DIGITAL DASHBOARD BEST PRACTICES REPORT

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IINAB®
NATIONAL ASSOCIATION OF BROADCASTERS

NAB DIGITAL DASHBOARD BEST PRACTICES REPORT

EXECUTIVE SUMMARY

In early 2017, NAB commissioned a project designed to help radio broadcasters better understand the way broadcast radio stations are displayed on automobile dashboards. The "good old days" when car radios consisted of two knobs and five preset buttons have been replaced by a modern-day array of displays, touch screens, features and the ability to enjoy audio content from a multitude of providers. Technology also affords broadcasters the opportunity to display on-dash station identification, artists, titles and images, as well as format and personality information.

While the broadcasting industry's competitors, including SiriusXM and Pandora, have a unified look and feel on the dashboard display, there is a lack of standardization among radio broadcast stations in the ways that content is displayed on both analog FM, using Radio Data System (RDS) and HD Radio receivers. Listeners scanning the dial will likely encounter a wide array of display formats.

This NAB project was designed to analyze the current state of broadcast station dashboard identification and develop a best practices guide radio companies can adopt. The goal is for broadcast radio to embrace a more unified display style that will achieve a positive, consistent user experience for drivers and passengers. To accomplish this, the industry will need a high level of collaboration between management, ownership, programmers, digital managers and engineers.

Jacobs Media and engineering consultant Glynn Walden collaborated with NAB staff and the NAB Auto Initiative Committee on this work. Jacobs Media conducted three in-market audits in Grand Rapids, Mich., (5/19) Philadelphia, Pa., (6/1) and Charlotte, N.C. (6/2), spending one day in each metro monitoring commercial FM radio stations in vehicles equipped with RDS and HD Radio with Artist Experience receivers. The audits were conducted during three dayparts - morning drive, midday and evening drive - and the information on the receiver displays was captured on video. Jacobs Media, in conjunction with NAB, developed a scoring system to tabulate the results.

Concurrently, Walden interviewed multiple system providers and engineering specialists. In the process, he developed additional best practices from an engineering perspective.

Key findings from the audits include:

There is room for improvement. The display of radio station text and image information is generally inconsistent, creating a sub-optimal user experience. Standards for formatting and composing information for dashboard display need to be developed and adhered to by broadcasters. While some broadcasters provide a quality in-car display experience, there are too many situations where information is spotty or inaccurate, content is redundant, there are typos and superfluous information and other elements that are impediments to a positive display look for broadcast radio operators.

The radio industry needs a standardized approach. The audit spawned a series of improvements broadcasters can make on both RDS and HD Radio systems:

- **Dynamic vs. static information.** Some stations provide a static environment for their content, while others use a dynamic approach and "scroll" or "chunk" information, creating a sub-optimal experience that can be harder to read. Overall, static is preferred over dynamic, but since many vehicle displays (typically character-based displays) rely on dynamic text, this practice is likely to continue. When using dynamic text, chunking is preferred over scrollin

- **Album art for FM-band HD Radio stations.** There is a lack of consistency in the use of display pictures and illustrations when music is playing. Some stations don't provide any album art, and in some vehicles (including the ones used for this audit) this can result in display of an artist photo or generic format slide originating from the car receiver, which is sometimes incorrect (in these receivers, a broadcaster-supplied image such as a station logo or album art will always be used in place of the receiver-based images). Spoken word stations are often poorly depicted in the Artist Experience format, infrequently displaying station formats and personality shows.

- **Case consistency.** Some stations use all caps, while others blend in all caps for some items and title case for others.

There is a lack of consistency during commercial breaks. There is no industry standard for showcasing advertisers during commercial breaks. Some stations continue to scroll or chunk station information, such as call letters or slogans, on RDS systems during commercials. In HD Radio receivers with Artist Experience, some receivers display a generic format slide in the absence of any broadcaster-supplied images, while others present a station logo, missing a valuable and sellable advertising opportunity.

Inconsistent use of available fields. RDS systems have two available fields for content display. The Program Service (PS) field has both static and dynamic capabilities and is comprised of just eight characters. It typically resides at the top section of the dashboard display. The RadioText (RT) field is comprised of up to 64 characters and is typically on the lower portion of the dashboard display.

The audits found there is no standard use of content displayed in these two fields. Some stations show title and artist along with the station's slogan and call letters in the eight-character PS field. Others show the station's slogan in the RT field only. Still others display the same information in both fields.

There are missed opportunities to showcase HD1 (main channel) stations, especially in the spoken word formats. Many stations miss the opportunity to brand their stations, high-profile personalities, morning shows and talk show hosts. This includes the name of programs, personality pictures or show or program logos. While music stations rely heavily on album art, talk radio stations are grossly under-identified on dashboard displays.

HD multicast channels generally lack branding of any kind. Rarely is there clear branding and identification of HD2, HD3 and HD4 stations that set them apart from their HD1 parent. Multicast channels are almost uniformly referred to as "WXXX HD2" despite the fact they often feature vastly different programming from their HD1 originating station.

Format designations need to be reviewed and expanded. Too often, the name of the format of the station is incorrect, or is simply listed as "Other." Classic Rock stations are often designated as "Rock." Hip-hop stations are listed as "R&B." Upon investigation, it became clear that not all popular radio formats are included in the system directory, and modifying them is an arduous process.

As part of this NAB project, this best practices document has been developed for programmers and engineers that provides basic recommendations for broadcasters to upgrade their in-car dashboard appearance.

TABLE OF CONTENTS

The National Association of Broadcasters is the voice for the nation's radio and television broadcasters. As the premier trade association for broadcasters, NAB advances the interests of our members in federal government, industry and public affairs; improves the quality and profitability of broadcasting; encourages content and technology innovation; and spotlights the important and unique ways stations serve their communities.

NAB delivers value to our members through advocacy, education and innovation.

OVERVIEW

In early 2017, NAB commissioned a project designed to help radio broadcasters better understand the way broadcast radio stations are displayed on automobile dashboards. The "good old days" when car radios consisted of two knobs and five preset buttons have been replaced by a modern-day array of displays, touch screens, features and the ability to enjoy audio content from a multitude of providers.

Today, it's not uncommon for a consumer to access audio content in their vehicle from satellite radio, mobile streaming audio apps and AM and FM radio stations. Yet, for the most part, each provider is displayed differently on the dash. Most of the time, platforms like SiriusXM and Pandora are consistent in their approach, offering clean, professional displays. When a listener switches channels within those platforms, they know what to expect.

This is not the case with broadcast radio. There is a lack of standardization among radio broadcasters in the ways content is displayed on the dash. This is the case across the two main systems in use – Radio Data System (RDS, for analog FM) and HD Radio (for AM and FM). When a listener scans the dial, it is likely they will encounter a wide array of content display formats, often significantly inconsistent. In many cases, the quality of a broadcast radio's station content display is subpar or isn't taking advantage of the available technology, failing to equal the consistent levels from the aforementioned mobile streaming and satellite radio competitors.

This is a critically important issue for radio broadcasters because the automobile is the number one listening location for radio station content. Gone are the days when the radio industry had this real estate to itself. The bar has been raised by new competitors, the auto industry continues to invest in new dashboard displays and technology and there is a much lower barrier to entry for content providers. This is turf that broadcasters need to strengthen by improving the user experience on auto dashboards.

