HD Radio EPG Project

Business Requirements and Use Cases

11 July 2008

Preface

This document is the product of a joint effort of BIA Financial Network (BIA*fn*) and Broadcast Signal Lab (BSL), in conjunction with Unique Interactive and other consulting subcontractors. It is produced under contract between the National Association of Broadcasters (NAB) FASTROAD initiative and BIA*fn*/BSL, and is therefore subject to all terms of that agreement.

Acknowledgements

This document is the result of collaborative authorship, specifically the work of Rick Ducey of BIA*fn*, David Maxson of BSL and Skip Pizzi (consultant to BIA*fn*), with contributions from Nick Banks and Adrian Cross of Unique Interactive. Editorial direction provided by Skip Pizzi, with helpful editorial guidance from David Layer of NAB.

Thanks also go to the many industry experts consulted in the research phase of this project for their generous contributions of time and information.

Finally, this project would not be possible without the cooperation of iBiquity Digital Corporation, most notably represented by the efforts of Joe D'Angelo.

The authors wish to express their gratitude to all who have contributed to the creation of this report, and we offer our thanks in advance to those who will so necessarily join these ranks as this project continues.

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1 Executive Summary

Digital radio broadcasting in the U.S. could benefit substantially by deploying an Electronic Program Guide (EPG) feature that is designed to become widely adopted. While iBiquity Digital Corporation has developed an EPG data structure for HD Radio™ technology,[1] the important work of developing the overall EPG ecosystem for U.S. radio broadcasting is now underway under the auspices of the NAB FASTROAD program. The NAB FASTROAD HD Radio EPG project is intended to focus and stimulate that work in a coherent, industry-wide fashion, with input from all key stakeholders.

This project is envisioned to have two Phases. This document is the first output of Phase 1, which will also include development of system architecture and specification documents, to be concluded by September 2008. Phase 2 envisions subsequent lab and field testing.

This document outlines what we feel are the key business requirements of such a system, and presents consumer use cases and other background to help the reader understand the rationale behind the envisioned EPG system.

Radio EPG systems are already in use elsewhere in the world. One leading developer of such services is Unique Interactive, a key contributor to the EPG specification used in the Eureka DAB format, and a partner in the initial development of the HD Radio EPG with iBiquity Digital. Unique Interactive is also a contributor to this NAB FASTROAD project, and their valuable experience as an EPG system developer and service bureau is shared herein.

EPGs are increasingly prevalent in digital television today, so most broadcaster and user awareness of EPGs flows from that medium. It is important to understand several fundamental differences between TV and radio in terms of EPGs:

- There are more radio stations to manage in any given market.
- There is no channel aggregator (as in cable or satellite TV), and no third-party program-data compiler businesses exist.
- Radio receivers are inherently mobile, so the list of available stations is constantly changing.
- Visual display screens on radios come in myriad shapes and sizes.

Taking these challenges into account, we present what we believe to be a workable design for a U.S. radio EPG system. It includes four possible delivery architectures that accommodate a range of station needs, from each station carrying their own EPG data, to various methods of cross-carriage via cooperation among station groups, or even an entire radio market. The EPG system further envisions

[1] *HD Radio* is a trademark of iBiquity Digital Corporation.

and accommodates a converged, future device that includes both HD Radio and wireless Internet capabilities.

We also expect that some stations will use EPG data more than others, and that receivers' EPG capabilities will vary widely, from the earliest and most basic EPG-capable designs, to more advanced models and those expected during the period of EPG service's ultimate maturity. A flexible modality for EPG service is therefore stressed throughout. Special consideration is also given to providing EPG parity between AM and FM stations, and how to accommodate stations that are not yet transmitting HD Radio signals (given that HD Radio receivers also pick up analog-only radio signals).

It is also critical to industry and mass market acceptance of EPG systems that the addition of EPG capability to receivers not be restricted to pricey, high-end designs. Thus the system presented here accommodates a wide and scalable range of functionality that will be useful on even the most basic units, and add further value as receiver capability increases. Nevertheless, while not *essential* to EPG capability, we acknowledge that EPG performance could be greatly enhanced by HD Radio receivers that include dual tuners, always-on or scheduled-wake-up background operations, backchannel capability (e.g., via integrated wireless Internet capacity), or any combination of these components.

The direct and indirect costs for broadcasters to add and operate EPG services should be minimal, in order to facilitate wide acceptance and use. The EPG system should accommodate existing elements of typical station infrastructure, and require a minimum of additional capital and operating expense. The additional digital broadcast bandwidth required to support EPG is also a concern, with some broadcasters suggesting that no more than 1 kbps per station should be dedicated to EPG data transmission.

Through extensive interviews with experts, we have developed a deep understanding of how consumers might use and benefit from a radio EPG service,[2] and how broadcasters might benefit from such service in the future operations of their businesses.

This initial portion of the project has culminated with clear guidance on what is essential, and what is desirable, in the design of an EPG system, the software that generates it, and the devices that audiences use to receive it.[3] These requirements will inform the process of developing a full EPG system as this project continues.

In general, we conclude that U.S. radio listeners will be better served if the array of available, local program choices is made known to them in the most convenient form.

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[2] A complete list of such use cases is found in Table 3 of the full report.

[3] A full list of these requirements is presented in Section 8 of the full report.

2 Introduction

The addition of an Electronic Program Guide (EPG) to HD Radio service has been under development for some time, and is about to become a reality.

This enhancement to HD Radio service could be more than just a simple feature extension, but may fundamentally affect the radio industry. It could provide significant incentive for conversion of stations that have not yet done so, and it could drive substantial new consumer adoption of HD Radio. EPG service will also help the radio broadcast medium remain competitive, by satisfying listeners who are becoming more sophisticated in their expectations of the services that accompany their digital media.

This improvement will not come without a coordinated effort among industry stakeholders, however. Unlike the television world, there is no existing (print-based) national or local program-schedule aggregation infrastructure on which to build. Thus the challenge is not merely technical in nature.

Nevertheless, there seems to be keen interest among broadcasters, receiver manufacturers and consumers in adding this capability to the U.S. digital radio environment. The current HD Radio transition provides the proper opportunity for such an advance.

To be optimally accomplished, this service must be deployed in a coherent fashion, with carefully synchronized cooperation of all stakeholders. The NAB FASTROAD HD Radio EPG project is intended to provide just such coordination by development of an incubation project and real-world test, of which this document is the first output component. [4]

In the following pages, this report provides the rationale and initial conclusions of the project team assembled by NAB FASTROAD, which are in turn based on deep analysis and consultation with many experts across all relevant components of the industry.

The document begins with substantial background on the process, existing technology and context, with an eye towards practical examination of what it would take to implement a radio EPG system in the U.S. broadcasting environment. It concludes with the primary conclusions from this stage of our work, a compilation of the consumer use cases, and the business requirements for a radio EPG system that naturally emerge from our research to date.

The BIA/BSL team welcomes reader feedback on this report.

[4] We are aware that some entities are or may be planning the development of proprietary EPG solutions, which our process does not include or address. The approach we espouse herein is an open, industry-wide development project, ideally intended to produce a system that ultimately becomes a standard feature of all HD Radio stations and receivers.

3 Project Background and Goals

The NAB FASTROAD HD Radio EPG Project will have up to two Phases as described below. Phase 1 work has been approved by NAB FASTROAD, and focuses on business requirements, overall system design and recommendations for a field test market. Phase 2 is anticipated to focus on lab and field testing.

This report is part of the Phase 1 deliverables, and presents results on “Task 0: Requirements.”

3.1 Background

This HD Radio EPG project is funded under a contract issued by the NAB FASTROAD (*Flexible Advanced Services for Television & Radio On All Devices*, www.nabfastroad.org) technology advocacy program of the National Association of Broadcasters. The overall mission of the FASTROAD program is to seek and facilitate development and commercialization of new technologies that can be exploited by broadcasters using radio and television broadcast spectrum. The EPG project described herein is being funded and is subject to oversight by the FASTROAD program office. NAB FASTROAD activities and initiatives involve technical and/or business-related aspects of innovative technologies that may be of interest to broadcasters. Unless expressly stated, such activities and initiatives do not imply NAB’s endorsement or NAB’s position on any particular policy.

NAB FASTROAD recognizes that while considerable systems engineering work has already been done by iBiquity on an EPG service protocol for use with HD Radio technology, little has been accomplished in the way of system design to establish a working EPG ecosystem within the radio broadcasting industry. For example, it has not been determined how stations in a market can best cooperate to populate EPGs and how this data can best be transferred and managed.

Further, while other EPG protocols (besides the one developed by iBiquity), suitable for use with the HD Radio system, are certainly possible, we anticipate that the iBiquity design will be the first to market and currently represents the best alternative for broadcasters and receiver manufacturers looking to utilize the capabilities of an EPG. Consequently, the work described herein has been conducted in close cooperation with iBiquity and assumes use of the iBiquity EPG technology.

3.2 Goals

The goals of the NAB FASTROAD HD Radio EPG project are intended to accelerate this development process by funding system design work, organizing a market trial/demonstration of the resulting EPG system, and preparing a final report that summarizes this work and makes recommendations for the future use and deployment of EPG systems using HD Radio technology. NAB FASTROAD envisioned the timetable as potentially an 18- to 24-month program to be conducted in phases as follows:

- **Phase 1** – Principal goals of Phase 1 are to complete the overall system design, and to select the radio market and broadcast stations for the field test portion of the project. This work is organized into four tasks: Task 0: Requirements; Task 1: Preliminary EPG System Architecture; Task 2: Select Radio Market for Field Test; and, Task 3: Final EPG System Architecture.

- **Phase 2 –** Principal goals of Phase 2 are to successfully complete the laboratory test/computer simulation of the EPG system, and make final preparations for the field test.

3.3 Task 0: Requirements

For "Task 0" our goal was to identify and document the business and functional requirements of an EPG system suited to the U.S. Commercial and Non-Commercial terrestrial HD Radio market. We identified and considered in a series of interviews and research a number of system requirements, including the following:

- Costs
- Business constraints on the transmission and reception of the HD Radio EPG
- What data will be included in the EPG
- Data refresh rate
- Transport layer independence
- Bandwidth requirements
- EPG information exchange process – ("Four Scenarios")
- Receiver classes (design issues, minimum requirements for EPG support)
- Legal considerations – IP prior art, patents
- The role of a market-oriented hierarchy in transmitting and presenting EPG

The following activities were conducted in the process of performing Task 0:

- Review relevant literature and discuss requirements concerns among the experts on the team
- Conduct interviews with industry experts at-large
- Review relevant marketing, product, standards and research literature
- Consider lessons learned in other EPG environments (e.g. DAB and DTV)

4 Delivery Architecture, Content Management and Receiver Design

Before discussing Use Cases and Requirements, it may be helpful to understand some fundamental concepts that have been explored by companies and consultants active in this space, and considered by various stakeholders, so far in this study. The issues below all have significant impact on the decisions made to date in determining Business Requirements for an HD Radio EPG.

4.1 Delivery Architecture

EPG delivery architecture involves several layers including integrating and delivering data from several sources to different types of recipients:

1. From Program providers to Stations (or groups and clusters)
2. Within Stations to interact with their internal automation and traffic systems
3. From the Station to Receivers
4. From Receivers to Listeners

Figure 1 below depicts a simple view of EPG data flows from one program source to one station.

