HOW DATA TRANSMITTED OVER AN IBOC STATION WILL BE MANAGED: USING A GATEWAY TO GENERATE DATA REVENUE.

David Maxson, Managing Partner, Broadcast Signal Lab, LLP
Paul Signorelli, CTO, Impulse Radio, Inc

ABSTRACT

The coming of In Band On Channel (IBOC) digital radio presents new opportunities for profiting from broadcasting data. Broadcasters are accustomed to plugging into their transmitters data subcarriers belonging to third parties. The subcarrier tenant rents bandwidth on stations on a full time basis. The new model for data flow in the IBOC environment will put broadcasters in the business of selling bits of data and managing myriad data clients on their broadcast channels. This new medium will require new strategies for efficiently selling, administering, queuing, transmitting and billing for data services.

This paper presents an inside look at the state of the art of broadcast data management for radio. Impulse Radio reveals the framework for the open data management protocol it is preparing in conjunction with iBiquity. The protocol provides a wealth of opportunities for capitalizing on broadcast data. The Impulse data content management gateway is presented as a model for dynamically managing the data capacity available on IBOC.

INTRODUCTION

This paper builds on the present-day understanding of data broadcasting for radio and develops a case for a more efficient way of managing radio data traffic in the future. The paper begins with a discussion of present-day radio data broadcasting architectures and business models. The building blocks of broadcasting on an In Band On Channel (IBOC) signal are discussed and compared to current conventions. This discussion reveals how the IBOC service lends itself to a dynamic data-management protocol, for both the program content with program-related data and any auxiliary data being transmitted.

The basic architecture of a data gateway is revealed as an ideal way to schedule, control, prioritize, transmit and charge for multiple data services. The gateway at the broadcast facility will have a complement in the receiver to select the data which the receiver is capable of handling. The Impulse Radio *Impulse Engine* data gateway is used as a foundation for this discussion of the data gateway concept.

The use of gateway architecture has implications in the manner in which data is routed and received. A set of use cases that was developed through the IBOC Data Forum is summarized to illustrate the types of capabilities for which the IBOC system and the data protocol are engineered. The use cases permit system designers to define classes of receiver and classes of service that enable a variety of functions to be performed by data-enabled radios.

PRESENT DAY RADIO ARCHITECTURE

IBOC technology promises the ability to transmit data on both AM and FM stations. Historically, FM has been the beneficiary of ancillary data and audio transmission technologies. The back of an FM exciter reflects the manner in which broadcasters visualize and use their auxiliary communications capabilities. (Figure 1)

Composite baseband as FDM model

The composite baseband of an FM signal is divided on a frequency division multiplexing (FDM) basis. Monaural audio is the only mandatory service an FM broadcaster must provide. It occupies the first 15 kHz of the composite spectrum. Specifications for stereo broadcasting are codified to enable all stations that transmit stereo FM broadcasts to function on all receivers equipped with optional stereo decoding capability. Not codified under FCC regulation, but established as a recommended standard with which receiver manufacturers and broadcasters may optionally comply is the Radio Broadcast Data Service (RBDS).[i] This subcarrier is used by some FM stations and is optionally available on consumer receivers to provide an enhancement to the FM radio experience, as well as other data capabilities.

To this point the discussion revolves around mandatory and optional consumer receiver standards. With RBDS, consumer-use standards overlap into the subcarrier region of the FM composite spectrum.

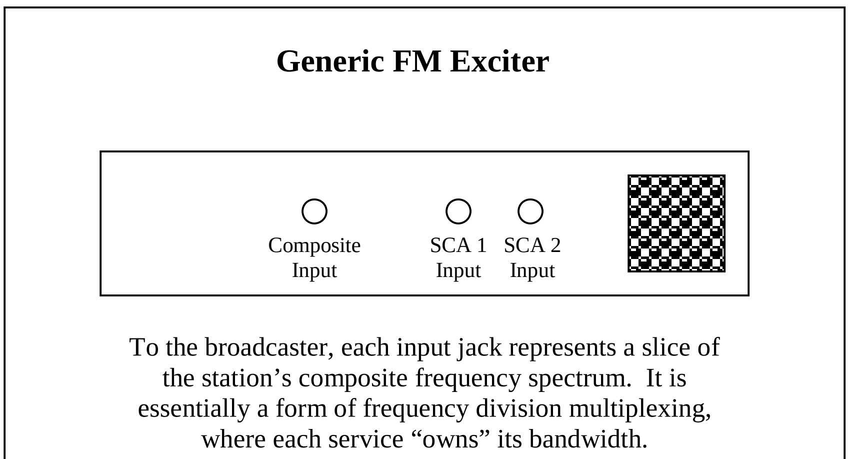


Figure 1

Myriad subcarrier technologies are available to transmit and receive audio and data that are not readily available to the typical consumer. The classic technology is the analog audio subcarrier that became a de facto standard for delivering subscription background music services. The controlled availability of subcarrier receivers kept the analog subcarrier from the consumer market for many years (with the exception of breadboard experimenters, who do not represent the typical consumer).

The analog subcarrier was found to be useful for specialty broadcast services that provided content such as ethnic programming or reading services. Consumers using these services on analog subcarriers had to obtain special receivers, usually fixed-tuned to the frequencies of the desired local station and subcarrier. This technology has never penetrated the high-volume consumer receiver market, thereby limiting the technology to narrowly-targeted, single channel radios and services.

Data services are also delivered on subcarriers, with a variety of technologies that run the gamut from open standard waveforms to proprietary ones, and from open standard data protocols to proprietary ones. As with the audio services, subcarrier data services are set up as narrowly-targeted, application-specific, single-channel radio services. (Of course, some services are offered to radios that are agile enough to find the best local signal carrying the desired service, yet they remain single-service radios of interest to narrow audiences or customer bases.)

Because subcarrier services evolved being subsidiary to the mandatory monaural FM audio broadcasts, with optional stereo, they have evolved as separate services in several dimensions. They provide separate revenue streams from the main program channel (or separate public benefits in a non-profit environment). They demand receivers distinct from the off-the-shelf consumer radios. Also, they are independently modulated and carried on segregated bandwidth on the FM composite spectrum.

Subcarrier tenants secure a piece of the host station's composite spectrum and are permitted to obtain as much throughput as they can technically achieve in that slice of spectrum. Whether or not they fully utilize that spectrum is not of concern to the broadcaster, only that the service is generating the desired revenue and/or public benefit. (Some subcarriers support station operations and are not considered in this context.)