This NAB project's mission is first to assess the current state of broadcast radio's use of dashboard displays in cars and trucks and then develop best practices that most radio companies can adopt. To accomplish this, the industry will need a high level of collaboration between management, ownership, programmers, digital managers and engineers.

There are two significant benefits for the radio industry in adopting these best practices. First, content in vehicles would be displayed in a more consistent way that makes it easier to understand and more enjoyable for listeners, who now have many different audio options in cars. Broadcasters need to ensure that at minimum, they present a quality visual experience equivalent to satellite radio and pure-play streaming services like Pandora and Spotify.

Second, the radio industry can demonstrate to the automotive industry that radio provides a quality in-dash experience. The way radio is presented in the car makes a statement to the automotive industry at all levels. For example, at the local level, when an auto dealership salesperson or trainer is showcasing a new car to a potential customer, the entertainment system is always demonstrated, usually to show off the best-looking content. By enhancing the way that radio is displayed, the likelihood of being a part of that demonstration will be increased.

NAB has long-term goals relating to radio's future in the car and the radio industry's relationship with the auto industry. In the short term, an industry-wide effort to improve the ways in which radio is displayed in fully-equipped recent model-year and new vehicles as well as in older cars and trucks is an important initiative that can benefit broadcasters in myriad ways.

Thus, the goals of this project are to improve the consistency and quality of the metadata - textual information such as song title and artist or format type - fed into in-car radio receivers, and establish best practices for the way it is displayed, while having the most positive achievable impact. It is noted that given the extraordinary number of radio receivers and displays in automobiles, some which have been in service for a few decades, the goal of reaching a 100 percent solution is unlikely. When developing best practices, our intent is not to disenfranchise listeners with older vehicles.

Jacobs Media and engineering consultant Glynn Walden collaborated with NAB staff and the NAB Auto Initiative Committee on this work. Jacobs Media conducted three in-market audits in Grand Rapids, Mich., (5/19) Philadelphia, Pa., (6/1) and Charlotte, N.C. (6/2), spending one day in each metro monitoring commercial FM radio stations in vehicles equipped with RDS and HD Radio with Artist Experience receivers.[1]

It is important to note that three markets do not constitute a definitive sample of radio markets throughout the U.S. However, the results of the audits produced a level of consistency in observation of how all the commercial stations in each market are supporting auto radio displays. These audits were not designed to yield definite, statistically significant display grades for the radio industry. Rather, the goal was to get a sense for what most stations are displaying in vehicles across a range of different markets and developing solutions and best practices to improve the situation from there.

Three audits per market were conducted in morning drive, midday and afternoon drive day parts. Radio displays were captured on video as the radios were scanned across the FM dial from 88 to 108 MHz, focusing on the commercial band radio stations. The results were transcribed into an Excel spreadsheet form, noting how each receivable radio station presented itself on the dashboard display. In each market, two cars were utilized for the audit – one with an RDS receiver and one with an HD Radio receiver with Artist Experience in order to observe performance across the full range of modern displays.

The focus of this report is on analyzing and synthesizing this data, as well as the overall experience of observing radio in these vehicles in real-time. Provided herein are recommendations on how broadcasters can improve the way the radio industry is presented on automotive displays, from both an engineering and marketing point of view. For the engineering perspective, Walden interviewed multiple system providers and engineering specialists, developing engineering best practices which are provided at the end of this report.

The combination of these two approaches provides radio broadcasters with a solid roadmap designed to quickly and efficiently enhance the in-car user experience.

MARKET AUDIT INDICATES NEED FOR IMPROVEMENT

The specific results of the audit are provided in a separate report, but the results are clear – the ways in which FM radio is presented in the car need to be properly evaluated by broadcasters on a continuing basis and in many cases significantly improved. While some broadcasters provide a quality HD Radio experience that includes album art, strong station branding and consistently good displays, for too many stations there is little to no information, content redundancy (an artist name and song title appearing in two places on the display), advertiser information on the display during a music or talk segment, typos, a confusing array of upper and lower cases and other signs of display chaos that detract from the overall consistency of the user experience, especially when switching from station to station or platform to platform.

When a driver listens to satellite radio, there is a consistent look and feel across each channel. Channels are branded and there is uniformity from channel to channel. Obviously, this is possible because the SiriusXM array of stations are all controlled by a single broadcaster.

In broadcast radio, scores of different broadcasters offer stations in a given market, thus leading to a lack of consistency and a hodgepodge experience. On a car equipped with an HD Radio receiver, part of this is due to the fact not all stations broadcast the HD Radio digital signal, and offer station information only using RDS. To make matters even more complex, there are essentially two levels of RDS information support – basic, using the Program Service (PS) field and advanced, using the RadioText (RT) field – providing different levels of content displays.

But the biggest problem, regardless of whether or not a driver is in a vehicle with an RDS or an HD Radio receiver, is the lack of a defined look and approach by radio broadcasters to create a standard, pleasing in-car experience. Oftentimes, there's a sense that the metadata is broadcast without being checked or properly edited and that monitoring of the station or the market to detect this is nonexistent. It also appears that different people at stations are responsible for this job (engineers, program directors, etc.), and that the system goes unchecked.

To provide a level of consistency for the audit, a scoring system was created. Every receivable FM station, regardless of the city of license, was observed and rated against several different criteria, grading and scoring each station according to the way in which that station's information was displayed. At the end of each audit, a color grade was assigned to each station as follows:

Green: The station utilized the full display functionality of the system (RDS or HD Radio) and information was displayed properly

Yellow: The station did not properly utilize all of the display functionality

Orange: The station's display functionality was poor or there were errors

Red: There was no display functionality

Below is a summary of how FM radio performs during the afternoon drive daypart in Philadelphia, the best market of the three, in the HD Radio-equipped automobile:

Philadelphia Audit: HD Radio Vehicle, Afternoon Drive

Score	Number of stations	Percent of total
GREEN	7	14%
YELLOW	25	49%
ORANGE	8	16%
RED	11	22%

During this daypart, only one-in-seven (14 percent) stations used the full functionality of HD Radio receiver display systems, while nearly half (49 percent) are under-utilizing these displays in some way.

In most cases, radio appears presented somewhat better in the simpler RDS display than it is on the HD Radio units in the test vehicles. Below is a summary of how FM radio performs during the midday daypart in Charlotte in the RDS-equipped automobile:

Charlotte Audit: RDS Radio Vehicle, Midday

Score	Number of stations	Percent of total
GREEN	9	33%
YELLOW	5	18%
ORANGE	8	30%
RED	5	18%

During this daypart, only one-third (33 percent) of the stations monitored are utilizing the full functionality of the RDS system display in a pleasing way.

Overall, a qualified conclusion about the three markets observed is that, especially for HD Radio-equipped vehicles, the bigger the market, the better the user experience.

All that said, there is a considerable level of subjectivity involved in the recording and scoring of this data. Broadcasters would be wise not to micro-focus on the specific results of particular stations in these markets, but to read this report in a more general way, taking note of the observations and recommendations, and then applying these to their own stations.

As noted, there are uncontrollable factors that impacted these test results, including HD Radio and RDS displays being quite different from vehicle to vehicle, location of the audits themselves, weather conditions, time spent on each FM frequency before returning to the "Scan" feature, and inadvertent errors on the part of the auditors.

AREAS FOR IMPROVEMENT

These audits demonstrate there is much room for improvement.

