DC. It is now operating on two Greater Media HD Radio FM stations in Detroit, Michigan, and is being prepared for adoption by major broadcasters nation-wide. The Active Alerts software is extremely flexible, and so it can be modified to meet the unique needs and protocol requirements of Brazil.



5. SONG TAGGING

- a. **Concept:** Tagging provides a simple way for radio listeners to capture information about songs heard on the radio for future purchase.
- b. **User experience:** The radio listener can “memorize” information about a song he is listening to on an HD Radio station by simply pressing the TAG button on the receiver, which stores the song title and artist information in the receiver’s memory. This information can be manually reviewed later by the listener, or automatically transferred to an iPod® or iPhone® for later purchase from the Apple iTunes® on line store.
- c. **Technical description:** The feature utilizes ID3v2.3 program specific data (PSD) fields for Song Title and Artist. Additional database codes can be added to the UFID field. When requested, the receiver stores a small token file (500 bytes) of information to identify the specific song and radio station which is used for later purchase of the song. The radio device will transfer the token file to a smart device (smartphone) for access to the music store application.
- d. **Receiver requirements:** The receiver requires appropriate application middleware and a hardware or software TAG button.
- e. **Transmitter requirements:** The Program Service Data PSDSDKGen software (v4.8 and above) resides on the studio automation system and formats PSD data for compatibility with the HD Radio broadcast.
- f. **State of commercial implementation:** TAG buttons are provided on dozens of models of HD Radio receivers, including radios provided by many automobile brands. The Tagging feature is supported by iPod® and iPhone® products, and by the Apple iTunes® on line store.



6. HD TRAFFIC

- a. **Concept:** HD Traffic is a data service unrelated to radio broadcasting, but which is transmitted to consumers over a radio station's HD Radio Datacasting channel. It is a new business model that provides a new source of revenue to broadcasters. Data about current traffic conditions is continuously transmitted via HD Radio Datacasting and is received on a specialized personal navigator via an imbedded HD Radio receiver chip. This information is integrated into the navigator's screen, informing the driver about traffic delays and suggesting alternate routes.
- b. **User experience:** HD Traffic assists a driver by helping him to avoid traffic congestion and delays, speeding his arrival and improving driving safety. It is a consumer service provided by his personal navigator, and the source of the data and transmission method is transparent to the user.
- c. **Technical description:** HD Traffic data is sent over a dedicated HD Radio Datacasting channel that is transmitted by one or more FM broadcasters in a given city. Analog RDS (Radio Data Service) channels may optionally be used to provide service in regions that do not have participating HD Radio stations, but data delivery by HD Traffic is up to ten times faster than RDS transmission.
- d. **Transmitter requirements:** software LOT SDK v4.3.3 or MSAC v1.0.8 or higher.
- e. **Receiver requirements:** Specialized personal navigators with embedded HD Radio receiver chips and appropriate interface software. The developer of the device may elect to optionally provide digital radio audio, or it may be a dedicated navigation device.
- f. **State of commercial implementation:** This service is already in advanced commercial implementation in the United States, offered by a consortium of several companies. The HD Radio transmission services are provided by Total Traffic Connect (Clear Channel radio stations nationwide) and the Broadcasters Traffic Consortium (a cooperative of eight radio station group owners*), with the traffic information being provided by NAVTEQ. Clear Channel and the Broadcast Traffic Consortium have each built national networks to broadcast HD Traffic. Specialized personal navigation devices with HD Radio receiver chips are provided by Garmin (Nüvi 3490LMT and GTM60 adaptor), and the service is also available in the integrated navigator functions of car radios offered by JVC (KW-NT500HDT and KW-NT800HDT) and the 2014 Mitsubishi Outlander automobile. Toyota and Lexus also recently announced plans to offer receivers that support HD Traffic services. The purchase price of the navigation device includes traffic service for the life of the unit. A portion of the device's selling price covers the traffic service, and this money is divided between the data service provider and the broadcasters. (See <http://www8.garmin.com/traffic/> for more information about existing commercial services provided, including a list of cities and coverage maps.)