Revenue Comparisons

What is the value of a subcarrier compared to audience-related station income? Is there room for growth in public use and revenue? Subcarriers are low overhead enhancements to a station's portfolio. Aside from occasional contract administration matters and routine or emergency maintenance by station technicians, the third-party subcarrier has no cost associated with its operation (except to those who feel the loss of main channel modulation with each subcarrier is a penalty).

In contrast, the main channel audio attracts a large audience whose desire for free entertainment drives revenue generation. Of course, as the core business of the radio stations, the main channel program has a cost to produce and transmit.

For a quick value comparison between radio and subcarrier earnings, the Boston market was selected. With an annual market revenue figure of just over one third of a billion dollars, and sixty-five stations listed in the revenue count, the average station revenue is about $5 million. Assuming a 40% cash flow margin, the per-station revenue is adjusted in the table below (fig. 2) to obtain an earnings figure. This annual earnings figure is weighted for the 53 kHz that the stereo audio occupies in the composite spectrum. This is an average estimate for all Boston radio.

Next, assume a subcarrier on an FM station in Boston generates $10,000 per month revenue with a 100% margin. A typical subcarrier will occupy an assigned channel of 67 or 92 kHz and require 25 kHz of the composite baseband.

The results of each per-Hertz-per-year earnings calculation are placed in a ratio to illustrate how much more the audio portion of the broadcast is worth to the station owner. In this example, the main channel audio is 9 times more productive per Hertz of composite spectrum. Using the same calculations for New York, San Francisco, and Los Angeles, with an estimated 50% higher subcarrier revenue in NYC and LA, the per Hertz earnings ratios are even more bleak for the best earning subcarriers, with radio earnings up to

Coarse Estimate of Subcarrier Value

	Market Radio Revenue (000)	Stations per Market	Average Station Annual Radio Revenue (000)	High Subcarrier Annual Revenue	Cash Flow Margin	Earnings BITDA (000)	Hertz Composite Bandwidth	Annual Earnings per Hertz
Main Channel, Boston Market	$362,100	65	$5,571		40%	$2,228	53,000	$42.04
Subcarrier Major Market				$120,000	100%	$120	25,000	$4.76
Broadcast to Subcarrier Earnings Value Ratio								9

Figure 2

twelve times more productive than subcarrier.

This shirtsleeve analysis selects middling radio revenue and high subcarrier income, erring in favor of the subcarrier income. However, it is left to others to consider variations in station margin, market size and other variables that might affect the results.

Implications on New Data Opportunities

If the hypothesis holds that subcarriers can be expected to be about ten times less productive than the corresponding bandwidth of the analog program, then it is clear that auxiliary services are an underutilized resource in the radio broadcast industry. The NAB Subcarrier Report[ii], last published in 1997, reported that subcarriers are utilized on less than half of FM stations, and two subcarriers or more are employed on only 8% of stations. This confirms that, industry-wide, subcarriers generate a far smaller piece of the earnings pie than radio revenue because of low station utilization of subcarriers. Low utilization and low per-Hertz earnings reinforce the notion that the public benefit potential of auxiliary services is not achieved with the current subcarrier business model.

The legacy of multiple subcarrier formats, proprietary applications and protocols, extra component costs in receiver design, and the resulting low utilization, contributes to the inefficiencies of the auxiliary data and audio services industry.

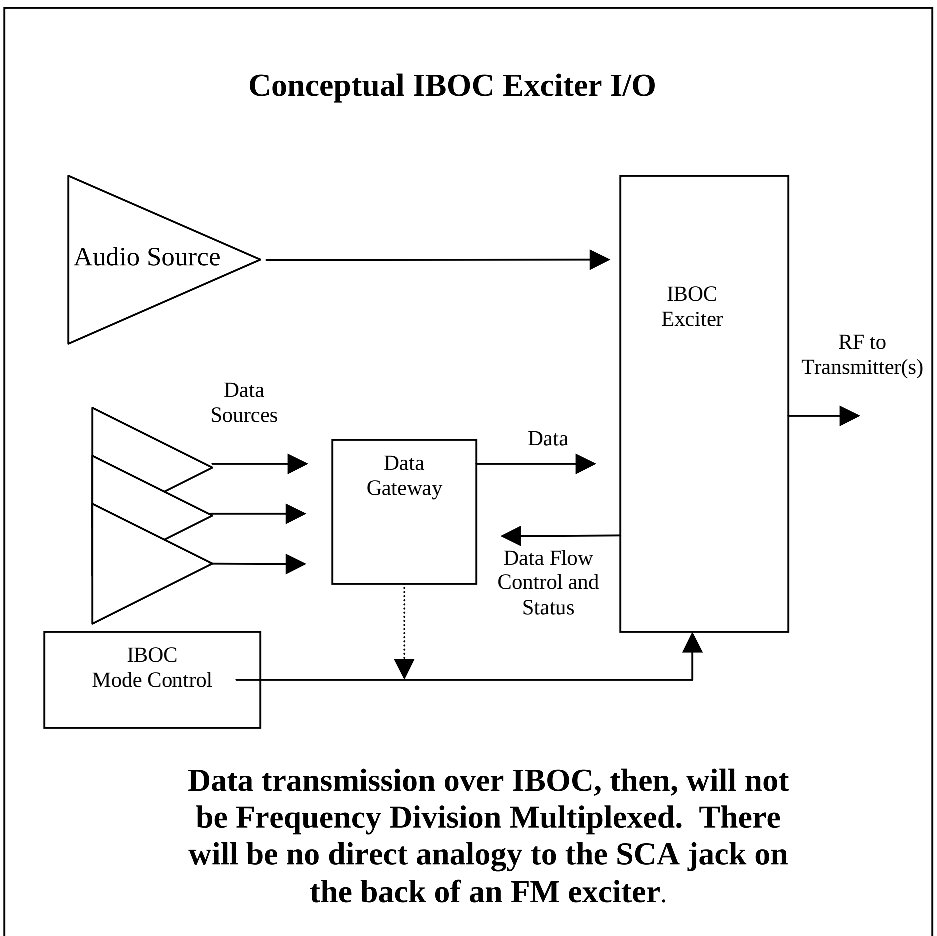


Figure 3

THE FLOW OF IBOC TRANSMISSIONS

IBOC broadcasting promises to change this paradigm. The IBOC platform will be capable of delivering main channel audio at bit rates selectable by the broadcaster.[iii] The remaining data capacity on the IBOC system will be available for providing enhancements to the main program channel and new auxiliary services. Because the IBOC system will generally interleave all the data it is carrying, receiver chips will receive all the "bits" of data that are transmitted and utilize only those bits that are intended for it to utilize.