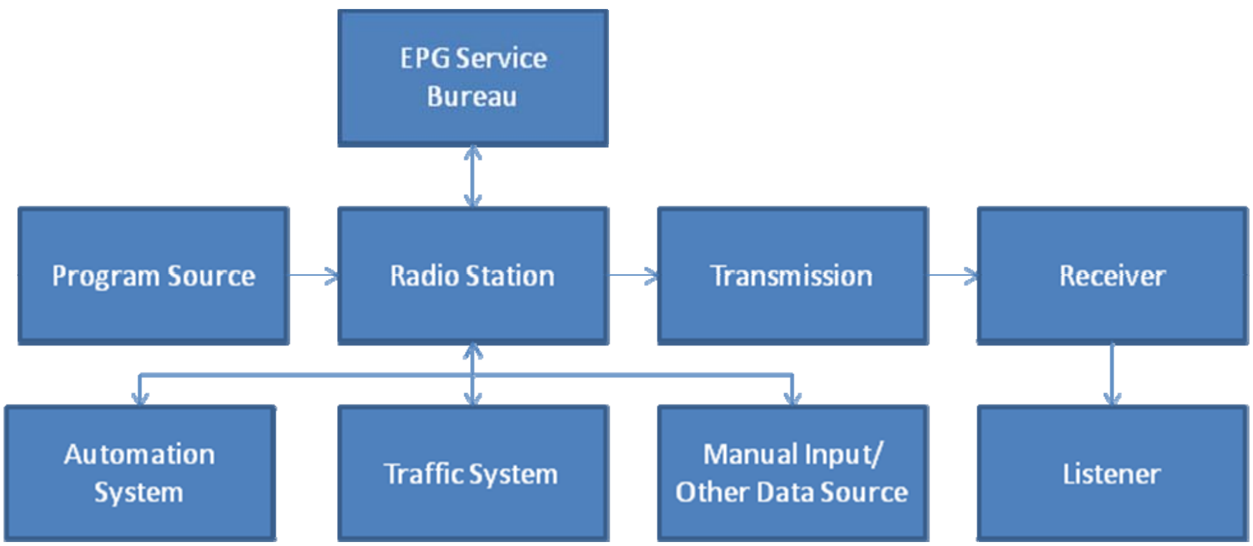

Figure 1. Basic data flow process for a Radio EPG.

4.2 EPG Content Management

In reality, however, EPG data flows and content management will be more complex, because the industry's business requirements likely will call for a scenario with *multiple* program sources, *multiple* EPG data sources and *multiple* stations operating in clusters in each market. Additionally, in-car radio listeners may receive radio stations from more than one market as they commute or shop locally or travel longer distances. The EPG data sources must be managed, relying on rules-based data structures, then loaded into the HD Radio Exporter for transmission to HD Radio capable receivers. Our further assumption is that the HD Radio EPG system must be flexible enough to accommodate several types of receiver classes (each with varying capabilities), and system extensions occurring over time.

4.2.1 EPG Service Bureau – Unique Interactive Case Study

As an example, Unique Interactive has developed its own commercially available radio EPG system, which is currently in use in the Eureka DAB environment. This system is described below and referenced elsewhere throughout this document.[5]

Figure 2 below presents the data flows from multiple radio stations to an EPG management system that can be deployed on site at a radio station (or cluster/group), or maintained by an independent third party (e.g., one of the services Unique Interactive provides for the DAB market in several countries).

In Unique Interactive's language, the party performing the master EPG management tasks for numerous stations is called a *Service Bureau.* The role performed by a Service Bureau is familiar to those radio stations that rely on on-line services to provide such functions as music title/artist databases, iTunes tagging services, spot delivery services, and the like. The EPG Service Bureau, whether it is in-house or provided by a third party, enables the sharing of information under carefully controlled conditions. The result is the provision of a coordinated, user-friendly EPG service that offers key virtues while minimizing risks. Among the virtues of a well-run EPG system are consistency of presentation to the user, security of information until released for transmission, equitable control of shared bandwidth under mutually established rules, and verified accuracy and timeliness of information.

The generic data flow diagram in Figure 2 depicts the core elements of the relationship among several cooperating stations.[6] In the context of the HD Radio EPG, each "Radio Station" shown in the Figure is equivalent to one *program service* on an HD Radio signal (for example, an HD-2 service transmitted on radio station WXYZ). Not shown are the optional connections between outside EPG sources, such as a program syndicator, and the EPG network.

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[5] Through this NAB FASTROAD project, Unique Interactive now brings its deep experience in EPG design to the HD Radio environment. The HD Radio EPG discussed herein is being designed specifically for the needs of U.S. radio broadcasting.

[6] In the Eureka DAB system, several (typically ~10) radio services are multiplexed together into a single transmission "ensemble," which includes a single EPG data stream for all services within the multiplex. These services generally originate from several different (often competitive) broadcasters, so a third-party is required to assemble the EPG data for delivery to the multiplex. In the U.S. environment, all multicast services on an HD Radio transmission signal will typically originate from the same broadcaster.

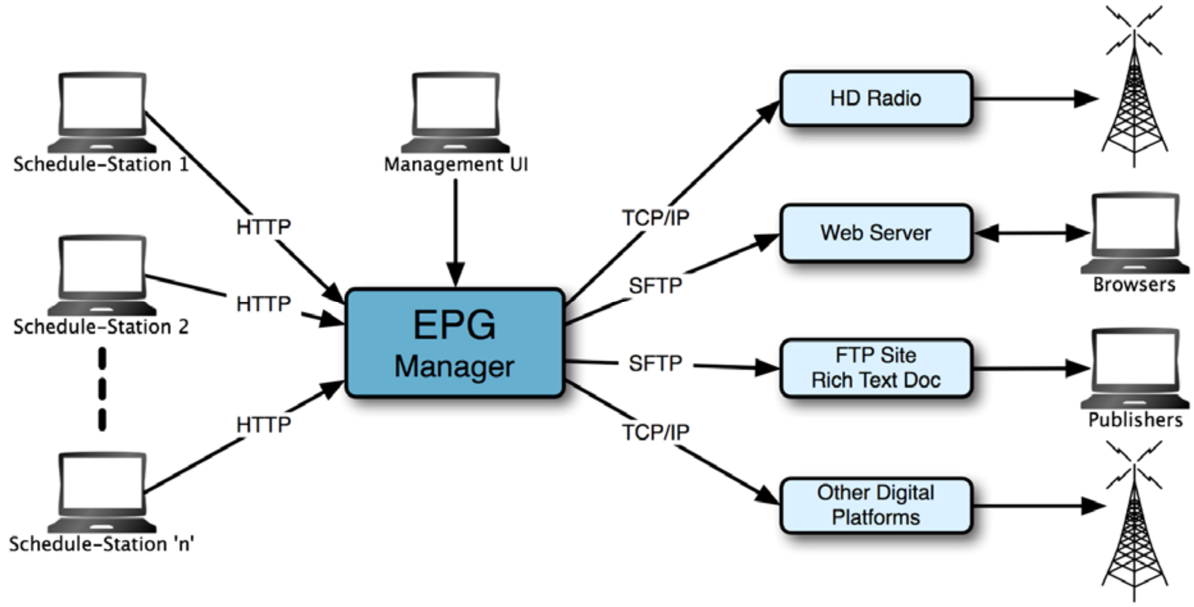

Figure 2. An example of an EPG Network's Management Structure (Courtesy Unique Interactive).

The resulting EPG data is delivered to various distribution platforms, as shown at the right of Figure 2. Examples of final display of EPG data on the DAB platform are shown in Figure 3.

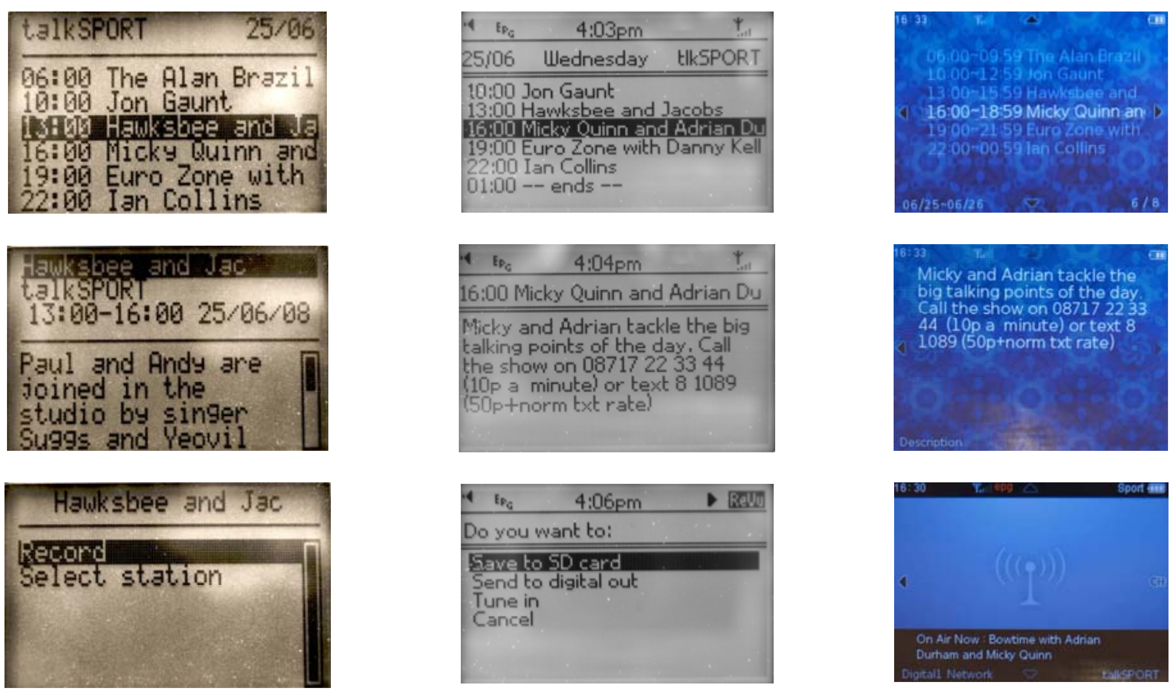

Figure 3. Some screen shots of EPG displays on various Eureka DAB receivers. At left is the Morphy Richards *Ordio*, at center is the Pure *Evoke 3*, and at right is the iRiver *B20*.

4.2.2 EPG Data Issues

A consideration that is of paramount importance is how EPG data will be delivered to consumers. This is a complex question for U.S. digital radio, and differs substantially from the existing and well-understood EPG model for U.S. digital television services, for several key reasons:

1. The number and variation of individual stations involved:
    - Radio stations are far more numerous than TV stations.
    - Radio stations are typically more geographically distributed than TV stations.
    - Radio stations tend to have a greater diversity of coverage areas (small to large) than TV stations.
2. The lack of a program guide service aggregator for the market:
    - Again, unlike television, radio stations have no common delivery platform, such as cable or satellite providers, on which to organize programming lookup tables.
    - This is also unlike Eureka DAB, wherein each *ensemble* of program channels ("stations") has its EPG data bundled into a single data channel.
    - There are also no existing third parties that comprehensively collect program schedule data from U.S. radio stations, as there have been for many years in the TV world (as a legacy of print-media program guides).[7]
3. The mobility of the receiver:
    - Because listeners are continually moving in and out of individual stations' coverage ranges, the list of currently available stations can change quickly throughout a market region.
4. The variety of receiver display types:
    - Unlike TV, radio receivers' display sizes, shapes and capabilities vary widely, from simple 8-character text displays to fully featured video screens.

Another critical question is how quickly up-to-date EPG data will be displayed on the receiver. This involves both transmission and receiver issues. As with any datacasting service, tradeoffs can be made between occupied transmission bandwidth and time required to display the information. There are two

[7] There are two major providers of such data for television stations in the U.S.: *Tribune Media Services* (http://www.tms.tribune.com/) and *Gemstar/TV Guide* (http://www.gemstartvguide.com/, recently acquired by Macrovision).

competing factors that put demands on EPG transmission bandwidth: 1) how much information must be delivered to complete the EPG, versus 2) how often the information is repeated to ensure prompt acquisition of the data to a newly tuned-in receiver. This could put broadcasters and audiences at odds, since many broadcasters feel strongly that the digital bandwidth devoted to EPG must be very narrow – perhaps no greater than 1 kbps on FM stations. This constraint may limit the ability of some receivers to display EPG data for *multiple* stations simultaneously, while only tuned to one station at a time.

4.2.3 Four Possible EPG Transmission Approaches

The unusual arrangement faced by a radio EPG service calls for an examination of multiple possibilities for delivery of EPG data to receivers. We have identified four distinct approaches, with variations (summarized in Table 1 below). In all cases, an individual station's EPG data is assumed to include its main and all its supplemental ("multicast") program services.