**The Broadcasters Traffic Consortium consists of Beasley Broadcast Group, Bonneville International, Cox Radio, Emmis Communications, Entercom Communications, Greater Media, National Public Radio and Radio One.*

7. TEXT AND INFORMATION SERVICES

- a. **Concept:** Continuous real-time text information is transmitted via HD Radio datacasting. This provides diverse text content that is available at the touch of a button on the displays of HD Radio receivers equipped with this feature. Fraunhofer Institute's *Journaline* is one example of a text and information service that has been commercially deployed via HD Radio datacasting.
- b. **User experience:** The listener selects the appropriate menu option on his HD Radio receiver to see immediate textual information such as news headlines, sports scores, weather and other information of interest, without any cost or subscription requirement.
- c. **Technical description:** Middleware on the transmission and reception sides allows the delivery of textual information via hierarchically-structured topic menus. This can take the form of an electronic newspaper or magazine. Broadcasters can incorporate data from existing sources such as RSS feeds and XML data. The information is encoded in a binary form and compressed to minimize transmission bandwidth.
- d. **Transmitter requirements:** Packet data service interfacing to MSAC v1.0.8 or higher, plus Journaline application software and a license from Fraunhofer Institute, or other equivalent application middleware.
- e. **Receiver requirements:** An HD Radio receiver with a suitable screen for textual display, and incorporating the appropriate client application software.
- f. **State of commercial implementation:** Journaline services are now being transmitted by Clear Channel radio stations in the United States. The first Journaline-enabled HD Radio receivers were introduced to the market in January, 2010. Current products include the JVC KW-NT50HD5, KW-NT500HDT and KW-NT800HDT navigation receivers.



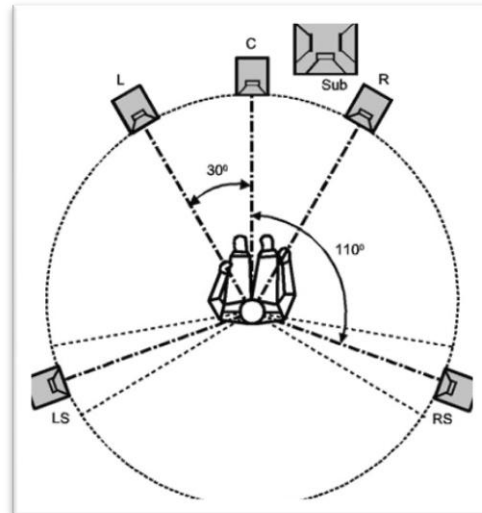
8. ELECTRONIC PROGRAM GUIDE

- a. **Concept:** The program schedules of all radio stations in a community are compiled and transmitted via HD Radio Datacasting to consumer receivers.
- b. **User experience:** Listeners can review a list of available programs on their radio screens and select the programs they want to hear directly from the schedule.
- c. **Technical description:** Each radio station in a community assembles a list of its daily programs and sends it to a central web address, where the schedules of all stations are combined into a single list. This list is then sent back to each station for transmission via HD Radio datacasting.
- d. **Receiver requirements:** Application software and a screen suitable for displaying multiple lines of text.
- e. **Transmitter requirements:** MSAC v1.0.8 or higher and 3rd party broadcast service bureau.
- f. **State of commercial implementation:** This application has been developed and tested; and commercial implementation planning is in progress.