Because the output of the IBOC receiver's demodulator is a stream of bits, it is a trivial matter to base on one chipset the design of a variety of receivers that are enabled to utilize different services on the bitstream. In contrast, today's subcarriers require side circuits to separate and demodulate them. Subcarriers are also less robust than main channel reception. With IBOC, data performance, with appropriate error protection, should be comparable to digital audio coverage.

Data transmission over IBOC, then, will not be Frequency Division Multiplexed. There will be no direct analogy to the SCA jack on the back of an FM exciter.

Figure 3, above, illustrates the logical relationships between the sources that might feed an IBOC transmitter. As of this writing, the specific connections that would be made to an IBOC exciter are not in the public domain. Therefore the flow in Figure 3 should not be interpreted as a literal block diagram.

Fundamentally, where an auxiliary service would have "leased a jack" on the rear of the FM exciter, the IBOC model permits a more complex system of allocating data flow.

THE CONCEPT OF MULTIPLE SERVICES SHARING THE PIPE

A paging service may hire a certain number of bits, with a certain maximum delay time between system receipt and IBOC transmission. This service may be willing to pay extra for priority service on some or all messages.

Meanwhile, the radio station may be offering a stored audio file to those with radios enabled to save and play it. Perhaps the audio has to have arrived by the time a program begins. And a financial data service may simply wish to obtain a certain number of bits per hour, with no other constraints on their delivery.

In the analog broadcasting world of subcarriers, each service would hire a subcarrier and try to fill it with revenue-generating content that relates to its core business. Unused data blocks or unprogrammed audio time represents bandwidth time that is lost to the subcarrier user and to the broadcaster.

In the IBOC data model, a data gateway can be inserted in the data path to administer the prioritization and flow of data over the air.

HOW A GATEWAY CAN ADMINISTER THE FLOW

The principles of data flow management have a surprising similarity to the principles of managing radio programming. Programming is scheduled typically in time blocks with a set of rules for filling those blocks—a certain number of spots per hour, music rotations, station promo announcement rotations, spot schedules and rotations. Spots are scheduled on a priority scheme, which allows a computer to determine which spots to shift in time or "bump" in favor of others. Program content flow is managed by preset rules and billable events are tracked, verified and billed.

The data gateway will perform these same types of functions in orchestrating the data flow. The gateway can look ahead in the schedule and determine what it must accomplish. Perhaps some program related data must get to radios in a timely fashion—not too soon that late tuners-in will miss it, but not too late that it will fail to synchronize with the programming. Perhaps the data has a looping rule that it must be sent three times over the course of five minutes to be sure that people tuning in can "catch up" with a full set of data related to the programming.

Meanwhile, the messaging service deposits a message with a delivery latency time attached to it. The gateway will have a set of rules that inform it how to prioritize the message delivery according to the contract with the service provider.

In this example, the financial service comes closest to the old subcarrier model because they have paid for a fixed number of bits every hour.

The gateway will look at all these scheduled and instantaneous events while referring to the rules it has been given for each service.

The gateway will also communicate with the IBOC exciter. It has to know that the station has decided to operate the IBOC audio stream at, say, 80 kbps for the next hour. This leaves the gateway to determine what to do with the remaining approximately 20 kbps[iv], based on all the data that is scheduled and arriving at the queue.

In addition to the fixed data bandwidth available after the audio coding rate is selected, there is "opportunistic bandwidth" available. As the audio coder is less challenged by less complex audio, it will temporarily have extra data capacity in its audio packets. iBiquity indicates that on the average approximately 3 kbps will be available on the FM audio stream in the form of this opportunistic data. If the gateway can obtain information about the opportunistic data from the audio chain or the exciter, it would be able to modulate the amount of data it is sending based on the amount of opportunistic data capacity available.

This function of the gateway is generally categorized as the flow control process that prioritizes and maximizes the data throughput. The flow control process requires a framework within which it can make decisions about data formatting, prioritization and flow. This framework is based on the anticipated ways in which the data delivery system will be used. This framework is defined by a universal data standard that spans a multitude of potential kinds of uses.

USE CASES

To create a universal data standard that can be employed by broadcasters and third parties to transmit data, and by receiver manufacturers and consumers to receive data, one must build a protocol that anticipates general ways that the system might be used. Does the system need to synchronize data events? Is there a need for security on data that is private or fee-based? If access is controlled to certain data, how should a universal standard be created so that receiver and chip manufacturers do not give the data away to enterprising users and individual service providers have the confidence that their authorizations to their clients are not in conflict with someone else's authorizations? What are the needs for authentication of communications and transactions? The list goes on.

Object oriented programmers study how a system will be used in order to identify the connections it must make with the outside world and the internal processes required to accomplish each task. The questions above arise from considering ways that the system could be used. Other questions may relate to human interface or peripheral interface issues. For instance, if a radio is going to deliver program related graphics, what are the display, memory, and processing demands? What are the receiver design implications about auxiliary audio files or streams? What are the limits to a display and controls on the dashboard of a car? How does one format data to send to it?

Use Case Analysis defines the problem in terms of how people will use the system. "People" in this case are broadcasters, service providers (i.e., Yahoo, AOL, AP, Reuters, etc.), telematics providers, and radio listeners. The problem to define is "what will people do with this new data pipe, that not only allows streaming audio and data, but the sending of any ASCII or binary data for a multitude of purposes".