Model	Description	Advantages	Disadvantages
Parochial	Each station transmits its own services' EPG data only.	• Only currently receivable stations are discovered • No competitive issues	• Slow to load full-market data at receiver • Receiver must continuously assemble market EPG on the fly
Master Station	One or more stations in the market carry EPG data for all stations in the market. Non-master stations in the market transmit "pointer" identifying the master station(s) carrying their EPG data.	• May be faster to load full-market data at receiver • More efficient use of market's datacast bandwidth	• Market data may include some stations not currently receivable • Requires data aggregation and unique hierarchy/management in each market • Possible competitive issues
Shared	Every station in the market carries (some or all of) the EPG data of every station in the market.	• Fastest to load full-market data on all EPG-capable receiver types	• Competitive issues • Least spectrally efficient (redundant datacast) • Market data may include some stations not currently receivable • Requires data aggregation and distribution within market
Network	Stations transmit a pointer to a general EPG resource along with station's location data (and/or receivers use geolocation) to filter localized EPG data from a master database. Delivery of EPG data may be via non-broadcast path (e.g., wireless Internet).	• Fast to load full-market data • Market data optimized for current receiver location, so less likely to include stations not currently receivable. • Spectrally efficient	• Requires more advanced receiver features to fully benefit from this model • Requires data aggregation (and possible unique hierarchy/management and/or distribution in each market)

Table 1. Summary of four possible delivery architectures for HD Radio EPG data.

To interpret the approaches, it is important to understand the principles of *basic* and *advanced* EPG information. Basic information is EPG data that is the minimum necessary to provide useful information on a station's program schedule. It may be abbreviated both in time (looking, say, only a day or so ahead) and in detail (containing, say, only daypart information but no program details). Advanced EPG information can include narrative description of programs, segmentation data (such as a list or brief description of stories carried in a news-magazine program), biographical or other background information on material currently playing, or simply information about upcoming content that is further in the future.

A station or a group of cooperating stations might choose to repeat ("loop") basic information more often than advanced information to ensure the rapid acquisition of the most important or timely data. To accomplish this, the basic information is placed in *carousels* that are scheduled for certain repetition rates depending on the current importance of their content.

The four models are described in further detail below. Primary parameters and tradeoffs to consider in this analysis are the various models' data bandwidth requirements, receiver display latency, system-management burden and complexity, receiver footprint (i.e., processing, memory, display requirements), and timeliness/accuracy of EPG data delivered to audiences.

4.2.3.1 *Parochial Model*

In this most primitive case, each station transmits only its own services' EPG data (basic or advanced). This includes all multicast services the station carries.

With this delivery model, the receiver is immediately aware of EPG data for the services transmitted by the currently tuned station, but to gain awareness of EPG data from other currently available stations, the receiver has to tune to each station. A second tuner or background operation will greatly speed the acquisition of EPG data from other stations in this model (see Section 4.3.1, *Latency-Reduction Schemes*, below), but short of these additional features, this model will likely be slowest to display a full-market EPG. Such latency could be exacerbated by this model's additional burden placed on the receiver to continuously build the market EPG "on the fly" at the receiver (as opposed to the pre-configured data models that follow).

An advantage of this model, however, is that the receiver's EPG is accurately populated only with currently available stations. (This advantage will become more evident when compared to the problems encountered in other pre-configured data models below.) This approach also avoids any competitive issues that might be involved when a station is called upon to carry EPG data from another station (again, see other models that follow, and also discussion in Section 4.2.7 below).

4.2.3.2 *Master Station Model*

Under this model, all participating stations in a market transmit a "pointer" to that market's Master Station(s) for EPG data. This implies that the impact on stations' datacasting bandwidth impact for adding EPG is very small, except for each market's Master station(s), upon which the impact is very large. For this reason, some form of compensation to Master stations may be required in this model. In any case, reasonable spectrum efficiency for datacasting bandwidth is provided.

This approach also requires the aggregation of EPG data from all stations in the market, either by the Master stations themselves or by a third party. A further requirement is the initial arrangement and ongoing maintenance of the hierarchy of Master and non-Master stations in each market. Again, this arrangement may be managed by the stations in each market independently, or by third parties.

There are a number of possible variations to the Master station model, as follows:

a) Master stations transmit *all* EPG data for all stations in their markets; individual stations transmit only a pointer to Master station(s).

b) Master stations transmit *all* EPG data for all stations in their markets; individual stations transmit only their own EPG data, plus a pointer to Master station(s).

c) Master stations transmit *only advanced* EPG data for all stations in their markets; individual stations transmit their own *basic* EPG data only, plus a pointer to Master station(s).

d) Master stations transmit *basic* information only for all stations in their market. Individual stations transmit their own *advanced* information, plus a pointer to Master station(s).

e) "Group Master" model: A multi-station group in a particular market determines which of its stations will carry EPG data for all of *its* stations in the market. The non-Group Master stations in the group transmit only a pointer to the Group Master station. (Some of the other basic vs. advanced permutations noted in the other variations of the Master station model above could also be applied to the Group Master model, providing further sub-variations on the latter approach.)

Advantages to this model include a possible increase in the speed of loading of the full market's EPG data by the receiver – although if currently tuned to a non-master station, this speed would only be fully achieved if a second tuner or background operation were available on the receiver (see Section 4.3.1, *Latency-Reduction Schemes*, below).

A disadvantage of this model arises from the possibility that a receiver may be considered to be within the confines of a market, but still not have the ability to successfully tune in all stations in the market (e.g., located at one edge of the market). If the EPG received from the Master station includes all stations officially classified as part of this market, some stations may appear on the receiver's EPG that are not actually available. This problem is multiplied in the case of the mobile receiver, where the currently unavailable stations on the EPG are continually changing. (See Section 4.2.3.4, Network Model below for possible solutions to this problem in more advanced receivers. See also further discussion in Section 4.2.6 below.)

4.2.3.3 *Shared Model*

In this case, each participating station in the market carries EPG data for all participating stations, in either of the following forms:

a) Every station carries *basic* data for *all* the stations in the market, plus its own *advanced* information.

b) Every station carries *all* data for *all* stations in the market (i.e., all stations in the market carry the same EPG data stream).[8]

This approach ensures fastest loading of the full market's EPG data, on even the most basic of EPG-capable receivers, since it is carried by any (participating) station that the receiver tunes to. Of course, this comes at the cost of spectral efficiency, at which this model is the poorest performer, due to the redundancy of the same EPG data being transmitted by all stations.

The problems noted above in Section 4.2.3.2 regarding the potential unavailability of some stations listed on the EPG also apply to this model, as do the requirement for EPG data aggregation from all stations in the market. There is no need to declare Master station(s) hierarchies in this model, however, although some mechanism for delivery of aggregated market EPG data to all stations in the market must be established.

4.2.3.4 *Network Model*

Here stations transmit only such information as is necessary for the receiver to discern where to look for the EPG data specifically relevant to the receiver's current location (and perhaps, any other location, such as a destination market). This could be transmitted in the form of an "enhanced pointer," and thus retaining most of the spectral efficiency of the Master station model above. Automatic geolocation (via Internet, wireless phone or GPS) in the receiver could then be applied, or manual location-data entry (e.g., via Zip Code) is possible for non-mobile devices. In any case, incoming EPG data is then appropriately filtered by the receiver from data received via the Master or Shared models above, such that only stations likely to be receivable in the receiver's current location will be displayed.

Alternatively, a pre-populated, localized EPG display could be delivered to the receiver via a non-HD Radio path, such as a wireless Internet connection. In this case, the receiver uses a backchannel to deliver its current location data to an interactive resource, such as a database-driven website, which responds with customized EPG data for the receiver's current location.

This model retains most of the advantages, while avoiding many of the disadvantages, of the other models above. (A data aggregation process of some form is still required, but data loads quickly, listed stations are all likely to be available, spectrum efficiency is retained, and competitive issues are not raised.) The additional requirements of this model would only apply to advanced HD Radio receivers, however, such as those that also included some form of geolocation and/or backchannel capability. Such an approach would therefore be seen as an extensible feature for future EPG service, but it could be

[8] Data bandwidth requirements for this approach may be prohibitive, particularly given that all stations will be carrying this same, large amount of data. Empirical results may confirm this if Phase 2 of this study is completed.

accommodated (or at least envisioned) in the initial system architecture. Meanwhile, it is not this project's intent to require such an advanced profile of features as the baseline receiver for EPG use.

Further, such an "aggregated but geo-sensitive" EPG presentation model could be made available immediately via the Internet to PCs, PDAs and Internet-capable mobile phones, in which a locationally aware client accesses a full market (or national) database, but only displays stations likely to be currently accessible to the user. This service could be used "offline" (i.e., not attached to a radio) as a reference to help listeners find radio content they seek, which they then tune manually on a conventional radio. If this behavior became popular, it might drive listeners to purchase new receivers that integrated EPG functionality for more streamlined, single-device operation.

4.2.4 Special Case: AM Stations

Because of their reduced digital bandwidth, AM stations may be particularly challenged to provide extensive EPG data on their own broadcast signals. This creates a mild dilemma since AM stations, particularly those with talk-dominated formats, may wish to be among the earliest adopters and heaviest users of EPG data presentation, and they could therefore be counted among its greatest beneficiaries.

Although it is the intention of this project to provide relative parity for AM and FM stations in an EPG context, this may not be fully achievable given the differential in datacasting capacity between the AM and FM HD Radio systems. This implies that the richness of display for AM EPG data may be constrained compared to that of FM, or it may be delivered to receivers with higher latency than FM stations' data. Alternatively, an AM station's EPG data might be carried by a co-owned or other FM station in the market, as described in Section 4.2.3.2 above.

It is the goal of this project to not substantially disadvantage AM stations regarding EPG capability. At present, the actual bandwidth requirements for a full radio market's EPG data is unknown, but a good understanding of it will be helpful (if not essential) to designing an appropriate solution for AM stations' EPGs.[9]

4.2.5 Special Case: Analog-only stations

Because HD Radio receivers are inherently also analog AM/FM receivers, it could be argued that any market-aggregated EPG delivered via the Master or Shared model above should also include AM and FM stations in the market that have not yet converted to HD Radio broadcasting, since these analog stations are also receivable on the user's HD Radio device. On the other hand, it could be interpreted as unfair for analog-only stations to be included in such market-aggregated EPG data, since there is no reciprocal carriage of any EPG data by the analog-only stations. A compromise solution in such cases might be the simple listing of analog-only stations in the EPG, but with no additional program schedule or station

[9] This is a key goal anticipated from Phase 2 of this study, if completed.

format data, and perhaps some visual indication (e.g., icon) on the EPG display denoting which stations are available in HD Radio format.

4.2.6 Coverage Matching

A specific user-experience problem is foreseen in the Master or Shared models, as discussed above: Depending on the current location of the receiver, not all of the stations delivered in the market-wide EPG may be currently receivable. Conversely, some stations from neighboring markets may be currently receivable, but they do *not* appear on the currently displayed EPG.

This problem could be partially addressed by the receiver adapting its display (e.g., "graying out" the unreceivable stations as it learns of their unavailability), but it is perhaps better accommodated by the Network model in Section 4.2.3.4 above.

In a preliminary attempt to quantify the coverage-matching problem, we conducted a survey of the variability in what stations can be received at any given location within and around a market.[10] The results suggest that a comprehensive and accurate EPG will be difficult to administer on both the transmission side and on the receiver side. The most reliable means of accurately and consistently identifying only those stations that can be received at the listener's location is achieved by the receiver conducting a continuous background scan of the radio dial (this would require a second tuner).

4.2.7 Competitive Concerns

Although the Master or Shared models in Section 4.2.3 above are both intended to reduce processing burden and latency in EPG-equipped HD Radio receivers (and utilize HD Radio datacasting bandwidth more efficiently), they each require stations to carry EPG data from other stations in some form. Early reaction from broadcasters to this premise has been strongly negative due to competitive concerns, regardless of reciprocity or remuneration that might be involved. Some broadcasters, however, given time to reflect on the implications of shared data, acknowledged the benefit of a more consistent user experience of the radio bands, as long as they had iron-clad protection from misuse or abuse of their stations' information. Reciprocity agreements could provide such comfort. Nevertheless, such initial defensive reactions, combined with the complexity of managing such a system and the coverage-matching issue noted in Section 4.2.3.4 above, makes it appear likely that the Parochial model above is most likely to find favor within the industry, at least initially.