9. SURROUND SOUND

- a. **Concept:** Surround Sound 5.1 channel audio is transmitted via HD Radio Technology. The system has been successfully tested with all commercially available surround sound technologies (matrix systems DTS-Neural, Dolby Pro Logic II and SRS; and also the MPEG spatial system).
- b. **User experience:** Instead of placing the sound source in front of the listener and using two speakers to create a stereo effect, surround sound places five or more speakers in a circle around the listener, placing him at the effective center of the sound. The technique enhances the perception of spatial sound, allowing the listener to identify the location or origin of a sound in both direction and distance. Unlike conventional stereo, the listener does not need to be in the "sweet spot" between the speakers for the best effect. The result is an improved listener experience, especially for motion picture sound and symphonic recordings.
- c. **Technical description:** The source audio is recorded discretely with four or more channels, which are then matrixed down to a two-channel stereo-compatible signal by means of psycho-acoustic software algorithms. The resulting two-channel signal is decoded at the receiver with a reverse algorithm to recreate a realistic approximation of the original Surround audio.
- d. **Receiver requirements:** Receivers must incorporate the appropriate Surround decoding software and provide output feeds for the correct number of channels. Because the radio broadcasting industry has not selected a single Surround technology as an industry standard, receiver manufacturers have not been willing to offer commercial radios with this feature.
- e. **Transmitter requirements:** Transmission using any existing watermarked Matrix Surround technologies is easily accommodated by HD Radio technology, because the matrixed audio is fed to the HD Radio audio chain in the format of a standard two-channel audio signal. This device is independent of the HD Radio equipment.
- f. **State of commercial implementation:** The HD Radio technology was demonstrated with all four major surround sound systems at the 2005 NAB convention. Surround reception via the HD Radio system was also demonstrated in a Lincoln MKT automobile at the 2010 CES convention. Public radio station KVOD broadcast live the entire 2006-2007 Colorado Symphony Orchestra season utilizing HD Radio technology and the DTH-Neural system. HD Radio technology is ready to support the commercial implementation of various surround sound technologies based on manufacturer/consumer demand of surround-sound services.

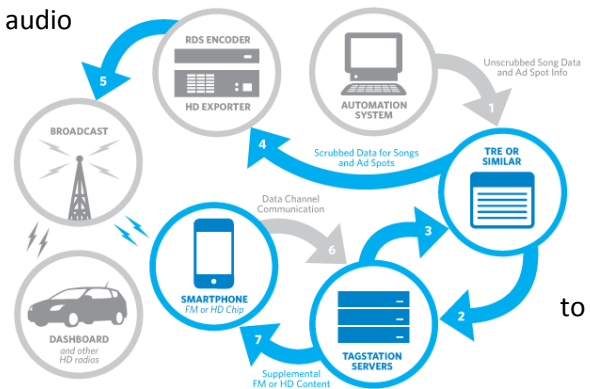


10. NEXTRADIO / TAGSTATION:

- a. **Concept:** Developed by the radio broadcaster Emmis Interactive, NextRadio™ and TagStation® are advanced interactive middleware applications designed for cellular telephones that incorporate HD Radio reception. NextRadio is the middleware application that resides in the cellular phone, while TagStation is the broadcaster's Datacasting transmission application. When used together, NextRadio and TagStation combine HD Radio Datacasting from radio stations with a cellular data return channel, permitting interactive functions such as social network sharing (Facebook, Twitter), delivery of discount coupons by radio, contest participation, song tagging and other advanced features.

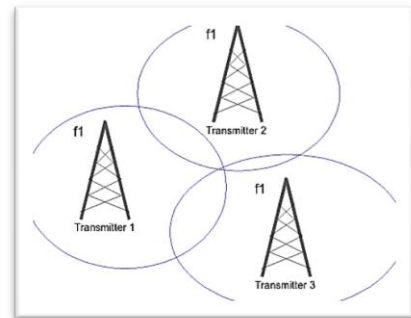


- b. **User experience:** Though his integrated smart phone/digital receiver, a radio listener can share his listening experience through social media or SMS messages, save information about favorite songs for purchase, capture and use discount coupons broadcast by the station, send messages or contest entries to station disk jockeys, save information to his calendar about events promoted by the station, and other interactive functions.
- c. **Technical description:** The broadcaster's audio software and hardware connect with TagStation servers over the Internet and send encoded information about their program content to the servers. These servers create the specialized TagStation data that is returned to the station over the Internet, which is then transmitted via HD Radio broadcasting to smart phones that incorporate an HD Radio receiver chip and the NextRadio application. A response from the telephone user is returned via the cellular data network and then forwarded to the TagStation servers by the cellular provider, and from there it is returned to the radio station over the Internet.
- d. **Receiver requirements:** A cellular smartphone with integrated NextRadio middleware and an HD Radio receiver chip.
- e. **Transmitter requirements:** Installation and configuration of TagStation software with internet access at the broadcast studio; connection to the HD Radio Importer via MSAC v1.0.8 or higher. The radio station's audio automation system must be capable of integrating with the TagStation software. The Importer must have Internet access, and the Importer and Exporter must be using software version 4.3X or later.
- f. **State of commercial implementation:** Many radio stations are already utilizing TagStation software. The NextRadio application has been field tested and is currently being marketed to the wireless industry. It represents one example of how advanced and powerful middleware applications can be developed by third parties and incorporated into HD Radio technology. For more information, see <http://www.nextradioapp.com/>