Realizing the given number of uncontrollable variables – numerous auto manufacturers that don't have their own industry standards, multiple display configurations, different system utilization across broadcast groups, lack of access to HD Radio (or even RDS) systems by some broadcasters and other factors – perfection is not achievable. But by recognizing there are attainable areas for improvement by following the best practices outlined in this report, the radio industry has the opportunity to greatly enhance the in-car user experience for both the audience and the auto industry.

Here are suggested areas of improvement identified by this project:

LACK OF STANDARDIZATION

There are multiple ways in which radio stations are displayed in RDS and HD Radio systems. Examples include:

- **Movement:** Dynamic vs. static information. Static is preferable because the display is more legible, user-friendly and less distracting. While it is more time-consuming to code information to conform with display character limits, in particular the eight character limit of the RDS PS field, the end result is better and cleaner. It should be noted that there a lot of automobiles with receivers that can only display textual information using the eight character RDS PS field, and that the only way to show song title and artist information on these displays is by using dynamic PS. Consequently, at least for the near term, broadcasters are likely to want to use dynamic PS even though it does not look as good as static PS on more modern displays. When using dynamic PS, there are two options, scrolling and chunking, and of these two, chunking is preferable.

- **Album art:** Lack of consistency of use of album art when music is playing, or displaying album art when other programming is on the air that does not correspond to the album art. Some HD Radio stations don't broadcast any album art or station logo images, and in some receivers this can result in display of an artist photo or a generic format slide originating from the car receiver, which is often incorrect (in these receivers, a broadcaster-supplied image such as a station logo or album art will always be used in place of the receiver-based images).

- **Case consistency:** Some stations utilize all caps for all fields, others blend all caps for some items and lowercase for others. All caps has become synonymous with shouting on text and social media platforms. Using uppercase and lowercase is preferred, with uppercase being used just to capitalize words.

RDS: Case Inconsistency
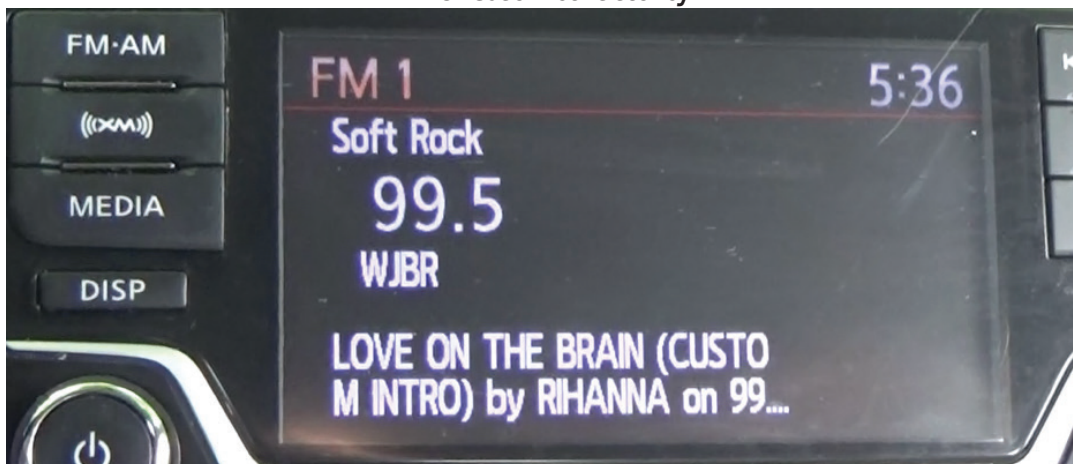
- **Commercial breaks:** There is no standardized approach for when a station is in a commercial break. Some stations continue to scroll information using RDS, such as slogan or call letters. In HD Radio receivers with Artist Experience, some receivers show a generic format slide in the absence of any broadcaster-supplied images. It is recommended that sponsor information, for example, a phone number as is done by SiriusXM, be displayed during commercial breaks. In the case of HD Radio, a sponsor logo should be shown in Artist Experience, which could benefit a station's sales efforts.

Poor Execution During Commercial Break

- **Music stations versus spoken word stations:** Generally speaking, music-formatted stations are showcased better on receiver displays than are spoken word stations, especially on HD Radio receiver displays. Because of the available metadata, it is relatively easy for music stations to have art (usually album art) displayed on a consistent basis concurrent with the content heard on the air. Spoken word stations have very few graphics displayed, thus leading to a sub-optimal user experience and poor in-car marketing and identification.

BRANDING

Many radio stations are missing the opportunity to effectively brand their stations, shows and personalities on in-dash displays. In both RDS and HD Radio systems, there are great inconsistencies in how station slogans and branding are shown on receiver displays. During morning shows, it is rare to see any branding on RDS displays for the names of talent or shows. On HD Radio displays, graphics featuring a morning show's logo or a photo are virtually nonexistent. As noted, spoken word stations – news and sports – are rarely well branded. Most do not feature a host, show name or topic displayed, especially on HD Radio receiver displays.

Given that radio talent is often the cornerstone of a brand, even the biggest stations in the largest markets fail to include program names, much less pictures of talent or program/host logos – a missed opportunity to not only showcase a big program or personality, but offer a differentiator from competitors such as Pandora, Spotify and SiriusXM.

As also noted, it is rare to see branding for HD2, HD3 and HD4 multicast channels. These channels are almost uniformly referred to as "WXXX HD2," despite the fact they often feature very different programming from their HD1 parent. If the multicast channel provides a simulcast of another station in the cluster, often an AM station, branding is rare. Sometimes, in athe case where the simulcast station is identified, it is featured along with the call letters of the HD1 parent station, thus creating branding confusion.

OVERALL CONSUMER EXPERIENCE

The user experience for radio in the auto is lacking in many cases and while this is often attributable to the technology used in the vehicle - for example, a text-only display - drivers aren't usually aware of these technical limitations, nor do they care. As users move from station to station or platform to platform, they expect a level of consistency and quality. Clearly, automakers are upgrading their dashboard display technology to achieve these goals. Many newer vehicles have receivers with pre-stored images that will be selected for display based upon the textual information being broadcast (in particular song title and artist). When broadcasters do not provide their own images, these receiver-based images may be used and the broadcaster has lost an opportunity to be in control of the consumer experience.

The load time of certain display elements on both RDS and HD Radio displays can be painfully slow. On HD Radio receivers, there can be gaps of 30 seconds or more on music stations while waiting for album art to load (sometimes these gaps are unavoidable, for example, when a listener tunes to a station mid-song, and hence, the station was not able to pre-load the image into the receiver as is normally done).

On RDS receivers, textual information is often difficult to read because of inconsistent scrolling or chunking of the information. On some stations, content appears one word at a time, on others it is fed letter by letter. Too often, the listener has to attempt to figure out the message. The net effect is that these data loading issues are annoying and can be embarrassing when only parts of words display and are difficult to comprehend. And of course, from station to station, the displayed information is inconsistent.

Developing a standard approach in the near-term is complicated by the fact that broadcasters are trying to support different types of receiver displays simultaneously. In many vehicles, the displays are character-based and rely on dynamic PS exclusively for textual information. On more modern displays, large LCD color displays offer richer content and support RDS RadioText and HD Radio Artist Experience. To provide support for character-based displays, broadcasters may want to provide more information than just static call letters and the station slogan in the RDS PS field, and instead use a dynamic PS approach. As previously noted, for dynamic PS the chunking approach is preferred over the scrolling approach.