The Parochial model places additional burden on EPG-equipped HD Radio receivers, since all aggregation of EPG data will necessarily take place in the receiver. There are a number of strategies that can be applied to receiver design that ameliorate this burden, although some of these have also found resistance from the consumer electronics community (see Section 4.3.1 below). Thus a compromise course that is acceptable to both broadcasters and receiver manufacturers for an initial EPG rollout will

[10] See Section 10, *Case Study of Inter/Intramarket Station Reception Variability*, compiled by Broadcast Signal Lab, LLP.

be required, with intrinsic scalability and versatility to accommodate future improvements and architectural modifications. The EPG system should anticipate a migration path to more complexity and capability as the market matures, of course. As is always the case in the broadcasting environment, new technologies must rely on the symbiosis of perceived values to the consumer, the broadcaster and the consumer electronics maker, and the likelihood that these perceptions will shift over time.

4.3 Receiver Design

With regard to the delivery architectures described above in Section 4.2.3, all models except the Parochial model are intended to provide pre-compiled EPG data to the receiver, thereby minimizing its need to collect and assemble an EPG "from scratch," and thus reducing processing burden and latency of data display. Our premise in pursuing EPG capability is that the listener will be better served by the radio broadcast medium if the array of program choices that is available on the radio bands, now and in the near future, is made available in the most convenient form.

Broadcasters have shown strong preference for the Parochial model, however, which puts added demands on the receiver to render the convenient display of available stations/programs. In its favor, the Parochial model avoids some transmission-side complexities and bandwidth inefficiencies found in the other delivery models. Therefore it is assumed that the Parochial model for EPG data delivery will be favored, at least initially, and be the simplest to implement while the EPG-capable receiver base[11] is in its infancy. Early generation EPG-equipped HD Radio receiver design should proceed with this approach in mind.

A Parochial-modeled receiver will need to collect EPG data individually from each station and compile an EPG "on the fly" from the collected data streams. This is in stark contrast to the commonly encountered EPGs of digital cable or satellite TV, where the receiver simply displays a pre-compiled EPG. This is also partially true in Eureka DAB, where each 1.5 MHz ensemble delivers a pre-compiled, aggregated EPG for all the audio services (typically ~10) on that ensemble.

The Parochial model also provides an additional advantage in that only currently receivable stations will provide EPG data. This avoids the problem faced by pre-compiled market-based EPG data (as in the Master or Shared delivery models above), which is delivered to the receiver via one or more stations that are currently receivable, but which might include data for stations that were currently *not* receivable. It also eliminates the *market-seam problem,* in which listeners on the seam between two markets must choose between two EPGs, neither of which is complete from the listener's perspective.

[11] It is important to note that for the HD Radio system to support EPG, additional protocols not yet implemented are required on both the transmit and receive side. Once EPG data is being transmitted on HD Radio stations, it will not be displayed on legacy HD receivers (but neither will it negatively affect them in any way – they will simply ignore it). A new generation of HD Radio receivers incorporating EPG capability will need to be deployed in order to fully enable the HD Radio EPG ecosystem.

(Such problems might be avoided by a system that included adaptive or geolocation abilities, but this would involve greater complexity than might be warranted, at least in an initial system design.)

Under the Parochial delivery model, in order to provide an acceptable user experience, some special techniques will be required of the receiver, as described below.

Further, although the Parochial model may be favored, we believe that there may be good reason that it not be the *only* model supported by an HD Radio EPG system. An alternative model that allows a station's EPG data to be carried by other stations in one or more of the forms outlined in Section 4.2.3 above (such as Variation (e) in Section 4.2.3.2) may be advantageous to or preferred by some stations -- particularly AM stations. Whether such architectural flexibility is feasible will be one of the key outputs of Phase 2 of this study, if completed.

4.3.1 Latency-Reduction Schemes

Assuming a Parochial model for delivery of EPG data (at least in the worst case, although it is likely to be the typical case, at least initially), one or more of the following could be used to provide an HD Radio EPG user experience without excessive latency.

4.3.1.1 *Dual-Tuner Design*

A dual-tuner HD Radio receiver could use one tuner to receive the currently tuned station while the second tuner continually scans the AM and FM bands for EPG data. This second tuner could be a data-only design (i.e., no audio decoder included) to reduce cost somewhat.

Alternatively, one potential benefit of an EPG is the ability to time-shift programming (i.e. record on schedule for later use). In such an integrated HD Radio/recorder unit, a full second tuner is almost essential (as in conventional DVRs), so that the user can listen to one program while recording another. On these devices, when not in use for recording, the unit's second tuner could scan and collect EPG data.

In either case, a second tuner could fairly quickly collect EPG data from all the stations currently receivable, for display on a full EPG screen if desired. As the receiver's location changed, the continuous scanning of the second tuner could update the EPG to keep it current.

4.3.1.2 *Always-On or Scheduled-Background Operation*

In lieu of a second tuner, an EPG-equipped HD Radio receiver with a single tuner could scan the AM and FM bands and collect EPG data while the radio was not in use. This could be done continuously ("always on" mode), or only periodically ("scheduled background" mode) to conserve power.

Another power conservation method calls for stations to transmit an EPG-refresh schedule, so receivers can be programmed to "wake up" at precisely the right time to capture updated information on key stations or programs.

Unfortunately, initial reactions from electronics manufacturers suggest that in automobiles (and to a lesser extent, in battery operated portable radios) any background operation while turned off will be problematic because of undesirable battery drain. Automotive “Controller Area Networks” (CAN) have stringent sleep-state power budgets for electronic subsystems.[12]

4.3.1.3 *Non-Volatile EPG Memory*

In addition to either of the above features, or on conventional single tuner design, the addition of non-volatile memory for storage of previously collected EPG data will be very helpful. This allows the receiver to display previously collected EPG data immediately upon start-up, rather than waiting for currently broadcast EPG data to be collected before display. While useful for all EPG-equipped designs, this feature is most helpful for basic models (i.e., single-tuner, with no background operation).

Using an internally or externally referenced clock (all HD Radio signals include a time reference that a receiver can resolve to the current time of day), the receiver can update itself upon start-up to delete outdated information from memory, and display stored data for the current time and later. It can then begin to load new and updated EPG data from the currently tuned station, and if it has a second tuner, from other stations.

To meet receiver price sensitivities, however, memory in most devices may be quite limited. Basic EPG data therefore should be formatted and limited in volume to support Basic EPG capability in simple receiver designs.

4.3.2 Display Types and EPG Uses

Another significant difference between television and radio EPGs is their display. Not only is it smaller on radio overall, but it will likely exist in a far wider variety of display types and sizes. At the low end is a simple text-screen display of one to three lines, each with 8 to 16 characters, similar to many of today’s standard car radios. A second class of display uses a larger-format text screen, with perhaps four to six lines of display, possibly allowing simple graphics (which might permit a small “grid” type EPG display). This type of display occupies an aspect ratio approaching 1:1, but could appear in a range of sizes, from handheld to automotive to tabletop designs. The high end receiver might include color, high-resolution graphics, with sizes ranging from 3”-4” on mobile phones to ~7” automotive displays (similar to today’s built-in GPS and in-car entertainment systems). It is also possible that component type home-entertainment HD Radio receivers with EPG capability might offer video output for display on home television screens. Table 2 below summarizes the general classes of displays and their applications.

This vast range of display types presents a daunting challenge to EPG system designers to create a scalable or hierarchical system that accommodates all devices. It also argues that EPG may be used somewhat differently in radio than in television. Consider the low-end receiver (which is likely to be the earliest available, and will probably always represent the bulk of the receivers in use). Given its small

[12] Conner, Margery, “Automobile Electronics Seek to Plug Power Leaks,” *EDN*, June 26, 2008, pp. 54-62.

display size, it is not well suited for showing the current programming on a large number of stations (i.e., not much vertical space for a grid display). It could be better suited to show the current programming on the currently tuned station only (main and supplemental services), and perhaps useful for viewing upcoming content schedule on the currently tuned station (e.g., look ahead by pushing right-arrow navigation key). At best on a text display, the horizontal scroll might provide the currently tuned station's program scheduling, and a vertical scroll could select additional programs or stations, if the device has a way to capture other stations' EPGs.

Such details of operation are best left to receiver manufacturers' implementation, but it is possible that text-based EPG displays are generally used for the display of the currently tuned station's EPG data only, while the full-market EPG (TV EPG-like) is only found on receivers with graphics-capable displays.

Display type	EPG data type	Potential EPG usage
1 or 2 line text display	Basic only	Horizontal and vertical scrolling of EPG text for currently tuned service (including multicast channels)
3 or 4 line text display	Basic only	Horizontal and vertical scrolling of EPG text for all currently available services
Small graphic display	Basic/Advanced	Horizontal and vertical navigation on grid display, with highlight on selected field and soft-key control to expose advanced data on currently selected field
Large graphic display	Advanced	Horizontal and vertical navigation via cursor/highlight on full EPG grid display, with option to show/hide advanced data

Table 2. Range of EPG display classes and data types in receivers, with envisioned consumer usage models for each. In all cases, vertical axis navigates through services, while horizontal axis navigates through time. Time axis is typically expected to extend into the future only, not retrospectively into the past (i.e., no earlier than start of current program).[13]

4.3.2.1 *Dynamic EPG Text*

Another possibility that may be well suited for radio EPG (particularly on low-end displays) is dynamic text that could be presented on a second display line, under the current static display of current program. While EPG data is generally assumed to be a static schedule presentation, only changing in the case of an overtime sports presentation, for example, the radio EPG may provide different opportunities to promote upcoming scheduled events on the current channel.

[13] Note that these usage models are purely suggestions for purposes of discussion here, and are not intended to be prescriptive. Actual usage models are best determined in EPG display implementations by receiver manufacturers.

Consider a case where the EPG on a two-line display shows the current program title on Line 1 and the next program on Line 2. Or Line 2 can be made available for text messages that the broadcaster sends as forward promotion for *any* upcoming item (contests, guest appearances, new song debut, “next traffic report in two minutes,” etc.).

On any size display, the use of some EPG data for forward promotion messaging serves as a partner to HD Radio PSD, allowing the latter to remain focused on “now playing” data in real time, while EPG deals with upcoming data in cached form. A high-end display can transparently incorporate both PSD and EPG data into a rich and useful single-screen layout, just as a website seamlessly assembles data feeds from multiple services onto a single page.

As a default condition between timely promos, a stock statement about the station or its format could be displayed as dynamic EPG text.[14]

Dynamic EPG text also provides a rotating sponsorship opportunity that stations might sell as a value-add to existing advertisers, or as a discrete availability.

4.3.2.2 *Advertising*

It may be possible or desirable to include advertisements in the EPG stream, in text and/or graphical form. The Dynamic Text feature noted above could be used for advertising text, and text or graphics could be included in grid-type presentations on larger displays.

The user experience of EPG-embedded advertising will have to be carefully thought through to ensure that the proper messages remain associated with each station's EPG listing, and that any advertising presented does not dominate the listener's experience of the currently tuned station.

In advanced receivers that include backchannel capability, a soft-key might be included to allow user response to an advertisement when the user navigates to the ad on the EPG display.

[14] In general, for services without a highly structured program format (such as a typical music station), EPG can be used to promote and position the station by displaying further detail or description of station’s format, its on-air staff, a sample playlist of commonly featured artists, and so on.

5 Cost and Design Issues

A further influential element to these Requirements is an understanding of the importance of cost in this context. One of radio's primary attributes is its cost-effectiveness of content delivery, and this must be carried over as much as possible to any added metadata services such as EPG.

This point has been stressed to us by both broadcasters and receiver manufacturers alike. Thus these Requirements and the subsequent EPG project work will bear such cost containments strongly in mind throughout.

This includes taking a conservative approach in terms of what the HD Radio EPG requires in transmission bandwidth, staff workload at stations and receiver components.

We present below the detail we have learned to date regarding new costs to broadcasters for providing EPG service.

5.1 Cost Structure for Broadcasters

The costs involved in deploying EPG on an HD Radio station are similar in magnitude and structure to the costs of setting up and running other program enhancement operations. For example, stations have experienced the process of setting up and running RDS data feeds, Program Service Data feeds (Title and Artist, at a minimum), and in some cases, iTunes functionality.

The elements of implementation and operation of such services, including EPG services, initially incur certain costs to start and prove the operation. Once set up, there are the ongoing operational costs.

5.2 Startup Costs

Again, as with any new system installation, such one-time costs are divided between materials and labor.