11. SINGLE FREQUENCY NETWORK

- a. **Concept:** A single-frequency network (SFN) is a broadcast network where several FM transmitters at different locations simultaneously transmit the same program on the same frequency channel. In addition to an FM station's primary broadcast site, additional transmitters ("repeaters" or "boosters") are placed at other locations to augment the station's coverage area, or to fill in holes in the primary coverage area caused by terrain obstructions. The SFN transmitters broadcast the same program services as the main transmitter (both HD Radio and analog services), and its frequency and data clock rate are synchronized with the primary station.
- b. **User experience:** The listener experiences little or no loss of service when traveling out of the main transmitter's coverage area and into the repeater's coverage area. The transition between the two signals can be especially transparent when the listener is receiving in the HD Radio (digital) mode.
- c. **Technical description:** Successful operation of a synchronous FM repeater is difficult to achieve in the analog realm without creating audio distortion in the receiver due to phase and modulation differences between the two signals. However, this technology is well suited to digital audio broadcasting, which is not degraded by these differences. iBiquity has conducted a number of successful field tests to demonstrate the effective use of digital SFN technology when operating with the HD Radio system. These tests included repeaters that duplicate the entire analog/digital hybrid signal, and others that transmitted just the digital sidebands. In addition to a need to deliver the station's program content to the booster transmitter site, the carrier frequencies of both transmitters and their digital audio word clocks must be locked to a common 10 MHz reference (typically derived from GPS satellite signals). Additionally, the program audio of the main transmitter must be carefully delayed by several microseconds to adjust for any time differences in the audio being delivered to areas of common reception by the two transmitters.
- d. **Receiver requirements:** There are no special receiver requirements.
- e. **Transmitter requirements:** Additional transmitter and antenna installations are placed at strategic locations, and all transmitters' frequencies and word clocks are synchronized to a common reference. Time delay of the primary transmitter's audio is also performed. The repeater's location, transmission power, antenna pattern and other factors must be carefully designed to meet each station's unique coverage requirements.
- f. **State of commercial implementation:** The HD Radio SFN technology was developed with help from an NAB FASTROAD study grant. It has been extensively field tested at iBiquity's experimental station W2XAB in Baltimore, and at commercial FM station WKLB in Boston. A field demonstration of the SFN technology operating over station WX2AB was observed by a delegation of Brazilian government officials in November, 2011. It is ready for commercial deployment by stations operating, or interested in operating, single frequency networks.