Long-term, the broadcasting industry should consider phasing out or "sunsetting" the support of character-based displays (i.e., the use of dynamic PS), as the penetration of full-featured displays increases. It may also be helpful for broadcasters to reach out to OEM receiver manufacturers and tier one suppliers and make recommendations on how to best handle dynamic PS information on full-featured displays, so as to minimize the issues of content duplication and unnecessary dynamic text movement.

FORMAT DESIGNATIONS

Too often, the name of the station format shown on the display incorrect, or is simply designated as "Other." For example, "Classic Rock" stations are often designated as "Rock," and "Hip Hop" stations are listed as "R&B." This is due in part to the fact that not all popular radio format names are included in the receiver, in particular RDS receivers, and these designations are not easy to modify. This is an issue worthy of further discussion within the broadcasting industry.

INCONSISTENT USE OF AVAILABLE RDS FIELDS

RDS systems have two available fields to display content. The PS field is comprised of just eight characters. For the receivers used in the audit, the PS field typically resides in the top section of the display, and as discussed, the text shown here is often dynamic in nature. The RT field is comprised of up to 64 characters and is usually, but not always, static on the display.

The audit found there is no standard use of the content displayed in these two fields. Some stations show title and artist along with the station's slogan and call letters in the eight character PS field. Others show the station's slogan in the RT field only. Still others have the same information in both fields, with the RT field scrolling and the PS field static.

RECOMMENDED BEST PRACTICES: GENERAL

These are the general areas that radio stations should focus on in order to enhance the way radio is showcased in automobiles. A separate section focusing on Engineering recommendations specifically follows this section.

REVIEW YOUR STATION'S USE OF THE RADIO DISPLAY

It appears that many stations' poor use of the display may result from a lack of continuous review. Many of the errors found could easily be caught by stations if there were a review system in place. It is recommended that each radio station take the following actions:

a. Both the engineering and programming departments need to collaborate on a thorough monitoring of each station's use of auto displays. A video recording of how the station appears on RDS and HD Radio receiver displays, including other, competing stations in the market, would be a plus. This might require renting a vehicle that has the proper in-car entertainment system, although given the diversity of most station staffs, chances are that most stations have employees who own a wide array of equipped vehicles. This exercise should include reviewing each element which will be visible on the display (music, artwork and other information like the station slogan, personalities, etc.) at the point in the station where the information resides, for example, the production system.

b. On a quarterly basis, designate two station employees – one with a vehicle equipped with an RDS receiver and one with a vehicle with an HD Radio receiver with Artist Experience – to conduct a comprehensive monitor of the station, using the recommended web form (below), to ensure that all standards are being met.

OPTIMIZE BRANDING

Broadcasters need to view the dashboard as an opportunity to market and brand their stations, personalities and programs in the most important listening location – the car. In short, this is a branding exercise and opportunity. While having engineering involved is essential, this also requires the vision of a programmer and a strategic sales manager. The recommended best practices to enhance and optimize branding are:

a. Develop standard content practices for music stations

- Capitalization of proper nouns (not entire words) – nothing should be in all caps.
- Consistent use of title and artist when music is played with first name followed by last name ("Bruce Springsteen").
- Removal of metadata notes and codes (Ex: "edited version," "clean version").
- Display name of host and/or show during talk segments.
- Review the static format designation/Program ID.
- During commercial breaks on HD Radio displays, display a logo of the advertiser with phone number or URL, the host or the station if an advertiser logo isn't available. On RDS systems, display the advertiser name and a phone number or URL.

Recommended HD Radio Layout

b. Develop standard content practices for spoken word stations

- Capitalization of proper nouns (not whole words).
- Display the name of the host or program either via text or graphically.
- Review the static format designation or Program ID.
- During commercial breaks on HD Radio displays, display a logo of the program, the host or the station if an advertiser logo isn't available.

c. Create program identification/logos for HD2, HD3 and HD4 channels

- Replace the call letters of the HD1 station as the name of these secondary channels (WXXX HD2), create a brand name that signals to the listener what it is they are listening to.

- Develop a unique logo for each multicast channel to enhance brand identification and listenership.

Well-Executed HD2 Branding
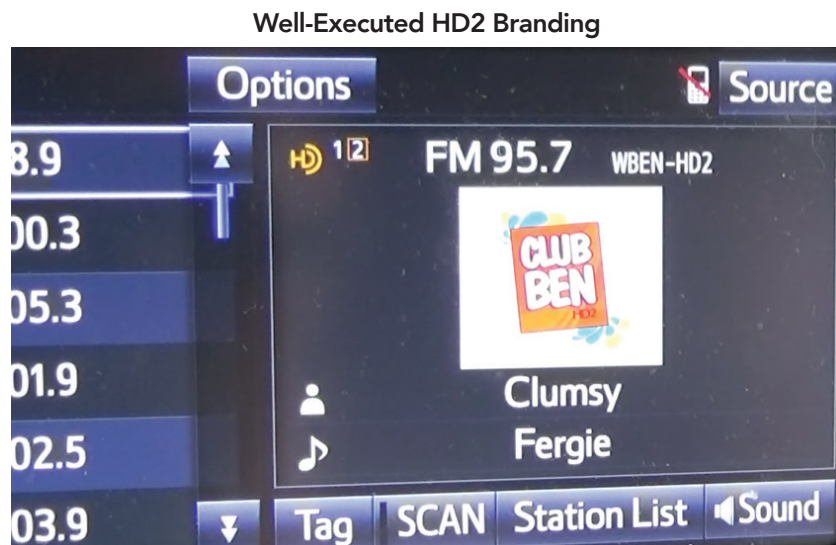
STANDARDIZE USE OF THE RT AND PS FIELDS

Broadcasters need to define the proper use of these two fields in RDS systems. Currently, both fields are used for a multitude of content, creating inconsistency and confusion. As previously discussed, use of the PS field in particular is complicated by the fact that there a lot of automobiles with receivers that can only display textual information using the eight character RDS PS field, and that the only way to show song title and artist information on these displays is by using dynamic PS. It is recommended that each of these fields be utilized in the following ways.

a. PS field – static – Because of the eight character limit, it is recommended that the PS field be limited to station-specific identifiers only, such as call letters, dial position or brief format or slogan information. The limit will require stations to economically use this field to clarify its identification rather than create unnecessary data distractions that go beyond eight characters.

b. PS field – dynamic – For broadcasters who elect to use dynamic PS, chunking of the text is recommended over scrolling of the text. By adopting a more economical approach and appreciating the fact that most listeners are driving, this encourages stations to select the most important word or words for their station to maximize this limited branding real estate.

c. RT field – It is recommended that RT be utilized to showcase what is currently being broadcast on the air. With up to 64 characters, there is ample room for title and artist, a station slogan and the name of the program or personalities or hosts. Stations should also scrub the text to ensure that digital debris isn't included in the RT display. Examples of text needing to be scrubbed includes "clean version," "short version" and other notes that may have been inserted into a station's system when the song was first added that were never meant to be displayed on a receiver.

REVIEW ALL ARTWORK IN THE SYSTEM

FM HD Radio stations need to be broadcasting artwork. Many newer Artist Experience-capable receivers in vehicles will display generic format artwork in place of broadcaster-supplied artwork and oftentimes the graphic is incorrect or odd. It is recommended that each station review the artwork in their system and/or meet with their artwork provider to ensure the proper art is broadcast at all times. It is also noteworthy that broadcaster-provided artwork always has priority in receivers with built-in artwork, so station or program logos should be regularly broadcast when no album art is available.