To define the problem one must:

- Examine the characteristics of both IBOC and radio
    - Broadcasting medium
    - Free ubiquitous / One-way point-to-multipoint / No impact to the network on adding users
    - Long-range data transmission at low power (low cost)
    - Good mobile reception at high speeds and in difficult conditions
    - Limited data bandwidth
- Examine the way a digital pipe enhances radio broadcasting (beyond digital audio):
    - Radio broadcasting in a non-linear mode
    - Brand new, adjunct business models
- Examine user preferences:
    - Entertaining and Informative information
    - Personalized content
    - Flexibility

This leads to the identification of the types of applications that would be well suited for IBOC and the types of features that the IBOC system would need to enable them. Features and applications examples are listed below

Applications Examples

- Program Associated Data
- On-demand programming
- Time-shifting
- Telematics
- Commerce
- Listener Interaction
- Subscription
- Supplemental Audio
- Messaging
- Electronic Program Guide
- Emergency Alert System

Features Examples

Feature	Description
Location Based Programming	Audio or data customized to the location of the vehicle
Time Associated	Audio or data customized to the time
Data Caching	Storage of audio and data on the receiver for later use
External System Interface	Using IBOC data to interact with another system such as a navigation system or an Internet application
Transactions	Using IBOC data to initiate response back to the data source via another channel such as the Internet or wireless web
Security	Protects access to data as well as protects the data itself for transaction based activities and subscription services
User Personalization	Data that is customized based upon user preferences

Figure 4

A list of possible use cases was assembled with the input of participants in the data forum hosted by iBiquity in the fall of 2001. The list is appended to this paper. It is also viewable at www.impulseradio.com/standards
user name: ibocstand
password: iboc4262

From studying the use cases, a pattern of classifications emerges. Two major classifications describe characteristics of categories of data services. Service Classes describe how groups of use cases are employed to provide a service, from a data transport perspective. Receiver Classes describe what a receiver has to do to handle the processing, rendering and delivery of data for particular services and applications.

The Service Classes are functional groups of services that are likely to share common applications, features, users, and receiver characteristics. In the table above, the Applications examples bear a strong resemblance in name to the Service Classes. The distinction between the two is that the Service Classes are related to the common transport and flow control issues of groups of Use Cases, while the Applications categories focus on the manner in which one or more Use Cases are implemented to provide useful functionality.

Each Service Class has implications on the design of receivers, for characteristics such as human and data interfacing, memory, processing power, and the like. To simplify the receiver and chip design process, and to foster a family of interoperable receivers, a set of Receiver Classes must be defined as well.

SERVICE CLASSES

The use case examination develops an understanding for the structure of data services, which are divided into Service Classes. At the base layer there is a general definition of a Data Service, and above that are application-specific rules that must be applied to the services.

The Data Service Definition identifies the physical attributes of the data service in the system. This answers questions such as: How is the data transported, is it streamed, is it file based? How much bandwidth does the service get? What type of error correction is associated with the data? Is the data encrypted? Is it binary data or ASCII data? Does the file have a time-too-live associated with it? Is it application specific data? Does it require authentication to use? Is the data synchronized (with audio, time, or location)? This definition creates an environment where unrelated data can readily coexist on the same channel.

Beyond the Data Service Definition, are the application specific rules that must be applied to services. These rules help establish the expectations for the consumer, the broadcaster (and their customers), and the community at large. For example, the treatment of information intended for display would have basic guidelines for its rendering. This might dictate that text never scrolls, to address safety concerns, and that an image must be rendered at or above a minimum resolution to satisfy an advertiser or an artist.

A Service Class, such as Program Associated Data (PAD), could benefit from the ability to synchronize with events on the audio channel, or with other PAD coming down the channel. In contrast, a remote control service, such as load management, has nothing to do with the main program and would not require program synchronization. Instead, the load management application would fall into a Service Class that might include location based or time of day functions in the radio and a standard Input/Output port for connecting to remote devices under control.

Service Classes are therefore groups of Use Cases that serve similar applications. Applications are associated with a family of features. Features are clustered into groups identified with Receiver Classes.

USE MAPPING

In Figure 5 below, the relationship between these groupings is shown as a functional map. For example, a series off use cases might involve providing content related to the station's main program channel (PAD). Some Use Cases might involve content that are graphics and text, some might provide audio, and some might involve listener response or interactivity.

Together, these use cases are grouped into a Service Class. However, this Service Class may feed several applications—processes that in this example are Program Associated, but have various purposes. One PAD application may simply be to play the main channel audio and display artist and title text. Another could involve feeding graphics to an interactive display that permits the radio listener to toggle into the stats of the pitcher on the mound.

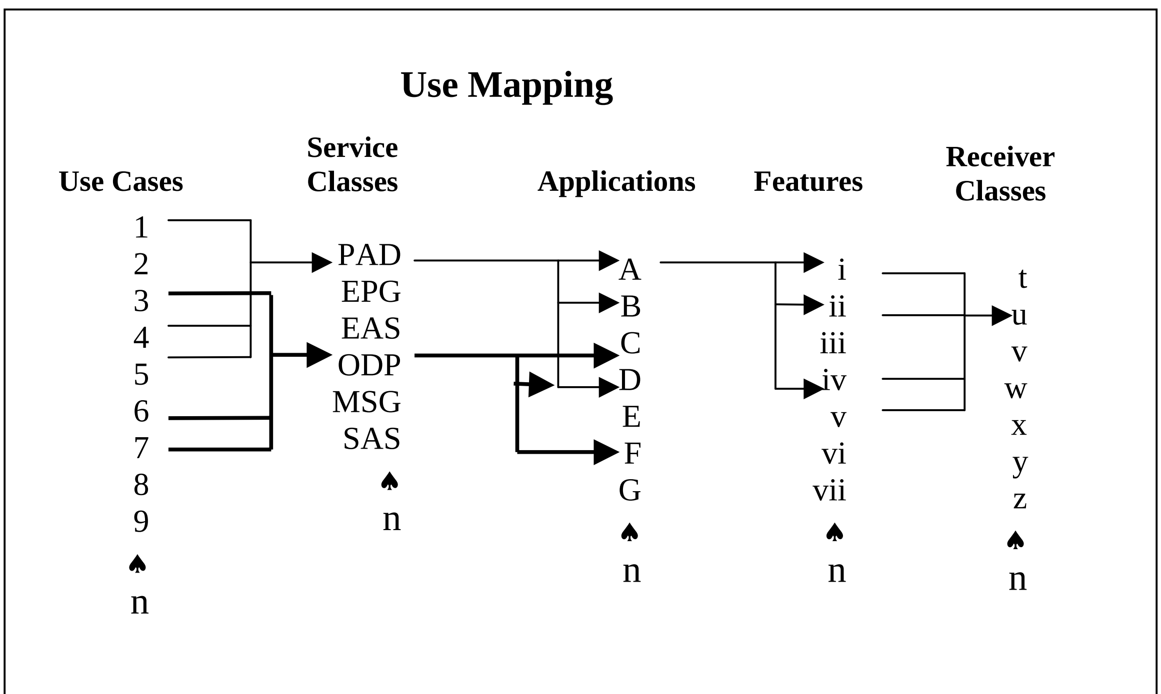


Figure 5

On another path in the Use Map is the example of a set of Use Cases revolving around On Demand Programming content (ODP). Together, they comprise the ODP Service Class. ODP applications may be program independent, or they may be related to the activity on the main audio program. In either case, ODP applications require capabilities that are distinct from PAD functions. ODP audio must be cached for later retrieval. Memory capacity and cache management features would be among the functions tied to the ODP Service Class. Meanwhile, the PAD Service Class chosen above might only involve temporary real time buffering and display rendering of text or graphical data, requiring a different but overlapping set of functions compared to the ODP Service Class.