C. ADDITIONAL INFORMATION CONCERNING THE COMPROMISE BETWEEN AUDIO AND DATA SERVICES OFFERED AND AUDIO QUALITY:

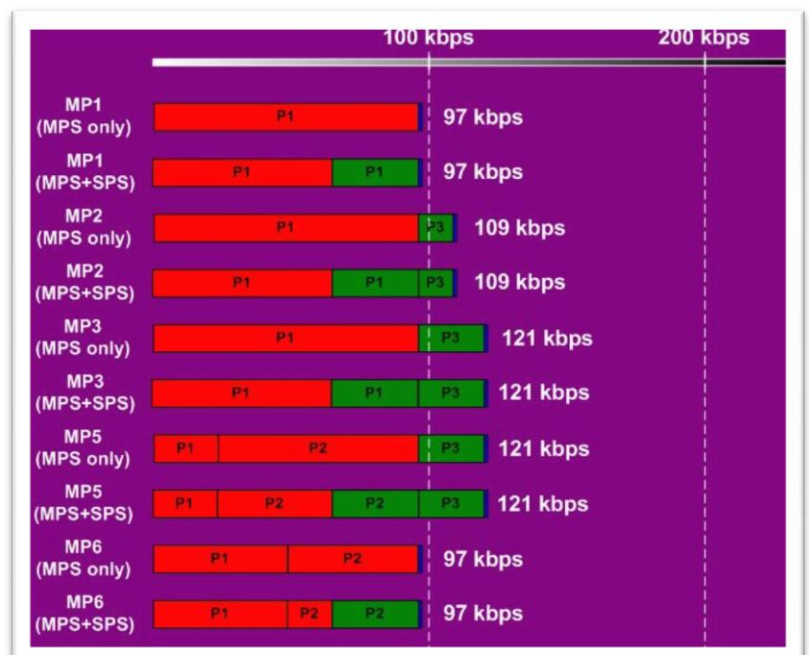
A fixed amount of total bandwidth is available for broadcast by an AM or FM station, as defined in the following table:

FM MODES:	Approximate data rate (kbps)					Waveform
	P1	P2	P3	P4	PIDS	
MP1	98				1	Hybrid FM
MP2	98		12		1	Extended Hybrid FM
MP3	98		24		1	Extended Hybrid FM
MP11	98		24	24	1	Extended Hybrid FM
MP5	24	74	(same as P1)	24	1	All Digital FM
MP6	48	48	(same as P1)	(same as P1)	1	All Digital FM
AM MODES:	Core carriers:	Enhanced carriers:				
MA1 Core	20	0				Core AM Only
MA1 Enhanced	20		16			Core + Enhanced AM
MA3 all digital	20		20			All Digital AM

Table 1: HD Radio AM and FM bandwidth options

The total available data bandwidth defined above can be allocated dynamically by the broadcaster between audio and data services. For FM HD Radio broadcasting, one to four program services can share the total available data bandwidth. A data sampling rate is assigned to the main program channel (HD1) and to each multicasting channel (HD2, HD3 and HD4), and these rates will define the received audio quality of those channels.

The number of bits assigned to each channel (from 16 to 96 kbps) is defined in software, giving the approximate audio performance specifications shown in Table 2:



Decoder rate, Core	Decoder rate, enhanced	Audio frequency response (Hz)	Dynamic range	Stereo separation (dB)	Quality level	FM service mode
FM SERVICES:						
96	0	20 to 20,000	96 dB	70 dB	Virtual CD	MP1-MP4
48	48	20 to 19,000	96 dB	70 dB	Virtual CD	MP6
48	0	20 to 15,000	65 dB	50 dB	FM stereo	MP6
24	72	20 to 16,000	96 dB	70 dB	Virtual CD	MP5
24	0	20 to 15,000	65 dB	Mono	FM Mono	MP5
AM SERVICES:						
20	16	20 to 15,000	72 dB	70 dB	FM stereo	MA1
20	20	20 to 15,000	72 dB	70 dB	FM stereo	MA1
20	0	20 to 15,000	60 dB	Mono	FM mono	MA1
20	0	20 to 15,000	60 dB	Mono	FM mono	MA1

Table 2: Approximate perceived AM and FM audio quality for different data rates. (NOTE: Because of data reduction techniques used by all audio codecs, it is not possible to accurately quantify audio quality.)

The “Datacasting” portion of the signal is any remaining part of the bandwidth that has not been assigned to audio channels, and it can be allocated to one or more data services. It is completely flexible in its usage, and can be configured to transmit either discrete files, packets or a continuous one-way data stream. The only requirement is for the creation of server and client applications for both the transmission and reception sides that utilize a common protocol and data format to provide for effective data transfer. The result is a flexible and efficient one-way, one-to-many data “pipeline” that can be utilized by application developers for any conceivable specialized purpose.

Existing HD Radio services that utilize the Datacasting bandwidth include Artist Experience, Journaline, Traffic, and the Electronic Program Guide.