PROVIDE ENHANCED INFORMATION ABOUT ADVERTISERS

The dashboard affords an opportunity to increase service to advertisers by providing enhanced information on the display while the ad is running. HD Radio's Artist Experience system is capable of displaying an advertiser's logo concurrent with the commercial being broadcast, while the text fields can provide additional information about that advertiser – phone number, URL, etc. However, advertiser information should not be displayed during program content (music, talk, etc.).

PROVIDE ENHANCED CONTENT TO INCREASE LISTENING

The dashboard display provides opportunities to set listening occasions and increase listening. For example, during a sports broadcast, a radio station could display the current score of the game, and at the end of an inning during a baseball broadcast, could display which hitters are coming up in the next inning. Talk programs could display the name of a guest and the topic being discussed. Music stations could display what's coming up next, including songs as well as contests. That said, it is recommended that occasion-setting information be brief, and further recommended that stations do not promote programs or features that are hours into the future.

RECOMMENDED BEST PRACTICES: ENGINEERING

BACKGROUND

Listener expectations have changed and audio entertainment content must be immersive in its engagement and offer a consistent feel across the various platforms upon which it is consumed. The improvements in digital dashboard displays offer radio broadcasters the opportunity to add visual engagement to audio broadcasts. Other audio services such as personal music delivered by a smartphone to the car display and internet (streaming) audio deliver additional program associated data such as the name of the song the artist and a visual display of the album art. Drivers routinely enjoy a consistent visual experience as they move among competing audio services such as Pandora, Spotify, SiriusXM and personal music collections.[2]

Free, over-the-air radio is capable of displaying the same information, however, it is not consistently being transmitted and displayed. This section offers a collection of engineering best practices that will lead to a better understanding of how to transmit this information and encourage radio stations to pay greater attention to accurately presenting these items on digital dashboard displays.

The key to this enhanced experience is metadata, the information associated with a station's audio events - primarily songs, spots and promos - and other related program information like on-air personality names, program names and station program schedules. When utilized effectively, this metadata becomes enhanced content for receiving devices and greatly enhances the listener experience.

To be most effective, metadata should be accurate to, and presented simultaneously with, the audio content being consumed and be transmitted by all stations in a market so that as listeners scan across the band they have a consistent user experience. To achieve this level of effectiveness, broadcasters must standardize their approach to metadata management and implement services that use metadata to enhance the consumer experience.

Radio broadcasters, particularly the major groups, need to make the displaying of visual metadata a high priority for the radio industry. The accurate and consistent delivery of this data involves a joint effort by the station's engineering and programming departments. The engineering department is responsible for the setup and maintenance of equipment that a station likely already has installed and the programming department is responsible for correctly entering the metadata and keeping it up-to-date.

As simple and elementary as it may seem, a quality and consistent visual display of information on today's dashboard has not received the industry-wide focus it should. While the time and energy invested in this project will pay immediate dividends in a better listener experience, the required labor and technical investments will also prepare radio for a smoother and more rapid deployment of future technologies.

METADATA ESSENTIALS

There are two types of metadata that can be displayed on receiver displays in automobiles - text-based and image-based. At present, image-based metadata is only available on HD Radio receivers that support the Artist Experience service, and at present, the Artist Experience service is only supported by FM-band HD Radio services.

As previously mentioned, many newer vehicles that support Artist Experience have receivers with pre-stored images that will be selected for display based upon the textual information being broadcast (in particular song title and artist). When broadcasters do not provide their own images, these receiver-based images may be used and the broadcaster has lost an opportunity to be in control of the user experience.

Text-based metadata is available for analog FM radio services that utilize the RDS digital FM subcarrier as well as for both AM- and FM-band HD Radio services. There are four principal text-based metadata services supported by most current automotive receivers:

1. Program Identification (PI) is used to convey the station call letters;
2. Program Service (PS) is the label of the program service consisting of not more than eight alphanumeric characters coded in accordance with the NRSC-4-B Standard.[3] PS is displayed on RDS receivers in order to inform the listener what program service is being broadcast by the station to which the receiver is tuned. An example for a PS name is "Hot 99.1" which is exactly eight characters long;
3. Program Type (PTY). There are 31 program format genres that can be sent in this field;
4. RadioText (RT) is a 64-character string that can be displayed eight characters at a time in older RDS receivers and as a 64-character field on newer receivers.[4]

METADATA DELIVERY EQUIPMENT

The implementation of RDS data is accomplished by broadcasters using a variety of methods to deliver metadata to transmission hardware. Most stations already have installed some, if not all, of the equipment needed to support metadata and some may need additional support services and software, while others may only need to configure the equipment they have to properly deliver the data to radio receivers.

In the simplest implementations, a station will have the automation system delivering the song title and artist information directly to the station's RDS encoder. This is not a recommended implementation, as the data available for the radio to display is limited and is subject to errors in the station's automation system database.

Additionally, all FM radio broadcast facilities should have a middleware system, either hardware or software-based, a data cleanup and image insertion service and an RDS encoder.[5] HD Radio stations (AM and FM) should have their HD Radio Importers and Exporters updated to the latest software revision which at the time of publication of this document is v4.4.7.[6]

The minimal equipment needed by a station for metadata support over just RDS is:

1. The station's automation system, which stores the songs used by the radio station and is the source of the song title and artist information;[7]
2. An RDS encoder.

Additionally, to improve the dashboard experience, stations should employ middleware. For example, Broadcast Electronics TRE, Jump 2 Go's JumpGate or DTS' Artic Palm.[8] The middleware system can be in the form of hardware or software as implemented on a PC. Middleware delivers the metadata from the station's automation system to the RDS and HD radio equipment. These middleware systems provide for additional functionality including, for example, scheduling of information by show daypart, scheduling of advertising campaigns and synchronizing of commercial information with commercial audio, such as the sponsor's web address, slogan, phone number and display logos.[9]

The middleware can and should be connected to a data correction and image insertion service such as TagStation or QUU interactive that takes raw data from the station's automation or middleware and sends it into the cloud for cleaning up and for providing additional information (with consistent data quality) to the RDS and HD Radio equipment.[10] There are several other systems in use outside of the U.S. that offer this functionality including Music Brain, used by the BBC and 7Digital, used by Radioplayer and DAB. For FM-band HD Radio systems, an example of the additional information to be added is album art for transmission with the Artist Experience feature.

HD Radio Importers and Exporters provide metadata for broadcast by the HD Radio system. The program service data (PSD) for the main channel audio service, HD1 (title, artist, album, etc.) are sent to the HD Radio Exporter along with the HD1 audio stream. The corresponding PSD and audio for multicast programs (HD2, HD3, etc.) are managed in the HD Radio Importer. Additionally, the HD Radio Importer also manages the Advanced Application Services (AAS) metadata including station logo, Artist Experience and traffic data services.

COMMITMENT TO DISPLAYING METADATA ACCURATELY AND CONSISTENTLY

Radio stations should commit to providing the following information, at minimum, to radio receivers to establish a consistent listener experience as radio competes head-on with streaming pure-plays, satellite radio and music collections:

1. Station brand name or station call letters;
2. Station program type ("PTY") identification ("Rock," "Country," "Sports," "Pop," etc.);
3. Title of song being aired or talk program airing;
4. Name of artist performing or talk program host or guest;
5. Album, commercial art or station logos (when available, FM HD Radio only)
6. Data for the RT field.