Moving along the map from applications to features, the applications for which people will buy radios will have to have certain features to enable those applications. Menu buttons, memory, hooks to an automobile data bus, a navigation system or a back-channel communications device, and the like will be required of a radio that enables certain applications. Some applications may share common features with other applications.

Features are grouped into sets that are common to applications or similar groups of applications. These are mapped to one or more receiver classes.

For example, a receiver in a dashboard of a car will require certain display features and display management features for in-vehicle safety. This same radio may be a no-additional-frills model that maintains lowest cost. One receiver class could be defined for this type of radio. To satisfy an additional Use Case another dashboard radio may have all of the above, and may require hooks to the automobile clock, the navigation system, and the concierge phone (e.g. On-Star). This could define another Receiver Class. Meanwhile, a home stereo, a portable boombox, a PDA radio module, or a personal computer peripheral, or an application specific load management controller may each fall into one or more other Receiver Classes.

RECEIVER CLASSES

As illustrated by the above discussion, a Receiver Class is a blueprint that must be followed for any receiver that wishes to enable specific use cases. Practically, enabling a use case equates to enabling the group of IBOC functions that are required by the use case. A receiver class is not a recipe that must be strictly adhered to. In fact, a proper receiver class would be devoid of any implementation details.

This is best illustrated by example. Take the use case that a broadcaster sends an on-demand traffic report audio cut to the listener. The Service Class to which this Use Case belongs will be described by a Data Service Definition that dictates the on-demand audio would be a file of a particular format. It could give guidelines for transport of the file; is it a stream or a file transfer? In this case it would probably be a file transfer.

The receiver class for on-demand audio would set some minimum space requirement for supporting on-demand audio. For instance, it might be that at a minimum, a receiver supporting on-demand audio must be able to store at least 30 seconds of audio files at one time. Receiver manufacturers could choose to put more memory in the device. That might make the receiver more attractive to consumer who want the device to retain information for longer periods of time or when they tuned off of the station.

Still in this example the receiver class is implementation agnostic. The form and exact amount of memory is up to the individual OEM, provided they meet the base requirement that broadcasters and other data service providers are delivering to.

CLASSES ARE THE KEY TO INTEROPERABILITY

With broadcasters, content providers and receiver manufacturers sharing the same hierarchy of classifications, any content transmitted by an IBOC radio station will be receivable by any radio designed to function under the Use Case of the content being transmitted. This permits broadcasters the flexibility to develop applications that people find useful while giving receiver manufacturers the latitude to implement those uses in their own ways.

The Data Service Definitions associated with each Service Class describe the characteristics of the Class that make it unique and the means to organize, transport, identify and render the data in that class. In addition to the specifics of such things as file formats supported, rendering or markup rules, storage expectations, interactivity expectations and the like, the Data Service Definitions relate to global features required by the Class.

Global features are features that are not specific to a single service class or application and are available to be applied to any class that requires them. Synchronization to programming or location or time is one set of these features that may be required to implement a Service Class.

Secure access to background music, financial data, copyrighted music, text or graphics is embraced by the Authentication and Encryption features.

The Transaction feature enables back channel communication to be established to make a purchase, enter information or make a request. The Transaction feature is not a definition of a particular means of communication (Wireless phone, 802.11, Bluetooth, Smart Card, etc.). Rather, it describes the information required and input and output required to initiate and complete a transaction. The choice of transaction medium remains in the hands of the service provider in conjunction with the radio designer. This way, three automobile electronics companies could design two back channel methods each and they would all work with their Transaction-capable IBOC radio. The broadcaster and service provider would know that when they design a new service to the specifications of the appropriate Service Class, it will be receivable by any radio built to function with the relevant Receiver Class.

In addition to creating an assurance of interoperability between many receiver brands and types, this classification hierarchy will give content and service providers assurance that their valuable content and services will be available only to those whom are authorized and used only in the manner allowed. Data could be permitted for one-time use, no-recording, pay per use, free use, or no-exporting to other devices, among others.

BUSINESS OPPORTUNITIES

Overall, the Impulse Radio Use Mapping hierarchy creates an environment in which broadcasters and receiver manufacturers can create applications that attract consumer interest and revenue. The Impulse Radio data gateway controls the flow of numerous data services sharing the same “data pipe.” Receiver manufacturers can implement the available broadcast data services while retaining the ability to differentiate their products from others.

The IBOC data protocol developed by Impulse Radio and based on the principles discussed in this paper creates the necessary bridge between those who produce content and services and those who produce the hardware to offer a rich array of opportunities to serve the public and obtain their business. The protocol harbors no specific application for data broadcasting, leaving the industry to create the applications.

The data protocol offers the hooks necessary to create applications that do anything imaginable on this point-to-multipoint data service. Impulse Radio, National Public Radio, Stratos Audio, Command Audio, Cue Networks, Visteon, Alpine and many other companies have or are developing services that can take advantage of IBOC data capacity and would be readily managed by a data gateway and received by radios compliant with the data protocol.

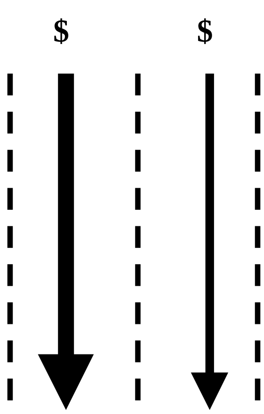
CONCLUSIONS

In this paper we have traced the evolution of the subcarrier industry to understand how it became a fragmented, non-universal, proprietary, narrow-casting service and how it is significantly less productive than main channel broadcasting.