5.2.1 Infrastructure Costs

There are several components that must be purchased to deploy EPG:

- All necessary iBiquity licensing to transmit EPG[15]
- Interface software to deliver data to the EPG
    - Standalone software to manage EPG data within the station, and/or
    - Software interfaces to traffic systems, and/or

[15] There will be a software update required to enable the transmission of EPG data, and it is not yet known if there will be any cost to stations to obtain this update.

  - o Software interfaces to automation systems, and/or
  - o Software interfaces to remote services
- Computer to act as EPG server
- The necessary networking interfaces, if any, to link server to transmission system and to outside services
- Monitoring equipment

5.2.1.1 *Resource Costs*

Those who have licensed other HD Radio transmission add-on capabilities (such as advanced data services and multicasting) will have a general order of magnitude in mind for such transactions.[16] It is likely that an EPG service will be offered as an upgrade to the data services package by iBiquity at some time in the near future. If this package is not already licensed and installed at a station, it would be required before EPG service could be run. The cost for the upgrade, if any, has not yet been determined by iBiquity.

If the station chooses to obtain the services of a third-party EPG Service Bureau, there may be initial costs to sign on to the Service Bureau's network or to obtain access to certain databases. The Service Bureau functions may be operated by one or more third parties, or run in house by a station or station group. Among the functions a Service Bureau might provide are EPG advertising (or underwriting) sales or barter services, content look-up and clean-up ("scrubbing") services, presentation quality management and quality of service administration, inter-station EPG aggregation and publication services. The Service Bureau works under rules of engagement among participating stations for administering quality of service and for managing the security of the information.

5.2.1.2 *Hardware Costs*

In the Internet-based information economy, the process of signing on to services requires almost no investment in capital equipment. It is assumed that the station already has internal LAN connectivity and has developed a secure and well-managed subnet structure. In such stations, at most, one might expect to assign a dedicated computer at a station or cluster to act as the dedicated EPG server. However, at least in initial phases, the demands of EPG transmission are fairly light (from less than 1 kbps to probably no more than 3 kbps), so it might be adequate to employ an existing server installed for other on-air operations or to re-use a spare computer in house.

It is likely that a station that has adopted HD Radio technology has the bandwidth necessary to transmit EPG from studio to transmitter. If the station maintains the HD Radio Exporter at the transmitter site,

[16] A complete listing of current HD Radio licensing fees for broadcasters is available at http://www.ibiquity.com/i/pdfs/Licensing_%20Fact_%20Sheet_2008A.pdf

some bandwidth must be set aside for EPG transmission over the Studio-Transmitter Link (“STL”) for which an off-the-shelf network interface might need to be added to the STL to transport the EP data to the transmitter. Stations using a studio-based Exporter and transmitting the baseband HD Radio data over the STL to the iBiquity Exgine at the transmitter site already have the bandwidth necessary to support EPG.

Monitoring EPG will ultimately be accomplished in the same fashion that stations monitor Program Service Data and RDS content – with consumer receivers that display EPG information strategically distributed among the offices of those who have responsibilities for EPG content delivery. The Service Bureau could assume responsibilities for verifying quality and consistency of the content, although only each station knows what really is coming up on its schedule.

5.2.2 Labor Costs

It is hard to predict the needs of any particular facility because there are several variables that affect how much work is involved to set up an EPG system. Some broadcast operations might elect to start small by setting up a stand-alone program and running a fixed program schedule that repeats generic program information week to week. This approach may require the least time to set up.

Other broadcasters may have the operational and technical resources largely already in place to support a smooth transition to EPG delivery. With an automation and/or traffic system publisher that is progressive and has promptly adopted and tested useful tools for storing, managing and exporting EPG data, little additional work is necessary to set up a rich EPG service. Software patches would be loaded; EPG policies implemented; network connections and assignments mapped.

Potentially complicating EPG system setup are the usual roadblocks that can surface with new systems. Custom software interfaces may be necessary to adapt a legacy system to deliver EPG data to the server. Work-arounds might be necessary to find places to file and store EPG data on systems not designed to manage the information. New software patches and upgrades for existing systems might require some debugging to make them work *in situ*.

We assume that it will take from 10 to 40 hours of time for a technical person to install and test the EPG system and an equivalent range of time for an operational person to negotiate with the EPG Service Bureau, create EPG policy, set up EPG fields, and input initial EPG information.

5.3 Operational Costs

Once the EPG system is up and running, it must be fed with data, maintained, and monitored.

5.3.1 Resource Costs

EPG data is considered "Auxiliary Data" by iBiquity and as such is subject to a data fee (payable to iBiquity) if transmission of that data results in revenue to the station.[17] According to the "HD Radio Broadcaster Licensing Fee Fact Sheet" (see footnote 16), "...stations pay 3% of incremental net revenue derived from Auxiliary Data" with a minimum annual fee of $1,000 per year. Consequently, any EPG sponsorship (such as that discussed in Sections 4.3.2.1 and 4.3.2.2) which generates revenue would be subject to this fee.

There will be ongoing costs for participating in a Service Bureau. These will depend on how much interchange of data there is among stations, which will be determined by which of the four basic distribution models is adopted in a market. To minimize the stations' out-of-pocket expense, the Service Bureau might offer certain services on a barter, or part cash/part barter basis. This will be possible if there are opportunities for monetizing EPG transmissions.[18]

Those automation or traffic systems that support EPG may build in the cost of supporting EPG services to their support fee structures, usually an annual fee paid annually or monthly. The incremental cost for maintaining EPG interfaces is likely to be minimal (perhaps less than 10% of annual fees) because it is a relatively low complexity feature added to the software's suite of tools.

5.3.1.1 *Hardware Costs*

There is no additional investment in hardware necessary once the system is set up, other than normal maintenance and upgrade costs.

5.3.2 Labor Costs

Stations have expressed high sensitivity to the incremental labor cost imposed by the EPG system. Operational staff continues to be stretched more thinly as the need for ever-increasing operational efficiency continues to loom in the face of new media competition. The "set it and forget it" model for EPG may be sufficient in the short term for overburdened stations. Rather than input custom program information for each new episode of a program stations might choose to default to the generic program name indefinitely. This may be satisfactory during the early growth period of EPG growth. Of course, it is more appealing to an EPG user to receive not only the generic program schedule but also compelling and timely information about each upcoming program, EPG will excite the marketplace more if it is a more dynamic resource to the listener.

[17] Auxiliary data is defined by iBiquity as "Any data made possible with HD Radio technology other than Main Channel Primary Data."

[18] It will take time to build a critical mass of EPG-capable receivers in the consumer marketplace, depressing the sales value of advertisements and interactive features on EPG for some time. It may be beneficial to put a unified EPG service on the Internet. Doing so would offer several benefits: 1) Foster more rapid deployment of EPG services; 2) Build audience awareness of EPG; 3) More quickly build an EPG audience for revenue generation.

To maintain a more dynamic EPG, stations will have to find ways to tie EPG data input into their work of managing their automation and traffic processes. Networks and syndicators can provide detailed advanced EPG information automatically, sent directly to the station's EPG server or EPG Service Bureau. Locally generated programming will require the development of personnel habits that might require a few minutes per day per program to update the upcoming program schedule as show titles, special guests, special promotions, program topics, bios, and the like become available.

6 Legal Considerations

The HD Radio EPG ecosystem involves several actors who must collaborate both technically and with complementary business models for maximum success. This necessarily involves a balanced approach among firms' competitive goals, earning appropriate returns on investments, mitigating risks and protecting intellectual property rights and other assets.

While the NAB FASTROAD HD Radio EPG initiative is not a standard-setting effort *per se*, there are some similarities that may be helpful to acknowledge. Much has been learned from past standard setting efforts that may be applied to the current HD Radio EPG development efforts. Some of the key actors in this process include iBiquity, broadcasters, consumer electronics firms, traffic and automation software firms, and others including the project team preparing this report – BIA Financial Network, Broadcast Signal Lab and Unique Interactive. Our collective goal is to design, build a prototype for testing and perhaps launch a commercial EPG service that interoperates with and adds value to a broadcaster's HD Radio-based digital radio service.

What is the best model of cooperation for companies involved in the HD Radio EPG ecosystem? Again, while we are not undertaking a formal standard setting process, we can look to the standard-setting community for some guidance.

Some key legal issues of concern that companies participating in the HD Radio EPG ecosystem should consider include:

- Intellectual property rights (IPR) – patents, copyrights, trademarks, confidentiality
- Antitrust
- Legal agreements – contracts, non-disclosure
- *De facto* (versus *de jure*) standards process
- Licensing
- Assertions disclosing IPR

We advise any company participating in the HD Radio EPG ecosystem to work closely either with in-house or outside counsel to protect its interests.

NAB FASTROAD may also wish to subsequently pursue the submission of some or all of the resulting output from this process to the National Radio Systems Committee (NRSC) or another body for *de jure* standardization, or the development of Guidelines or Recommended Practices. In the case of standardization, additional IPR issues may need to be addressed, depending on the IPR policy of the standards body (e.g., assurance of RAND licensing terms from all contributors).

7 Use Cases

Because a radio EPG is an entirely new enterprise, it is helpful to first envision what a radio EPG "product" might be like, and how consumers or businesses might use it.

Many readers will be familiar with television EPG service, and although the basic premise of a radio EPG is the same, its application and usage will necessarily differ in several key ways (as mentioned previously above).

7.1 Table of Consumer Use Cases

The following table presents a summary of the most compelling Consumer Use Cases suggested to date for a Radio EPG.

No.	Use Case/Feature	Description	EPG Data type[19]	Display capability[20]	Memory requirements	Comments
1	Available Stations	Most basic EPG function: EPG shows list of currently receivable stations, updated for mobile users or as reception conditions (or multicast offerings) change.	Basic	Low	Low	
2	Multilingual	Display of available languages for a station's EPG data.	Advanced	Low	Low	
3	Now Playing	Supplemental, not redundant, to PSD. Includes currently tuned station "now playing" data, such as verbose format description, program title, segment title, host, guests, artist or song detail..	Advanced	Low	Low	
4	Tagging	Store ID of program or segment found in EPG for later on-line search (e.g., subsequent podcast download).	Advanced	Low	Medium	
5	Favorites List	User marks favorite stations, programs, events, personalities for EPG info subset display, and/or for detailed download/updates.	Basic/ Advanced	Medium	Medium	

[19] See Section 4.2.3 for a discussion of EPG data types.

[20] Low = 1 or 2 line text display; Medium = 3 or 4 line text (or small graphical) display; High = 5 or more line text (or large graphical) display.