Typically, items 1 and 2 are accomplished by a one-time setup which occurs when the RDS encoder or HD Radio transmitters are initially deployed. For some stations, the program type may change according to daypart and in those instances this information would be expected to change accordingly.

Items 3 and 4 are typically delivered as an output from a radio station's automation or digital playback system. Item 5 can either come from the station's automation system or a software- or hardware-based data service like TagStation.

For item 6 there is a function that requires an initial setup when installed. The engineer in conjunction with the programming department needs to setup in the middleware precisely which text from the automation system will be sent to the RT field. The middleware assembles the data, some fixed and other as inputs from the automation and TagStation-like services. The RT field can contain song, artist, station slogans, web address, etc. In HD Radio, this field is called PSD. As for RT, PSD is setup in the middleware and is assembled from information from the station's automation system and TagStation-like services.

Information residing in the station's automation service is most vulnerable to errors and omissions that could result in a poor

visual experience in the automotive dash. To create the highest level of standardization, a broadcaster will need to involve the programming department to review the active on-air library, as in most stations this function is not typically handled by the engineering department. Additionally, it is recommended that the station employ a software data service to correct errors in the data contained in the automation system and to provide a consistent data presentation.

METADATA BEST PRACTICES: GET IT RIGHT, RIGHT FROM THE START

The most effective way to manage metadata for the purposes of providing enhanced content to the listener on dashboard displays requires cooperation and effort from multiple departments within the radio station organization.

Engineering resources are best suited to complete technical setup, ensuring that data flows to and from a centralized metadata management system to all appropriate inputs and outputs to support a variety of services like HD Radio, RDS, digital dashboards, hybrid radio services (over-the-air plus broadband), website now playing information, etc.

Content curators from a number of departments (programming, marketing, digital, sales, etc.) are best suited for the day-to-day management of metadata to ensure brand and product consistency. For example, using a centralized management system, someone in programming is likely best suited for song and artist title input, whereas a member of the digital team may be best suited to work with station programming and traffic to establish and maintain the station schedule. Subsequently, a member of the sales team may be best suited for gathering the enhanced content for commercials. These responsibilities will vary by station personnel, staff sizes and departmental structure.

To ensure the highest level of accuracy, it will be necessary for someone at the station who is familiar with the content to review the song title and artist information, looking for:

1. Spelling errors.
2. Use of upper and lowercase spelling and not all capital or all lowercase spelling.
3. Consistent entry of artist names, i.e., first then last rather than mixing first and last with last and first throughout the database.
4. Removal of cryptic notes, primarily directed at the on-the-air talent, from the song title and artist fields as this may confuse the audience if seen on a receiver display. These notes may be visible to the audience and could be embarrassing.

SIMPLE SYSTEM RDS ENCODER ONLY

The simplest metadata delivery system uses a direct connection from the automation system to the RDS encoder.[11] Older systems may use a serial port connection, but most contemporary RDS systems employ TCP connections over ethernet cable. See Figure 1, which depicts the simple RDS system. This is not a recommended set up.
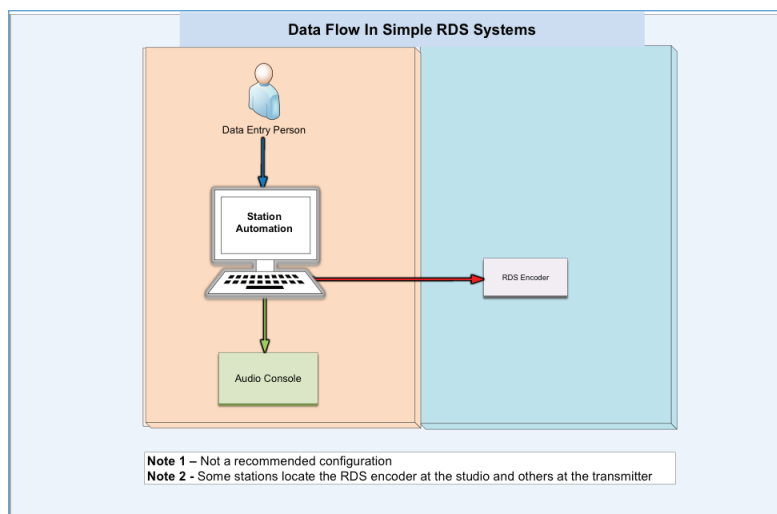

Data Flow In Simple RDS Systems

Data Entry Person

Station Automation

RDS Encoder

Audio Console

Note 1 – Not a recommended configuration
Note 2 - Some stations locate the RDS encoder at the studio and others at the transmitter

Figure 1 – The simplest system employing a direct connection from automation system to RDS encoder

SYSTEM WITH MIDDLEWARE

More sophisticated station metadata delivery setups use a middleware device, either hardware- or software-based, residing on a computer to deliver the metadata to the RDS and HD Radio equipment. These same devices can also supply data to the station's internet streams, websites and "now playing" destinations such as billboards and NextRadio, see Figure 2 below.[12] The system components are typically connected via TCP connections.
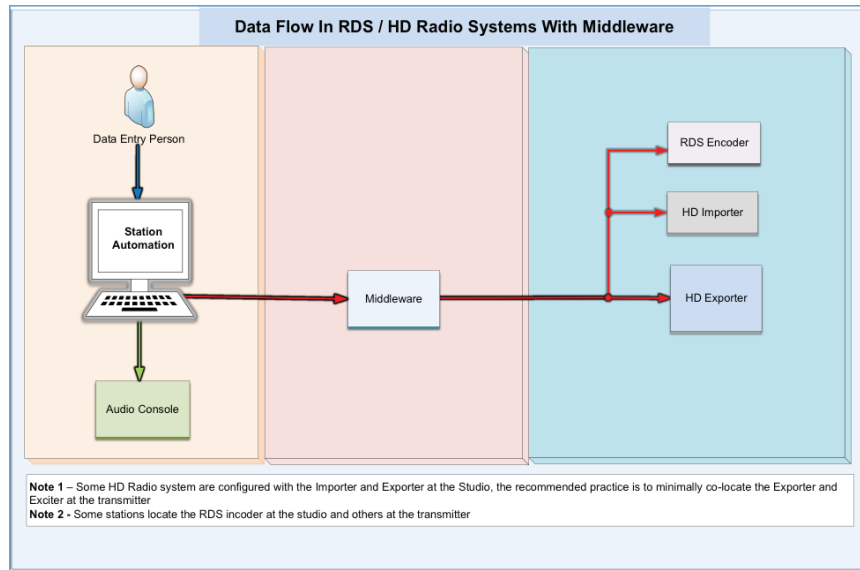

Figure 2 – Metadata delivery system utilizing middleware.