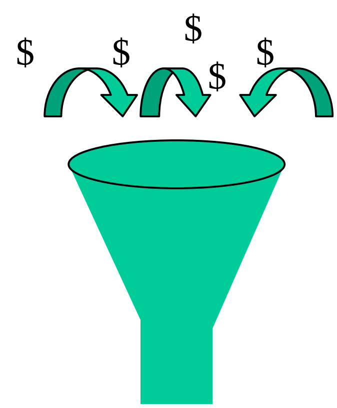
The IBOC data model offers a unique opportunity to create a universal, flexible, adaptable, entrepreneurial data broadcasting medium that will encourage financially viable content and services to be delivered to large audiences. From a regulatory standpoint, IBOC data services will still fall within two familiar categories, Program-Related Content that enhances the listener’s experience of the main audio service, and Auxiliary Content that is separate from, and subsidiary to, the main program channel.

Data Business Models

Subcarrier Business Model		Broadcast Business Model
Proprietary		**Universal**
Linear	**Access**	**Non-Linear**
Single Party Content		**Multiparty Content**
Fixed Monthly	**Revenue**	**Demand-Based**
Long-Term Deal		**Many Market-Based Deals**
Custom		**Generic**
Costly	**Receivers**	**Cheap**
Low Volume		**High Volume**



SCA 1 SCA 2



Data Gateway

The Impulse Radio *Impulse Engine* was presented as a model for a data gateway that can manage the flow of data for multiple services, allowing broadcasters to maximize the utilization of every bit of data bandwidth available to them. Broadcasters can exert more direct control over the transmission of data to maximize the value of IBOC data to the consumer public and maximize its economic viability.

The universal IBOC data protocol is based on the principles of Use Case analysis from which Service Classes, Receiver Classes, Applications and Features are derived.

The protocol will ensure that when a new service is offered under any of the Use Cases, one or more receiver classes will be able to predictably fulfill the use, independent of the brand of receiver. Receiver and chip manufacturers will be able to enhance the minimum features of any receiver class and configure their devices to be compliant with the applicable class yet to design them to suit their own product design and differentiation needs. A new service provider utilizing an existing Use Case will find his service inherently compatible with receivers designed to support that use case.

The Data Business Model figure (6) above illustrates the opportunity the US radio industry faces by embracing the non-linear Data Gateway model for managing IBOC data in comparison to the traditional linear model employed in subcarrier leasing today.

Over the course of the next few months, broadcasters will decide which side of the diagram they choose to embrace and, in effect, their own financial future. As the data protocol gels into a final form, and the capabilities of the IBOC data services are defined with the casting of the protocol into silicon, Broadcasters must now- today- lay the foundation for profitable and universal data businesses.

Broadcasters must become deeply involved in the development process by demanding the tools, the technology, and the communication with the consumer electronics industry that is required to expand their business into the digital age.

The subcarrier revenue analysis presented in this paper suggests that there are more fish to be caught in the broadcasting pond than in the proprietary services pond. Broadcasters can only maximize the potential of IBOC data broadcasting by resolving to own, control, and use their own bandwidth for new services directly related to their current audiences and business cases. In short, IBOC gives broadcasters a once-in-a-lifetime opportunity to create a new business category that relies directly upon their strengths—broadcasting useful things to a mass audience.

David Maxson
Managing Partner
Broadcast Signal Lab, LLP
64 Richdale Avenue
Cambridge, MA 02052

508 359 8833
dmaxson@broadcastsignallab.com

Paul Signorelli
Chief Technology Officer
Impulse Radio, Inc.
826 Broadway, Ninth Floor
New York, NY 1003

(p) 212-260-4529
(f) 212-260-4971
paul@impulseradio.com

Appendix
Selected Examples of Use Cases

Code	Category	Function	Description
PAD001	PAD	Advertiser places visual advertisements	An advertiser places an ad during regular programming that is viewed on the screen of on a receiver by a user.
PAD002	PAD	Advertiser places supplemental audio advertisement with on-demand audio	An advertiser places an audio ad at the beginning and/or end of a piece of audio that is stored on the receiver and played by the request of the user.
PAD003	PAD	Advertiser enhances main program audio ad with visual data	An advertiser has data related to the information conveyed in the audio portion of an advertisement appear on the visual display of the receiver as the ad is heard by the user.
PAD004	PAD	Advertiser enhances program audio ad with supplemental audio data	An advertiser has supplemental audio data stored on a receiver for a period of time after an ad is aired to allow the user to retrieve pertinent information (such as prices, locations, phone numbers, etc.) related to the ad at a later time.
PAD005	PAD	Broadcaster enhances music programming with supplemental data	A broadcaster has data related to a song being aired appear on the visual display of the receiver.
PAD006	PAD	Broadcaster enhances music programming with supplemental audio data	A broadcaster has audio information related to a song stored on the receiver for a period of time it has aired to be played back upon request of the user.
PAD007	PAD	Broadcaster triggers visual traffic report on receiver	A broadcaster sends visual traffic information that is displayed on the receiver and viewed by the user.
PAD008	PAD	Broadcaster triggers visual weather report on receiver	A broadcaster sends visual weather information that is displayed on the receiver and viewed by the user.
PAD009	PAD	Broadcaster triggers visual news report on receiver	A broadcaster sends visual news information that is displayed on the receiver and viewed by the user.
DLS001	DLS	Broadcaster sends a music download to a device.	The broadcaster sends a special music service that consists of music that users can purchase by subscribing to the service.
DLS002	DLS	Device uses profile to select downloaded music	The device uses a profile to determine if the user is entitled to the music.
DLS003	DLS	Device writes downloaded music to a permanent storage device	Device selects music by profile from a download service and stores the information on a permanent storage unit on the device.
DLS006	DLS	Device plays music from a download service	User selects option to play download music and the device reads selections from the storage device, whether it is a CD, permanent storage, removable flash memory, etc., and plays them.
DLS008	DLS	Broadcaster sends a news download to a device	The broadcaster sends a special news service that consists of news that users can purchase by subscribing to the service.
DLS011	DLS	Service provider transmits an electronic version of a periodical	Service provider transmits an electronic version of a magazine or a newspaper that the device will then record for later viewing or hearing by the user.
DLS013	DLS	Service provider transmits an electronic version of a book	Service provider transmits an electronic version of a magazine or a newspaper that the device will then record if the user has subscribed for it, for later viewing or hearing by the user.
EAS001	EAS	User receives a warning about an emergency situation.	An emergency service provider alerts the community at large via one more IBOC stations.