No.	Use Case/Feature	Description	EPG Data type[19]	Display capability[20]	Memory requirements	Comments
6	Follow the Program	For portable/mobile receiver, when moving out of currently tuned station's coverage area, EPG searches for another receivable station with same program at same or later time (or same/similar station format).	Advanced	Medium	Low	Dual tuner required
7	Social Listening	Share EPG profiles with others.	Advanced	Medium	Low/Medium	Back-channel required
8	Affinity Clubs	EPG remembers that listener is a member of an affinity (e.g., "loyal listener") club and display rich/updated data relevant to club members, and perhaps not available to non-club members.	Advanced	Medium	Medium	
9	Day Part Preferences	Using History function (see below), EPG is sensitive to day parts and remembers your (i.e., device's) weekday versus weekend listening patterns.	Advanced	Medium	Medium	Relies on History function
10	Find	User can seek certain Program clock ("weather/traffic on the 8s"), Promotion clock ("next chance to win at 15 past the hour") features and instruct radio to tune to them directly whenever they are discovered. Receiver can also check History or Favorites for recently listened to programs and search if any are currently on air.	Advanced	Medium	Medium	
11	History/ Recent Station List	EPG remembers stations recently or most often listened to and automatically generates a "favorite stations" subset; if available, receiver can also seek/download more detailed program data for these stations.	Advanced	Medium	Medium	

No.	Use Case/Feature	Description	EPG Data type[19]	Display capability[20]	Memory requirements	Comments
12	Instant Gratification	User wants to know what programming is available now in order to quickly go to a new program. Two possible modes are: (a) “start-up listening” for a newly tuned radio and (b) “transitional listening” to serve listeners seeking a new program on another station due to loss of current signal or desire to try another program.	Advanced	Medium	Medium	Back-channel would facilitate this case
13	Look Ahead	Select station in EPG, get look-ahead window (perhaps next 30-60 minutes of programming). On a station with multicast services, EPG could look ahead on all of that station’s streams in a single view.	Advanced	Medium	Medium	
14	User Profiles	Set up/store individual EPG profiles on device. Controls which types of data to download, display. Can store History, Favorites, Promos, Sync preferences, other configurations on per-user basis.	Advanced	Medium	Medium	
15	Custom Program Schedule	User schedules certain programs to record and playback in sequence, such as when starting the morning commute. Sponsorships retained within program playback (with perhaps additional sponsorships added by EPG).	Advanced	Medium	High	Integrated recorder required
16	Pause/Replay	Pause/Store/Replay segments, with EPG data retained. Recording captures PPM watermarks, so audience research data is also retained for time shifted listening.	Advanced	Medium	High	Integrated recorder required

No.	Use Case/Feature	Description	EPG Data type[19]	Display capability[20]	Memory requirements	Comments
17	Respond to Advertise-ment	While advertisement text runs on EPG (or on a graphics-capable display, user navigates cursor/hotspot to on-screen advertisement or logo), user presses soft key to initiate action (particularly useful if Back-channel or Internet connection is available).	Advanced	Medium/ High	Medium	Back-channel would facilitate this case
18	Promos	During on-air promos for upcoming shows, user presses "More Info" (softkey) and EPG stores/downloads more and updated data for these programs. If record capability is available, user can set the receiver to record the show directly while the promo airs.	Advanced	Medium/ High	Medium/ High	Integrated recorder desirable
19	Respond to Dynamic Text	While dynamic text announcement runs on EPG, user presses softkey to initiate action (e.g., record show, set reminder, get more info, etc.)	Advanced	Medium/ High	Medium/ High	Back-channel would facilitate this case
20	Sync	Sync personal EPG profiles on devices, web. If connected to web, download richer, multimedia data, RSS feeds.	Advanced	Medium/ High	Medium/ High	Back-channel required
21	Record from EPG	Select program for future recording from EPG display; include recurrence settings (one episode, all episodes, first-run only, this time slot & channel only [daily, weekly], any time title appears on this channel, any time title appears on *any* channel, etc.).	Advanced	Medium/ High	High	Integrated recorder required

Table 3. An initial list of HD Radio EPG consumer use cases, listed in order of increasing receiver-capacity requirements.

7.2 Business Use Cases

We have also encountered several usage models in the EPG environment on the business side. These are fewer in number than the consumer cases above, but less theoretical, since they are already in place or under development.

7.2.1 ESPN Radio Example

As an example, we point to a recent announcement by ESPN Radio of innovative new services for HD Radio stations and their listeners.[21] Targeting its list of 1,714 stations broadcasting HD Radio services, ESPN is making available sports content to subscribing stations which can customize and program their own "ESPN HD Radio Stations" using an ESPN Network Appliance.

The network appliance essentially is a content server that allows an affiliated station to preprogram content to air via an Internet connection selecting from an array of ESPN content options. In addition to providing conventional audio content, the content server also provides access to information stations may datacast such as bottom-line data, clock and score information and other non-audio services designed specifically for the HD Radio system.

7.2.2 Internet Extensions

While the NAB FASTROAD project award directed us to focus on services delivered using the radio broadcast channel, we inevitably observe the compelling and growing expansion of broadcast content to non-broadcast platforms, and the growing competition from Internet "pure play" stations (i.e., those online radio services that are not associated with an FCC-licensed operation).[22]

We see strong evidence of increasing reliance on Internet services both by broadcasters themselves and by their audiences to enhance and extend not only the possibilities of distributing programming but indeed the stations' ability to acquire and schedule programming as well as supporting new ways for the audience to relate to favorite stations and other audience members.

We recognize broadcasters' attempts to offer new ways of reaching their audiences. For example, seeking more embracing solutions to serve its 110 million weekly listeners, Clear Channel announced a deal with Receiva that makes broadcasts available from more than 800 terrestrial AM/FM stations through tabletop Internet radios,[23] including Clear Channel's HD2 and HD3 multicast services. This solution supports "reception" of Clear Channel radio stations via the Internet not only on PCs but also through home electronics products equipped with the Receiva module. Clear Channel also supports signal distribution through other platforms such as Sono's wireless multiroom audio system, select hotel on-demand media services, and cell phones operating on the Sprint, U.S. Cellular and Metro PCS networks.

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[21] "ESPN Radio Introduces Content and Associated Content Delivery System for HD Radio™ Broadcasting UEFA Euro Cup 2008 Soccer Matches to Launch New HD Radio Network," press release, June 3, 2008.

[22] Incidentally, we recognize that the localism offered by broadcast radio is a powerful tool in maintaining the supremacy of radio as a listening medium. EPG should help to maintain broadcast radio stations' advantage over pure-play online radio services in the local market.

[23] Palenchar, Joseph, "More AM/FM Stations Come to Internet Radios," *TWICE (This Week in Consumer Electronics),* May 19, 2008.

Observing new relationships among audience members and media in the Web 2.0 world, the British Broadcasting Corporation commissioned a new prototype radio called *Olinda*.[24] The two defining features of Olinda are its modular design to support new functionality and innovations and its ability to promote social networking among radio listeners using built-in WiFi Internet connectivity. Social networking is one of the key attributes associated with Web 2.0. Another of the features supported by the Olinda radio is the "Whatson" function, which according to the Olinda product literature, "would track and in some instances control (by selecting a station) the listening which is done using the Olinda radio, helping the listener achieve a healthy balance of program formats (e.g., news, classical, talk and pop)."

7.2.3 Service Bureau vs. Station-based EPG Management

As noted earlier, one of our project team members, Unique Interactive, has extensive experience in developing and offering commercial electronic program guide services for the Digital Audio Broadcast market. [25] We offer this example as a relevant case study of an EPG Service Bureau versus stand-alone station operations. The "service bureau" paradigm could be performed by a third party, by radio group owners for some or all of their stations, or even by owners of market-level radio station clusters (among other options).

7.2.3.1 *Unique Interactive EPG Business Models*

Unique Interactive's EPG Management System can be provided in either of two ways:

1. It is offered as a managed solution by Unique Interactive, which can be accessed by radio stations over private circuits or securely over the Internet. With such managed service, Unique Interactive provides full product support and security upgrades, including a managed upgrade policy.

2. Alternatively, the EPG Management System software can be shipped to a broadcaster as a stand-alone product with the possibility of customizing the user interface to suit the customer's needs. The system has localized language support, and can be further personalized with a direct translation into a chosen language.

Radio station EPG data can be re-purposed by the system for use across a number of different delivery platforms. A comprehensive EPG management solution will mean that the program listings data only has to be entered into the system once, but can be used in many distribution formats, as shown earlier in Figure 2.

[24] "Olinda – Prototype Radio of the Future," *NAB Radio TechCheck*, May 19, 2008.

[25] See: http://www.uniqueinteractive.com/index.php?option=com_content&task=view&id=14&Itemid=28.

8 Business Requirements

The business requirements for an HD Radio EPG system are detailed below. (Note that specific EPG technical and software requirements are covered in a separate document.)

Our approach identifies business requirements that exist not only for the current HD Radio ecosystem but also considers future directions.

8.1 Business Requirements List

The following is a list of collected Radio EPG Business Requirements compiled to date by this project. They are subdivided by industry sector, separately addressing the business requirements for consumer receivers, for broadcasters' EPG architectures, and for EPG-generating software systems.

Note that standard terminology is used throughout, wherein "shall" denotes a required feature, and "should" indicates a preferred feature.

8.1.1 Receiver Requirements

1) The EPG-capable HD Radio receiver shall follow iBiquity design recommendations (Best Practices document).

2) The EPG-capable receiver shall be designed such that it adds a minimum number of required components to a standard HD Radio receiver. Nevertheless, EPG-capable HD Radio receiver designers should envision and work to accommodate the option of advanced receiver features such as dual-tuner, Internet/backchannel access, and/or "Always On" or "Scheduled/Background" operation, for improved EPG user experience.

3) The EPG-capable receiver shall include a display screen adequate to present (in dedicated or switched form) at least one 16-character line of textual EPG data. Designers of EPG-capable receivers should work toward providing display screens that allow at least three 16-character lines of textual EPG data with scrolling capability, or graphical/video displays with navigation control.

4) The EPG-capable receiver shall include a CPU with operating speed and performance adequate to provide a good EPG user experience, with minimum latency throughout.

5) The EPG-capable receiver shall include adequate hardware and software functionality to provide simple and intuitive navigation features for EPG display and user operation, including the use of one or more softkeys for user-initiated response to dynamic EPG transmissions.

6) The EPG-capable receiver shall support record-from-EPG control if integrated recording is offered by the receiver, including support for multi-tuner capability and program-scheduling conflict resolution. (Such receivers should also anticipate and appropriately accommodate the possibility of a station being out of range during the broadcast of a previously ordered recording.)

7) Certain EPG-capable receivers shall support accessibility to visually impaired users.

8) The EPG-capable receiver should include some amount of non-volatile RAM to retain previously gathered (and still temporally valid) EPG data upon start-up, or for use upon loss of digital service but retention of listenable analog service.

9) Certain EPG-capable receivers designed for mobile operation should support voice-activation by users.

10) EPG-capable receivers should include fast and intuitive Search functionality, and the ability to easily filter full EPG data into “favorites” subsets.

8.1.2 EPG System and Delivery Architecture Requirements

1) The EPG system shall hierarchically support a wide range of receiver display types, providing adequately rich data for each and optimized for minimum latency of display/refresh.

2) The EPG system shall support a wide range of metadata information styles, ranging from static format to deep program segment descriptions.

3) The EPG system shall provide data in a form that allows minimum acquisition time by receivers for the most critical data.

4) The EPG system shall function on a basic, EPG-capable HD Radio receiver, but should envision and accommodate the option of advanced receiver features such as dual-tuner and/or “Always On” or “Scheduled/Background” operation for improved EPG user experience. In the latter case, care should be exercised in system design to keep receiver power consumption to a minimum.

5) The EPG system shall be designed primarily to support one-way broadcast operation to EPG-capable HD Radio receivers, but should secondarily envision support of advanced receivers with backchannel capability (i.e., integrated Internet connectivity) and/or geolocation ability (manual or automatic).

6) The EPG system shall be designed primarily for over-the-air delivery by HD Radio stations, but shall also accommodate aggregated and localized Internet delivery.

7) The EPG system shall support both stand-alone, station-based data assembly and third-party “service bureau” assembly.

8) The EPG system shall provide such support as necessary to allow an open market of EPG “service bureaus” to exist.

9) The EPG system shall be optimized for delivery of each station’s EPG content by that station’s HD Radio datacasting service, but it shall also support the ability for one station to carry another station’s (or multiple stations’) EPG data, or a portion thereof.

10) The EPG system shall enable highly efficient use of broadcasters' HD Radio datacasting spectrum resources, and offer a wide range of control to individual broadcasters over the allocation of bandwidth to EPG vs. other data services.

11) The EPG system shall support the insertion of advertising content, in both text and graphical forms.

12) The EPG system shall support the display of both dynamic and static text display.

13) The EPG system shall support the use of softkeys on the receiver for user-initiated action in response to dynamic EPG transmissions.

14) The EPG system shall be fully compatible with NRSC-5-x and any other relevant NRSC Guidelines.

15) The EPG system shall support the inclusion of conditionally accessed content.

16) The EPG system shall provide such support as necessary for accessible operation of receivers by visually impaired users.

17) The EPG system shall provide such support as necessary for voice-activation and response by receivers.

18) The EPG system shall support short-form indication (icons) for various standard content features included in broadcasts (including conditional access).

19) The EPG system shall reserve adequate resources for future extension.

20) The EPG system should support alerting features as appropriate (EAS, Amber, etc.)

21) The EPG system should provide support for interface with third-party devices (APIs).

8.1.3 General Software Requirements (Business)

(See also separate *Software Requirements* document from this project for specific, technical software requirements for EPG service-generation.)

1) The EPG system shall be relatively easy to implement by broadcasters, and provide adequate interface to existing systems and services in common use by the U.S. radio industry.

2) The EPG system shall allow secure operation and adequate review of all data content by broadcasters prior to transmission.