SYSTEM WITH MIDDLEWARE AND WEB-BASED CLEANUP AND DATA ACQUISITION SERVICES

Figure 3, shown below, is a further enhancement of the system shown in Figure 2, providing for the middleware system to send raw data from the automation system, via the web, to a data clean up and image insertion software service like TagStation. Once data clean up and image insertion services are performed, the service returns the data to the middleware for distribution to the RDS and HD Radio equipment. Additionally, the software service can add album art, advertisement art and station logos for stations using HD Radio Artist Experience technology.
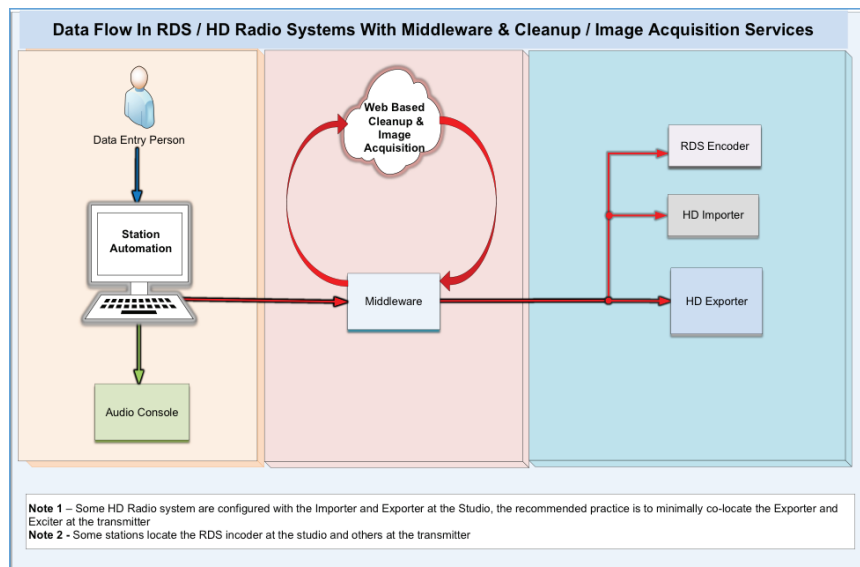

Figure 3 – Metadata delivery system utilizing middleware and cloud based cleanup and image insertion service

LOADING IMAGES IN HD RADIO

The normal data transmission rate of the FM-band HD Radio system is 96 kilobits per second (kbps) within the with an additional 24 kbps of data provided in the extended hybrid mode, which must be divided up among the main channel audio channel, multicast audio channels, data delivery services such as traffic services, the logo service and Artist Experience artwork. The 24 kbps of data in the extended hybrid carriers is not shared with the 96 kbps of data in the normal data carriers. Thus, the 24 kbps delivered by the extended hybrid carriers can only be used in total for data services or a low bit rate multicast audio channel. The bandwidth required for Artist Experience images must come from the 96 kbps of the normal data carriers.[13] The truth is that many stations are using all of their available bandwidth for audio and data services, so in order to support enhanced metadata services like Logo Service and Artist Experience, the stations must make compromises when utilizing their bandwidth.

Xperi recommends that a station set aside four to five kbps to accommodate visual services. This allocated bandwidth is sufficient to convey logos and any commercial or album artwork needed to support the main and multicast channels. The frequency of transmission of the station logos is established in the setup of the middleware, and is typically set to every five minutes. The more bandwidth that is set aside for these services, the faster the images will load. The time needed to load an image to a receiver is dependent on the content of the image and ranges from five to 10 seconds. If a listener tunes in during the middle part of a song, displaying of the image will have to wait for a resend of the album art.

As the current song is approaching completion, generally at three-fourths of the way through, the metadata system will start the processing for the artwork image for the next song. The image is pre-sent and stored locally in the radio and will be displayed when the song plays and the song title and artist information for the new song is transmitted. The image is typically refreshed two times while the song is playing. Commercial events with artwork are treated in a similar manner.

The system defaults to the previously stored station logo when it is not called on to play album or advertiser artwork. Systems such as TagStation can have templates set up to display talk show hosts or other program associated artwork in lieu of the station logo.

HOW RECEIVERS DISPLAY RDS METADATA

Receivers differ greatly in how they display the transmitted metadata so it is important that broadcasters understand how receiver displays function.

Basic RDS receivers will display the PS static eight-character station ID or dynamic PS data. The 64 character RT message field is automatically displayed in displays of less than 64 characters by scrolling or chunking the text. Basic RDS receivers will have only an eight-character display. With older RDS radios, the listener must press a button to see the 64 character RT information. Be aware that some receivers will block this display if the car is traveling more than a pre-determined speed. Newer receivers will display both the PS/dynamic PS and the full 64 character RT message automatically.

METADATA RECOMMENDATIONS

PROGRAMMING

1. Getting correct entries into the song title and artist fields of an automation system is the first step. To do so, every song in the station's automation system must be reviewed to insure the accuracy of the data.

2. As new songs are entered, be sure that the data is in the same format as the existing tunes in the database.

3. When entering data in the song title and artist fields, adding anything more than the actual artist name, song title, etc. will make someone else's job more complicated down the line.

4. Program associated data is not just for music, it is also important for spoken word stations. These stations can increase audience engagement by sending the name of the program, the host name and picture for FM-band HD Radio stations or hybrid radio services like NextRadio, topic being discussed, guest and call-in telephone number.

5. AM-band HD Radio stations should not forget that program-associated data is available and can transmit, as discussed above, show information, sports scores, weather, traffic bulletins, stock prices and synced advertiser's slogans, phone numbers and web address.

6. The station's programming management and engineering staff should all own or rent a car with an HD Radio that can display Artist Experience so that they can see what listeners are experiencing.

7. Be sure that the station call letters (PI) are correct.

8. Be sure that the station slogan or ID is correct.

9. If a station is merely sending text from an automation system to an RDS encoder, a middleware system such as Jump 2 Go, TRE or Artic Palm should be added.

10. Every station should be using a software service like TagStation to clean up the data for an accurate and consistent user experience. You can sign up for TagStation at www.tagstation.com/signup or get information on QUU Interactive at http://www.quuinteractive.com/radioservices.htm.

11. Make use of the RT field in RDS systems.

12. Station programming staff should review on a weekly basis the song match rate, which indicates the percentage of the music library which has been successfully matched to clean metadata, as well as the unmatched songs, which need to be corrected.[14]

13. TagStation training for programming can be found at: https://tagstation.zendesk.com/hc/en-us/articles/115000700043-TagStation-for-Programming.

ENGINEERING

1. Correctly enter the Program PI code by following the text-to-code conversion table D.6 in the NRSC's NRSC-4-B Standard, April 2011 (http://www.nrscstandards.org/sg/NRSC-4-B.pdf). It is very important to not leave the default PI code in an RDS encoder. When the same PI code ends up on multiple, unrelated stations, advanced receivers can then execute seemingly random jumping from station to station.

2. Consult with the station programming department to identify the PTY code that the station wishes to use to identify its format on the radio display. Refer to Table F.2 in the NRSC's NRSC-4-B Standard (http://www.nrscstandards.org/sg/NRSC-4-B.pdf) and enter the appropriate PTY code into the RDS and HD Radio equipment.

3. Set the RDS injection level. While there is no specified level, 4 to 5 percent injection levels are common and provide reliable RDS encoding throughout the station's service level.

4. The PS data can be displayed either as static or dynamic, and in the case of dynamic as scrolling text or chunking PS scroll (dynamic PS or DPS). This function is controlled by the RDS encoder and requires a configuration setting or DPS command to use this feature.[15]

5. Set up middleware to display desired information in the RT field in RDS systems.

6. Set up middleware for displaying the PSD information in HD Radio systems.

7. For stations employing HD Radio systems, consult with the station's programming department to set up the Station Information Services (SIS): station call, PTY, station slogan and station message.

8. In HD Radio systems, be sure the Exporter and Importer software versions are up to date. The current version number (Exporter and Importer, August 2017) is v4.4.7. This is what manufacturers are shipping and this will support all current features.