EAS002	EAS	Send a weather alert	A weather alert is sent to a car alerting the driver to an impending weather event.
EPG001	EPG	Broadcaster transmits an electronic program guide of channel services	The broadcaster transmits a special service that indicates all of the services available on the channel and gives a description for each, and the user views them on the receiver.
EPG002	EPG	Receiver displays program guide information based upon device capability	The receiver scans the information in the electronic program guide and only displays the services that the device is capable of handling.
EPG003	EPG	Receiver displays program guide information based upon profile	The receiver scans the information in the electronic program guide and only displays the services that the user has indicated they are interested in by their profile.
EPG004	EPG	User selects a service from the electronic program guide	The user chooses a service from the electronic program guide and the device starts rendering that service.
FLM001	FLM	Fleet Management Schedule Distribution	A set of schedules and objectives for a specific fleet of vehicles is broadcast via the IBOC network.
FLM002	FLM	Request for mission status	A request for a status update from a specific fleet of vehicles is broadcast via the IBOC network.
LBP001	LBP	Broadcaster sends location encoded traffic information to be integrated with on-board GPS	A broadcaster sends traffic information encoded by zone and the user sees the traffic that is effecting their current zone and surrounding zones where the zone information is supplied by the on-board navigation system of the vehicle.
LBP003	LBP	Broadcaster sends location encoded ad information to be integrated with on-board GPS	A broadcaster sends an ad for a chain of stores or restaurants in a city encoded by zone and the user sees the information for a store or restaurant in their zone where the zone information is supplied by the on-board navigation system of the vehicle.
MSG001	MSG	Service provider sends a numeric page	Service Provider broadcasts a numeric page to an addressable device and the device with the matching address receives the message and displays it.
MSG002	MSG	Service provider sends a text page	Service Provider broadcasts a text page to an addressable device and the device with the matching address receives the message and displays it.
MSG003	MSG	Service provider sends updated stock quotes	Service provider sends updated stock quotes to addressable devices and the devices with appropriate addresses receive the messages and display them.
MSG004	MSG	Service provider sends updated financial information	Service provider sends updated financial news to addressable devices and the devices with appropriate addresses receive the messages and display the news.
MSG005	MSG	Service provider sends updated news information	Service provider sends news headlines to addressable devices and the devices with appropriate addresses receive the messages and display them.
MSG006	MSG	Service provider sends updated sports information	Service provider sends sports scores to addressable devices and the devices with appropriate addresses receive the messages and display them.
MSG007	MSG	Device uses profile information to customize messaging service	Device receives message service data encode by areas of interest and the device uses a service profile to display only the area of interest to the user.

LBP002	(LBP)	Broadcaster sends location encoded traffic information to be integrated with IBOC GPS	A broadcaster sends traffic information encoded by zone and the user sees the traffic that is effecting their current zone and surrounding zones where the zone information is supplied by an IBOC based GPS calculation.
MSG008	MSG	User receives a page and responds on a two-way network	The device receives a page via the IBOC network and displays it to the user, the user responds on a two-way network to the entity originating the page with the source address information included in the message.
LBP004	(LBP)	Broadcaster sends location encoded ad information to be integrated with IBOC GPS	A broadcaster sends an ad for a chain of stores or restaurants in a city encoded by zone and the user sees the information for a store or restaurant in their zone where the zone information is supplied by an IBOC based GPS calculation.
GPS001	(GPS)	User uses IBOC data to calculate global position	User uses IBOC broadcast data from three locations to triangulate global position.
ODP001	ODP	Broadcaster supplies on-demand visual traffic reports	A broadcaster sends visual traffic information that is stored on the receiver and viewed at the request of the user.
ODP002	ODP	Broadcaster supplies on-demand visual weather reports	A broadcaster sends visual weather information that is stored on the receiver and viewed at the request of the user.
ODP003	ODP	Broadcaster supplies on-demand visual news reports	A broadcaster sends visual news information that is stored on the receiver and viewed at the request of the user.
ODP004	ODP	Broadcaster sends an on-demand traffic report	A broadcaster sends a traffic report that is stored on the receiver and played back by the user at their request.
ODP005	ODP	Broadcaster sends an on-demand weather report	A broadcaster sends a weather report that is stored on the receiver and played back by the user at their request.
ODP006	ODP	Broadcaster sends an on-demand news report	A broadcaster sends a news report that is stored on the receiver and played back by the user at their request.
PER001	PER	Service provider personalization request to the user	A service provider sends a request using the IBOC network to users asking the user to personalize the service using criteria particular to that service.
PER002	PER	User receives customized services	A broadcaster sends a data service with information that is customized by areas of interest to the user, the receiver uses on on-board profile to only display information of interest to the user as indicated by the user.
PER003	PER	User enters profile information into the device manually	A user enters profile information for a service using the input of a receiver device.
PER004	PER	User enters profile information on a web server	A user enters profile information for a service at a web site and the receiver uses a two-way network connection to retrieve the profile.
PER005	PER	Service profile is permanently stored on the receiver	The device receives profile information and that profile is stored on a permanent storage unit on the device.
PER006	PER	Service profile is stored on a web site.	The device receives profile information and the information is posted to a web site using a two-way network connection.