3) The EPG system shall have a modest software footprint that enables inexpensive HD Radio receivers to provide Basic EPG functionality.

9 Industry Interview Summaries

To inform our understanding of the business requirements for an EPG solution for the U.S. radio market, we conducted a series of executive interviews with companies serving different parts of the digital radio ecosystem. The information and opinion thereby gathered is reflected throughout this document, but is presented in more directly attributed form below for further reference.

Our interviewees work for companies ranging from broadcasters to programmers to technical facilities to consumer electronics and semiconductor firms. Our goal was to collect and document views on the business requirements from several perspectives for sake of thoroughness, and to identify honest areas of debate.

In this section, we provide a summary of some of the key points from these interviews, to provide somewhat more granularity and personality to the discussion above. We do not identify the individuals interviewed, but for sake of context we list their titles and the type of company with which they are affiliated.

We begin with a summary of generally held concepts or frequently repeated views, then present the individual summaries of each interview.

9.1 Overview of Comments

There were some overall trends observed among the interviews. We found the commonality of opinion voiced on several topics particularly noteworthy.

From the broadcaster perspective, perhaps the most important issue was the concern about the workload demands of maintaining an EPG. It is reassuring that broadcasters and their systems' manufacturers imagine using existing automation and traffic systems to maintain and deliver EPG information, as well as to automatically import EPG data from outside program sources. If a station has no resources to maintain an EPG, at least the station would be able to set up a static program schedule that could repeat from week to week.

Another insight gleaned from the interviews reflects the format-oriented nature of most radio stations, in contrast with the program-oriented nature of others. The television EPG model evokes the image of a listing of scheduled programs and program details looking as far forward as one or two weeks. Format-oriented stations tend to look at their format as the defining characteristic for which listeners tune in. To promote new tune-ins and encourage listeners to return to the station, these broadcasters would utilize an EPG system in unconventional ways. Format-oriented stations could use EPG to provide the same kind of forward promotion they use on-air for contests, call-in giveaways, and other programming events such as special guests, special performances or music debuts.

The broadcasters suggesting these uses for EPG also indicated that radio listeners tend to have short-term views that EPG would serve best by being focused 24 hours, or at most 48 hours, ahead. Those stations with block formats and program-oriented content such as talk, time-brokered, and certain non-commercial formats, would still benefit from publishing longer-term schedules. The EPG design will need to support both kinds of EPG information in a manner that appears unified to the listener.

Some broadcasters initially expressed suspicion that by publishing an EPG and possibly by sharing information for transmission, their competitors might be able to take advantage. As they processed the EPG concepts in discussion with us, their initial reactions were softened as they began to think of the benefits of EPG. Nevertheless, they expressed the expectation that the EPG network and transmission scheme should be set up and proctored in a way that prevents competitive abuse.

Broadcasters also emphasized the necessity of connecting EPG with applications on the World Wide Web. Many stations already have embraced the concept of driving the audience to the web to reinforce their relationships to the station, and of streaming the program on the web. EPG applications should be portable for Web presentation and interaction.

9.2 Individual Interview Summaries

Key findings of each interview conducted for this project are summarized below in outline form, listed under the title and affiliation of each interviewee.

9.2.1 VP Sales & Marketing, Radio Automation company

- A lot of what will become EPG data is not already captured at the radio station (e.g., music show title, DJ name), so some new workload will be added.
- Makers of traffic systems generally more resistant to change than those making automation system. Any EPG interfaces more likely to come more quickly from the automation side.
- Concerns lie with Input and Output – Input is harder to solve, Outputs are much easier. His company already handles nearly a dozen destinations from a single audio channel metadata stream.
- Extremes among station use cases range from simple formatic block programming to rich and varied program oriented public or talk radio stations. A good EPG system would have to work well with both extremes.
- EPG would be good for the industry.
- Need to determine a data format first, then companies can figure it out from there.

9.2.2 VP Digital Media, Consumer Electronics company

- “Always on” is a no go in the car due to very strict battery drain requirements (~1mA/device down to as low as 0.3mA/device).
- Dual tuner designs cost twice as much, no efficiencies in shared front end.
- Recommends 4kbps to 8 kbps for EPG data speeds.
- 3 display classes:
    - ~7” QVGA and 3”-4” mobile phone color displays
    - 4-6 text line screens (fluorescent/LED/LCD, etc.)

    - 1-3 text line screens
    - 3 receiver classes: $99 – good; $199 – better; $$$ - best
- Combined IP/HD Radio device is sleeping with the enemy.
- HD Radio Multicasting increases the need for EPGs.
- EPGs could change the whole way users interact with their radios.

9.2.3 Executive, major Radio Audience Research firm

- What does the audience want from EPG?
    - Artist/title
    - Formatic descriptions in English
    - "Find" function
- Critical to have a "transportable EPG" between off-air and web.
- EPG "look ahead" function should be near term (e.g., 30 minutes), not week ahead like TV.
- Weekend programming may be less familiar to listeners so EPG would add value in this daypart.
- Conduct EPG test in PPM market to assess impact.

9.2.4 Director of Operations, top 10 Radio Broadcast group

- All informational input flows from the Programming department. Additional tasks to create EPG cannot be assigned there as they're already overloaded.
- Very important to have EPG support ad or sponsorship revenue models.
- EPGs must limit station data to what's currently receivable.
- EPGs should include HD and analog radio services – "radio is radio."
- 5 kbps to 10 kbps max data rate for EPG, bandwidth is too precious to give more.
- Prefers each station to transmit its own EPG data, having a master station transmit EPG data is undesirable for competitive reasons.
- Market level EPG could work if competitive stations couldn't see programming until moment of display.
- Limit EPG display to stations currently receivable versus stations in market.
- EPG data can't take more than a minute or two to load.

9.2.5 Managing Director of News & Programming, top 10 market Public Radio station

- Possible staffing challenges for EPG on weekends with fewer staff working.
- EPGs will support less need for on-air promotion, provides benefit to listener of being less repetitive on-air.
- Stations with active web operations could drive EPG from that department.
- Envisions pervasive Internet connectivity in the car one day.
- Goal is to give listener a similar experience to that of a streamed program with interactive visual display.

9.2.6 Senior Vice President, Engineering, Fabless Semiconductor company

- No cost efficiencies in two-tuner approach.
- Sophisticated EPG might work in high end radio with less price sensitivity, harder in low end radios.
- Basic receiver may have to settle for EPG on current station and recently tuned stations due to memory and display limits.
- Master station model won't work for basic, one-tuner receiver because it would divert listener from the station they're listening to.
- Can't gather data in cars while turned off…too much battery drain.

9.2.7 Vice President of Program Development, top 20 Radio Broadcast group

- No simple way for radio stations to manage EPG in their current workflow. Requires new job training and maybe new positions which are not available.
- EPG gets us closer to being better programmers; many items of meticulous programming have gone by the wayside. Shows us great power of personality but also the negativity if someone babbles on too long.
- Radio needs to reinvent itself with the web, it reinforces listening. Build the database, build listener loyalty. Interactivity with the audience is critical.
- For our business to thrive, we need to be better at cross-platform opportunities.
- EPG should be simple, focus on personality, quick moments, show highlights, scan-able, fitting short attention span.
- EPG should be at the market, not the station level; make the medium easy to use first, then drive them to your station.

9.2.8 Senior Director of Engineering, major Sports Programmer

- Would like at least 2 display lines and a Record function for EPG.
- 7 days of EPG data not needed. Choices should include "get more info" and longer look ahead in schedule.
- Master market guide is good but sort-able by program source (as well as by station).
- EPG + geolocation service…what's on now…here?

9.2.9 Director of Engineering, top 10 Radio Broadcast group

- Using PSID data to reinforce call-in number for talk shows; promote morning shows.
- Third party EPG data aggregator…hard for stations to pay for this, ad model would be helpful.
- EPG should serve web and broadcast listeners; we're in the programming business, platform independent.
- PDs overwhelmed but webmasters handle lots of data. EPG process could be fairly automated and webmaster could run it.

9.2.10 President, Radio Broadcast group

- Radio is station based, not program based like TV…less value for an EPG.
- EPG has to add a “wow!” factor that consumers would see as really valuable.
- The problem of informing radio listeners of “what’s on” will only get worse as we get into more delivery options like cell phones and web. An EPG can really help us with this challenge.

9.2.11 Senior VP, Engineering Services, top 5 Radio Broadcast Group

- Concerned with amount of data required vs. the benefit. Lots of opportunity to increase use of lookup tables and data compression. If it takes too much data to transmit EPG, no broadcaster is going to use it.
- Need reliable source for obtaining scheduling data. Not concerned about competitors seeing program info in advance. More concerned about false information being transmitted maliciously by competitors.
- Need somebody to define what’s in the market, where does the market end? E.g., does Philadelphia market include Atlantic City? What about suburban stations? Where do you draw the line? How do you handle non-HD analog stations?
- Once you decide which stations to include in a market definition, how do you ensure accurate data? Do stations input their own data? Or does some third-party data facility (service bureau)?
- Need to define limitations and best practices for broadcasters and receivers to avoid inconsistent use of fields, such as is being done now in RBDS, where title and artist and promos are all put into PS field.
- From automotive (OEM) standpoint, most next-gen receivers have or will have dual tuners so they can scan bands, receive data to see what’s really available. Not necessarily the same for CE.
- Important to consider need to think about amount of work receiver has to do.
- Could be a lot of places to pull EPG data from. Concerned that, as with RDS, broadcasters may eventually not use EPG as originally designed.
- Also consider dense markets like East Coast. What if receiver is sitting in Princeton, NJ and EPG says tune to 100.3 MHz? This could refer to several stations. System could add in lat/long coordinates into EPG data for station to help receiver. “If I can receive Z-100 in New York, must be close enough to receive other NY stations,” kind of logic.
- Existing iBiquity EPG spec can update look-up tables, overwrite values. Really requires a service bureau. Multiple stations may use same look-up table values. Existing EPG only has 30 look-up table values, however. Not enough.
- Personal belief that EPG needs to be sent in 1 kbps or less per transmitter, and serve the entire market. Go higher than that, broadcasters will find higher value elsewhere; go less than that, user experience not worth it.
- No concern with carrying competitors’ data; you carry mine OK, I’ll carry yours OK. Just sign agreements and competitors will behave.

10 Case Study of Inter/Intramarket Station Reception Variability[26]

In this survey we consider the challenge of developing a model for a radio EPG in the U.S. that displays only the stations receivable at the listener's current location. This is a dynamic situation, because there will be different sets of receivable stations in different parts of the same radio market. Indeed, radio stations from *adjacent* markets often will be added to the list of currently receivable stations at any given location. To guide the decision-making process on how EPG should be organized and transmitted, this survey explores the variability of stations that can be received at any given location within and around a market. We selected a single market having several closely adjacent markets for this initial case study (Boston, MA).

The results are presented below, with conclusions following.

10.1 Background

The EPG could become cumbersome if it were to present to the listener a very high percentage of listings from stations that cannot be received at the listener's location. In addition to potentially presenting too much unnecessary information, the EPG might also fail to list all the available radio programs at the listener's location. This could occur if the EPG is organized and transmitted in pre-assembled form on a market-by-market basis. Listeners on the fringe of a market or on the overlap of adjacent markets may be forced to choose which market's listings to use. This challenge has not been addressed by any existing radio EPG system.

For illustration, consider the Eureka DAB system, where one radio channel contains an "ensemble" of about a dozen audio program channels. The DAB network can also employ numerous transmitters broadcasting the same ensemble on the same channel (using *single-frequency networking*, or SFN). The ensemble carries an EPG that describes the programming available on the ensemble. The same EPG serves listeners no matter where in the geographic market the listeners are (or even in neighboring markets, if regional/country-wide SFNs are used), because each receives the same set of programs on the ensemble. One disadvantage to the DAB EPG model, however, is that the listener only sees EPG data about the ensemble currently received. If there are additional ensembles operating in the market, the receiver will not see the EPG data for those services until that ensemble is tuned in. In such multi-ensemble cases, there is typically no way for the listener to see comprehensive information about all program choices in the market on a single EPG display.