9. The station's engineering team should have full-time access to an HD Radio receiver in order to observe the metadata, album art and commercial art.

10. TagStation information for engineering can be found at https://tagstation.zendesk.com/hc/en-us/articles/115000621246-TagStation-for-Engineers.

ABBREVIATIONS

Abbreviation	Definition	Notes
AM	Amplitude Modulation	Modulation system used in the U.S. AM band.
AAS	Advanced Application Services	Advanced Application Services.
BBC	British Broadcasting Corporation	
DAB	Digital Audio Broadcast	A digital radio service developed by Eureka consortium used throughout Europe and in other parts of the world.
FM	Frequency Modulation	Modulation system used in the FM band (87.8 – 108 MHz).
kbps	Kilobits per second	
NAB	National Association of Broadcasters	
NRSC	National Radio Systems Committee	A standards setting committee co-sponsored by the Consumer Electronics Association and the National Association of Broadcasters. http://www.nrscstandards.org
PAD	Program Associated Data	Text or graphics that are synchronized with the associated program audio.
PI	Program Identification	A code added to the RDS system to transmit station call letters.
PS	Program Service	An eight-character label of the program service, station slogan. Originally intended to be displayed as a static text field, the PS is widely used in the US in a dynamic fashion to provide song and artist to receivers with simple eight character displays.
PTY	Program Type Code	A six bit code included in the RDS system to identify one of 31 program types to be displayed on the radio receiver.
RDS	Radio Data System	A digital FM subcarrier that is used to add digital data to analog FM transmissions.
RT	RadioText	This is an RDS field intended to display a 64-character text field.
SIS	Station Information Services	Two kbps of data reserved for station information in HD Radio systems.[16]
STL	Studio Transmitter Link	Device or system used to convey audio and data from the studio to the transmitter
TCP/IP	Transmission Control Protocol / Internet Protocol	A protocol for delivery of a data stream between applications running on hosts communicating by an IP network.

DEFINITIONS

Term	Definition
Artist Experience	The image delivery feature of employed by HD Radio systems to insert station logos, advertising logos, program associated logos and album art into FM-band HD Radio transmissions.
Connected car	The connected car generally refers to a vehicle that is connected to a mobile broadband service. It can be connected with a built-in cellular modem that can support a plethora of visual information functions, essentially supporting a Hybrid Radio functionality; or it can be connected using a mobile phone's cellular modem and reflects certain phone features onto the car display system and allows interaction with the phone features via the car's driver controls.
HD Radio	A digital radio service developed by iBiquity Digital Corporation, now Xperi. The system is used to add a digital broadcast component to AM and FM transmissions, and has been adopted primarily in North America.
Hybrid radio	A system where internet data is used to augment over-the-air audio broadcast with additional visual data and to allow call to action responses from the listener. In mobile applications, the internet connectivity will typically come from the user's smartphone or a cellular modem installed in the vehicle.
Logo service (Logo)	The HD Radio system supports a logo service to display station logos for the main HD1 and, for FM-band HD Radio, any associated multicast channels (HD2, HD3 and HD4).
Metadata	Data simultaneously transmitted to support other services, in the case of radio this data supports the audio program segment of the over-the-air transmissions. Radio station metadata can contain information associated with a station's audio events - primarily songs, spots and promos - and other related program information like on-air personality names, program names and station program schedules.
Middleware	A hardware or software service that is used to route data from a radio station's automation system, that should be augmented by a data clean up and image insertion service, to the station's RDS and HD Radio equipment.
NextRadio	NextRadio is a hybrid radio mobile app for Android smartphones that can simultaneously pair over-the-air analog FM broadcasts with internet-provided images, text and points-of-interaction that are specific to the audio content being broadcast at any given moment.
Radioplayer	Radioplayer is a radio technology platform, owned by UK radio broadcasters and operated under license in some other countries. It operates an internet radio web tuner, a set of mobile phone apps, an in-car adaptor, and a growing range of integrations with other connected devices and platforms.
TagStation	A metadata management service that empowers radio stations to centrally manage the enhanced content associated with their on-air programming, in order to present a consistent product experience across multiple technologies (RDS, HD Radio, NextRadio, streaming, station-branded apps, etc.).
QUU Interactive	A service for cleaning up raw data as supplied by the radio station's automation system, adding additional program associated data, inserting logos and advertising and album art.

ENDNOTES

1. A separate report is available from NAB which describes the audits in greater detail.

2. SiriusXM does not currently display album art but displays a logo representing the channel being received.

3. As previously discussed, many broadcasters are using PS in a "dynamic" fashion to send song title and artist information, intended for use on receivers that only have character-based displays.

4. Some receivers with only 32-character displays display the total data field sequentially. Additionally, some receivers will block this display if the car is traveling more than xx MPH.

5. While the image insertion is only for HD stations, the data cleanup service is essential to the reliable and consistent delivery of data to analog and HD Radio receivers.

6. Many AM stations have a single box HD Radio exciter with an integrated importer and exporter function.

7. The automation software needs to be configured to output the data.

8. For information on Broadcast Electronics TRE see http://bdcast.com/products/studio-products/datacasting-the-radio-experience; for information on Jump 2 Go's JumpGate see http://www.jump2go.com/, and for information on DTS' Arctic Palm see http://arcticpalm.com/

9. Additionally middleware systems can supply metadata to support streaming players, hybrid radio applications like NextRadio, the connected car and now playing systems.

10. TagStation provides two levels of service that communicates with the station's middleware. There is a free option that provides data cleanup and images for HD Radio systems with Artist Experience. Stations that want the ability to manage custom content to be displayed in the visual experience and station usage reporting data must subscribe to TagStation for a fee. QUU Interactive is a service that communicates with the station's middleware to clean up entries from the automation system and add album art as is supported by Xperi's Artist Experience.

11. The automation software needs to be configured to output the metadata.

12. NextRadio is a hybrid radio mobile app for Android smartphones that simultaneously pairs over-the-air analog FM broadcasts with internet-provided images, text and points-of-interaction that are specific to the audio content being broadcast at any given moment. When a song airs, listeners see album art, song title, artist name; they can purchase the song, "like" or "dislike" it or share that they're listening via social media. Listeners can also scroll a list of recently played songs and engage with the programs or DJs on-air. When a jock is in a talk break, or long form programming is being aired, listeners can see information about the personality or program and can engage with the station with one click. NextRadio also makes spots and promos more effective by transforming the audio call-to-action into a seamlessly integrated opportunity for the listener to take the desired action using the internet-based capabilities of the smartphone.

13. As an example, 48 kbps assigned to the main audio channel (HD1), 32 kbps assigned to the HD2 multicast audio channel, 12 kbps assigned for a traffic service and four kbps assigned for Artist Experience artwork results in all of the data capacity within the normal carriers being used. An additional 24 kbps is available when operating with the additional extended hybrid carriers which could be used for a third multicast audio channel, HD3.

14. A report generated by TagStation for effective management of program associated text and images.

15. In the PS scroll mode, there is an eight character scroll which moves one character at a time. This is not recommended, as rarely are full words displayed, making the display hard-to-read and creates greater driver distraction. In the PS block mode, the message is a word scroll so full words are shown making the display easier to read. For words of more than eight characters, most encoders perform some justification for a better display.

16. An additional 2 kbps of data not included in the 96 kbps of the main HD radio carriers. Thus, the total bandwidth of the HD radio main carriers is 98 kbps.