PER007	PER	Service profile is stored on a removable flash memory card.	The device receives profile information and the information is stored on a flash memory card that can be removed from the device.
PER008	PER	Service profile is stored on a CD.	The device profile is written to a CD and the receiver reads the profile information from the CD.
PER009	PER	Service profile is stored on a tape.	The device profile is written to a tape and the receiver reads the profile information from the tape.
RCM001	RCM	Radio station conducts a contest	Radio station sends data eliciting a response to a contest from one or more users in order to win something where the user responds to the contest via a two-way connection on the device.
RCM002	RCM	Radio station conducts a poll	Radio station sends data eliciting a response to a poll question from one or more users where the users responds to the contest via a two-way connection on the device.
RCM003	RCM	Radio station conducts a poll integrated with profile information	Radio station sends data eliciting a response to a poll question from one or more users where the users responds to the contest via a two-way connection on the device and the device transmits profile information back to the station.
RCO001	RCO	Service provider sells pre-recorded audio	The service provider transmits data that allows the user to purchase pre-recorded audio that is associated with the song or artist being played by the radio.
RCO002	RCO	Service provider sells concert tickets	The service provider transmits data that allows the user to purchase concert tickets that are associated with artist being played by the radio.
RCO003	RCO	Guest author sells a book	The broadcaster transmits data that allows the user to purchase a book by a guest being interviewed by the on-air personality.
RCO004	RCO	Radio station conducts promotion on behalf of a guest	The broadcaster transmits data promoting events on behalf of an artist whose song is being aired, or who is being interviewed by on-air personality.
RCO005	RCO	Retailer sells advertised merchandise	A retailer transmits data that allows the user to purchase merchandise related to the advertisement is being played on the radio.
RCO006	RCO	User conducts purchase via the device	The user interacts directly with the device to engage a commerce transaction.
RCO007	RCO	User manually inputs commerce instructions on the device	The user uses buttons on the receiver to initiate the commerce transactions.
RCO008	RCO	User uses voice response to initiate a commerce transactions	The user uses a voice response capability of a device to initiate a transaction.
RCO009	RCO	Device conducts transaction via a two-way connection	The device transmits the purchase instructions to an appropriate service provider using a two-way network connection and responds back to the user as to the result.
RCO010	RCO	Device conducts transaction via a flash memory card	The device records the purchase instructions to an appropriate service provider using a removable flash memory card which is later placed in a machine with a two-way network connection to transmit the information to the service provider.
RCO011	RCO	Device conducts a sale via bluetooth	The device transmits the purchase instructions to a machine with a two-way network connection using bluetooth. The purchase instructions are sent by the machine to the service provider.

RCO013	RCO	User requests more information on a product	The user interacts with the device to request more information about a portion of the broadcast such as an ad, a song, a guest, a station promotion, etc.
SAS001	SAS	Broadcaster transmits a free supplementary music program	A broadcaster sends secondary audio program consisting of a different selection of music than the main audio programming that the user can optionally choose to listen to.
SAS002	SAS	Broadcaster transmits a for-fee supplementary music program	A broadcaster sends a secondary audio program consisting of music that the user can subscribe to by entering an authorization code into the listening device.
SAS003	SAS	Broadcaster transmits a free supplementary news program	A broadcaster sends a secondary audio news program that the user can optionally choose to listen to.
SAS004	SAS	Broadcaster transmits a for-fee supplementary news program	A broadcaster sends a secondary audio news program that the user can subscribe to by entering an authorization code into the listening device.
SAS005	SAS	Broadcaster transmits a free supplementary weather program	A broadcaster sends a secondary audio weather program that the user can optionally choose to listen to.
SAS006	SAS	Broadcaster transmits a for-fee supplementary weather program	A broadcaster sends a secondary audio weather program that the user can subscribe to by entering an authorization code into the listening device.
SAS007	SAS	Broadcaster transmits a free supplementary traffic program	A broadcaster sends a secondary audio traffic program that the user can optionally choose to listen to.
SAS008	SAS	Broadcaster transmits a for-fee supplementary traffic program	A broadcaster sends a secondary audio traffic program that the user can subscribe to by entering an authorization code into the listening device.
SAS009	SAS	Broadcaster transmits a supplementary location based traffic program.	A broadcaster sends a secondary traffic program than is encoded with zone information and the user will hear the traffic information that effects the zone they are in and surrounding zones.
SDS001	SDS	Broadcaster transmits a free data news program	A broadcaster sends a data news program that the user can optionally choose to view on the receiver.
SDS002	SDS	Broadcaster transmits a for-fee data news program	A broadcaster sends a data news program that the user can subscribe to by entering an authorization code into the receiving device.
SDS003	SDS	Broadcaster transmits a free a data weather program	A broadcaster sends a weather program that the user can optionally view.
SDS004	SDS	Broadcaster transmits a for-fee data weather program	A broadcaster sends a data weather program that the user can subscribe to by entering an authorization code into the receiving device.
SDS005	SDS	Broadcaster transmits a free data traffic program	A broadcaster sends a data traffic program that the user can optionally view.
SDS006	SDS	Broadcaster transmits a for-fee data traffic program	A broadcaster sends a data traffic program that the user can subscribe to by entering an authorization code into the receiving device.
SDS007	SDS	Broadcaster transmits a location based traffic program.	A broadcaster sends a data traffic program than is encoded with zone information and the user will see the traffic information that effects the zone they are in and surrounding zones.
TEL001	TEL	Update service station information	The on-board service station information for the city or region a car is traveling in is updated via an IBOC network.

TEL002	TEL	Send a telematics weather alert	A telematics weather alert is sent to a car's telematics weather system on the IBOC network.
TEL003	TEL	Update point-of-interest information	The on-board point-of-interest information for the city or region a car is traveling in is updated via the IBOC network. This information includes names, locations, phone numbers, and even menus.
TEL006	TEL	Stolen car retrieval	A telematics message is sent via the IBOC network to cars in a city or region asking for a specific car to report its location via its two-way network where the car or cars being asked to respond have been stolen.
TEL009	TEL	Request traffic pattern information from vehicles by zone	A message is broadcast via the IBOC network asking vehicles to respond with location information via their two-way connection if they are in the zone indicated in the message.
TEL011	TEL	Update navigation information	Updates to the on-board guidance database for a region a car is traveling in are made via the IBOC network.
TEL012	TEL	Update traffic information for on-board navigation system	Traffic information is broadcast via the IBOC network that is coded by zone so that the on-board guidance system of the car can help a vehicle avoid potential traffic jams.
TEL014	TEL	Vehicle theft countermeasures initiation	A user notifies the police vehicle was stolen and a message is sent to the vehicle via an IBOC network to initiate the on-board theft countermeasures.
TSS001	TSS	Service provider encodes a portion of the broadcast for recording purposes	Service provider encodes a portion of a broadcast so that a device can determine the beginning and end of a program so that the device may record and label the program.

Bibliography

[i] *UNITED STATES RBDS STANDARD, Specification of the radio broadcast data system (RBDS),* National Radio Systems Committee, April 9, 1998

[ii] *FM Subcarrier Report/ Technology Guide,* National Association of Broadcasters, 1997

[iii] *Report to the National Radio Systems Committee, FM IBOC DAB Laboratory and Field Testing,* Appendix A, iBiquity Digital Corporation, August 2001.

[iv] i*bid.*