In contrast to the European centralized broadcasting model provided by Eureka DAB, in the U.S. FM and AM radio frequencies are allocated to provide the geographic diversity that is the hallmark of the

[26] Study and analysis for this section was performed by Broadcast Signal Lab, LLP, for purposes of the NAB FASTROAD HD Radio EPG initiative.

localism on which this country's broadcasting system is based. As a result, listeners in different areas of the same market will have different sets of radio stations from which to choose.

10.2 Method

To measure receivable radio stations at different points in a single radio market, we plotted a 6-point by 7-point matrix on a map of metro Boston (see Figure 4 below). The map points were approximately twelve miles apart. Of the 42 points, 13 were outside a nominal 40-mile radius, or were in Massachusetts Bay. Of the remaining 29 points, three points near the 40 mile radius to the northwest were not visited. A reference point was selected in central Boston. A technician traveled to the reference point and the 25 other test sites, and operated a Kenwood HD Radio receiver in scan mode. Each station that was picked up in the scan was logged by frequency and by reception quality. A judgment was made to exclude analog stations that were too noisy to be listened to comfortably. Otherwise, all analog and HD Radio signals were logged. Both the AM and FM bands were scanned.

For a first pass, all acceptable quality signals that were caught in the receiver scan were tabulated. The Boston reference point provided the master list of stations to which all other sites' data could be compared. Three station classes were tabulated for each site – "Matching," "Missing," and "Extra." "Matching" refers to the count of those stations received at a test site that were the same as stations received at the reference point. "Missing" is the opposite of Matching, i.e., the number of stations received at the reference point that were *not* received at a test site. The sum of the Matching and Missing at any test site equals the total count of stations received at the reference point (27 Commercial FM, 6 Non-Commercial FM, and 30 AM stations received acceptably on the scan taken at the Boston reference point).

Finally, some stations were received at each test site that were not received at the reference point. These are "Extra" stations.

Note that the 40-mile radius was selected because: 1) Class B FM stations have protected contours at about 35 miles; and 2) the city centers of the Providence and Worcester markets are within 40 miles of Boston.

10.3 Results

Based on the results of the survey, there is a substantial amount of programming choice available on the radio. At the Boston reference point, 63 radio stations were received with acceptable audio quality. The ideal EPG would provide the listener with the ability to easily hone in on his/her preferences among those choices.

10.3.1 FM Analysis

At the reference point, 27 Commercial FM stations were captured in the scan. At the 25 test sites, there was an average of 17 Matching stations and 10 Missing stations. The 25 sites had an average of 14 Extra stations not received at the reference point. See Table 4 for statistics.

	Average	Standard Deviation	Maximum	Minimum
Matching	17.0	3.4	24.0	11.0
Missing	9.8	3.4	16.0	3.0
Extra	14.0	6.9	27.0	3.0

Table 4. Statistics on received Commercial FM signals at 25 test sites within 40 miles, with respect to the Boston reference point.

Table 5 reduces the nominal radius of the test sites, looking more closely within the dominant service area of the Boston stations. The average Matching count rises to about 20 stations per site in this case, and the Extra station counts decline to an average of 12 per site.

	Average	Standard Deviation	Maximum	Minimum
Matching	20.3	2.4	24.0	17.0
Missing	6.5	2.1	9.0	3.0
Extra	12.4	9.0	27.0	3.0

Table 5. Statistics on received Commercial FM signals at 8 test sites within 20 miles, with respect to the Boston reference point.

Table 6 and Table 7 below show similar findings, respectively, for the market's Non-Commercial FM stations.

While there were occasional stations arriving from distant, non-adjacent markets, the vast majority of the received signals at all sites were signals one would expect to be available at the site, i.e., stations whose protected service contours overlap or come close to the site, whether they transmit from within the Boston market or from a peripheral market.

When moving about a market, the influence of rimshot stations near the market perimeter can be seen, given that the signal from a Boston area station located, say, on the North side of the market is not received on the South side. Also, some stations could not fully cover the market because they were Class

A FM stations with limited footprints. Six Class A stations – all Non-Commercial Educational (NCE) stations – were missed by the scan because they were operating at less than 250 watts and their coverage footprints fell between the measurement-grid points. The 62 Class A FM stations that were received were each captured at 3 to 9 sites, depending on terrain, station antenna height and interference limits, if any.

Some Class D and translator stations were captured, but due to their low power levels, the 12-mile grid frequently missed stations in this class. This illustrates one of the challenges in listing stations on a directory or EPG, i.e., if low power stations are to be included in an EPG system, the resulting demands on the transmission, reception and presentation of EPG data must be anticipated. The reception of lower-power stations within the market is underrepresented in this study due to granularity of the test, so the true impact of its findings in many cases could be even worse than indicated here.

	Average	Standard Deviation	Maximum	Minimum
Matching	2.9	1.4	6.0	1.0
Missing	3.1	1.4	5.0	0.0
Extra	2.7	1.5	5.0	0.0

Table 6. Statistics on received Non-Commercial FM signals at 25 sites within 40 miles, with respect to the Boston reference point.

	Average	Standard Deviation	Maximum	Minimum
Matching	4.1	1.1	6.0	3.0
Missing	1.9	1.1	3.0	0.0
Extra	1.8	1.5	4.0	0.0

Table 7. Statistics on received Non-Commercial FM signals at 8 sites within 20 miles, with respect to the Boston reference point.

10.3.2 AM Analysis

On the AM band, the results were fairly similar to those of the FM band, as detailed in Table 8 and Table 9. One difference was noted, however. While it was common to see two to four different stations on some FM channels, when the market is encircled by stations on the same channel, there were few AM frequencies on which more than one AM station was detected around the grid.

	Average	Standard Deviation	Maximum	Minimum
Matching	14.0	6.5	28.0	7.0
Missing	16.0	6.5	23.0	2.0
Extra	7.9	3.1	15.0	3.0

Table 8. Statistics on received AM signals at 18 sites[27] within 40 miles, with respect to the Boston reference point.

	Average	Standard Deviation	Maximum	Minimum
Matching	14.9	6.7	28.0	7.0
Missing	15.1	6.7	23.0	2.0
Extra	7.9	1.2	10.0	7.0

Table 9. Statistics on received AM signals at 8 sites within 20 miles, with respect to the Boston reference point.

10.4 Summary

The results of the six tables above are normalized and presented for comparison in Table 10. The normalization consists of presenting each average and standard deviation value as a percentage of the total number of stations for each station type at the Boston reference point. This enables comparison between the three types of stations – FM Commercial, FM NCE and AM.

[27] A data collection error caused the loss of AM-station data for 7 of the more distant sites, reducing the total number of test sites to 18 for this part of the study.

		Full Radius (40 mi)		Reduced Radius (20 mi)	
Station Type	Value	Average	Std Dev	Average	Std Dev
FM Commercial	Matching	62.8	12.8	75.0	8.8
	Missing	36.3	12.7	24.1	7.7
	Extra	51.9	25.4	45.8	33.4
FM Non-Commercial	Matching	48.7	22.5	68.8	18.8
	Missing	51.3	22.5	31.3	18.8
	Extra	45.3	24.3	29.2	24.8
AM	Matching	46.7	21.7	49.6	22.5
	Missing	53.3	21.7	50.4	22.5
	Extra	26.5	10.3	26.3	4.2

Table 10. Statistics on received signals at test sites, given as percentage of the total number of stations received at Boston reference point.

10.5 Conclusion

Some other types of radios will likely be less sensitive and selective than the Kenwood, resulting in a lower station count in some locations. This would likely result in reception of fewer lower-powered and distant-market stations, while favoring the stronger in-market and near-market stations. A pre-assembled, full-market EPG cannot anticipate the sensitivity of the radio, so it would be up to the receiver design to figure out which stations are actually available to the listener at a given location.

The results of this study suggest that a comprehensive radio EPG will be difficult to administer on both the transmission side and on the receiver side. Consistently, about half of the stations available at the market's reference point are not available at other places in the market. This occurs despite the fact that the center of the market is near the transmitting sites of the major market stations.

The most reliable means of identifying only those stations that can be received at the listener's location would be with the receiver conducting a background scan of the radio dial. In this way, the radio becomes empirically aware of which stations are actually available to the listener. Because of the variability of stations received at any given location, the alternative appears impracticable. Moreover, even if a locationally aware receiver might properly filter a full-market EPG to be relevant to its location (and its tuner's sensitivity), transmitting a full-market EPG on one EPG data stream would require considerable bandwidth to cover all stations in the entire market *plus* any stations that overlap from all adjacent markets.

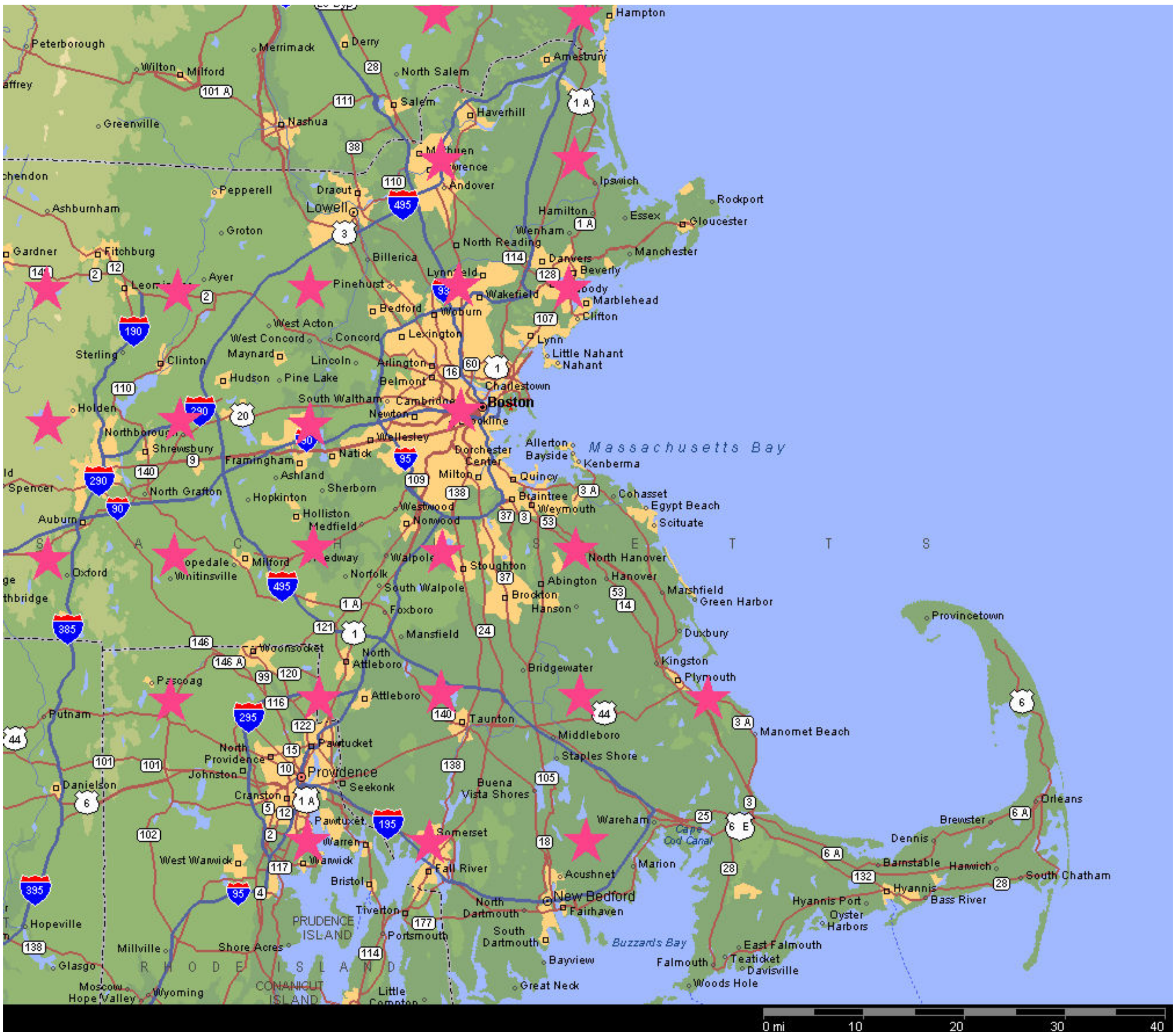

Figure 4. Map of survey area. Stars indicate location of test sites (star in central Boston is reference point).