Standards for Hybrid Radio

Nick Piggott
The RadioDNS Project
London, United Kingdom

Abstract - Broadcast radio and Internet Protocol (IP) have diverse and complementary technical attributes. Whilst radio stations use both technologies separately to distribute their programs to listeners, creating a hybrid solution that is a seamless combination of both technologies could enable a step-change in the listener experience of broadcast radio and remove some of the inherent difficulties, both technical and commercial, of streaming over the Internet. This paper considers the issues involved with creating open standards for hybrid radio that can be freely adopted by manufacturers, broadcasters and service providers, the business drivers behind them, and the practical issues of implementation.

Broadcasting has strong technological attributes which make it uniquely suited to radio as it has been traditionally known; a medium where each individual station is consumed by a relatively large proportion of the population; where consumption is free at the point of delivery; that is available mobile and ubiquitously within the planned coverage area; and where a large proportion of the population consume the medium (as a whole) concurrently over a short window of time. Broadcasting is attractive commercially as it is cost-effective both as a capital investment and operationally.

Reinventing Radio

The traditional proposition of radio is under pressure. New entrants are seeking to redefine consumer understanding of radio to include streamed, personalised, music services, commercial clients are looking for improved efficiency and accountability when delivering display advertising, and consumers are constantly having their expectations of media experiences raised. Radio needs to offer better variety, better navigation, better presentation and better reporting, which demands better meta-data, better visual information and connectivity. Within the confines of the technology of broadcasting, the ability for radio to adapt to meet these changes is limited.

Analogue broadcasting has apparently reached the pinnacle of its capabilities. AMSS [1], the signalling system for AM, seems to have little adoption. RDS [2] was introduced for FM broadcasts just under 30 years ago, and brought simple improvements to navigation - station names, text information, traffic and alternative frequency information, and limited meta-data carriage. The data rate of RDS is unlikely to change from the current established standard of 421.8 bits per second. Whilst capable for specific applications, like TMC, it is not suitable for rich meta-data provision.

Digital broadcasting platforms can address some of the shortfalls of an analogue broadcast system. The can carry a variable number of audio services, along with meta-data and binary data such as images and audio files. Dependent on the overall capacity available in the digital broadcast platform, the consumer experience of radio can be improved, and transmission costs reduced through infrastructure sharing and spectrum reuse.

IP for Distribution

There is an argument that the industry should transition distribution from broadcast technologies to rely entirely on IP (Internet Protocol) [3] as a distribution platform. Prime facie, IP seems to meet the burgeoning requirements of radio distribution, however, it is not infallible.

This paper doesn’t seek to comprehensively assess the benefits and weaknesses of the IP distribution system. Such assessments have been done elsewhere, and often concluded that IP infrastructure is still too naive to replace broadcast radio in its entirety, and may not be able to do so in the foreseeable future. However, to set the context for hybrid radio, there will be a brief review of some specifics.

IP is intended to transport bi-directional data between two uniquely addressed endpoints on networks that may not be directly connected. Indeed, an individual IP packet can traverse networks operated by different companies, implementing different network management policies, with bandwidth that is not guaranteed or stable. IP is designed to get there ‘eventually’, not ‘immediately’. Much streaming is deployed now on a ‘send and hope’ basis, decreasing the encoding bitrate until the end result is sufficiently stable.

Mobile delivery of radio over IP is also not particularly spectrally efficient. Whilst various techniques can improve the effective information density of spectrum used for mobile IP, the typical density is 1.3bit/s/Hz (3G 1EV-Do Rev A) [4]. A pragmatic model of a suburban environment might see 50MHz of spectrum dedicated to 3G and LTE, and 75% of that spectrum used by radio listening at peak. Modelling this against the 2MHz of broadcast spectrum required to deliver the same services, and the cost effectiveness notwithstanding, there may even be a regulatory case to answer over efficient use of spectrum.

THE CASE FOR HYBRID RADIO

Hybrid Radio is the seamless combination of broadcast radio and IP connectivity, to create a composite experience that is better than can be delivered by broadcast alone.

To assess the value of hybrid radio and whether it should be standardised, we need to consider the following:

- The experience we want to deliver to the listener
- Which devices we want to target
- The manufacturers of those devices
- The costs of implementing the technology for the broadcaster and device manufacturers
- The benefits of interoperability

The improvement to user experience must be the primary driver of the assessment of the case and its component parts. The experience should be a demonstrable improvement over what exists for radio today, it must preserve everything that is valued in broadcast radio today, and present it in the context of a modern application environment. Listeners must *demand* this new experience in order to justify the investment in technology to produce it.

Radio needs meta-data and images. Station logos are important for navigating radio, as covershots when navigating radio programmes, and as visuals to accompany what's playing, and links to webpages. Regardless of the debate within the industry, other media navigation, including 'streaming radio apps', is visually rich. To present only a text environment is out-dated.

It is possible to deliver this additional data content over a digital broadcasting system. Unfortunately the growth in display resolutions is causing image file sizes to increase accordingly. An image that would previously have been acceptable at 200pixels in a 7kbyte file size, now needs to be 1000pixels in a 120kbyte file size, a 17-fold increase in size. Transmitting the ideal set of images on a digital radio platform would make acquisition times unreasonably long and data usage disproportionately high. It may be appropriate to transmit a basic enhancement service over the air, and supplement it with additional content delivered over IP. For analogue radio, delivery of all the digital assets over IP is the only credible option.

This improved user experience is dependent on a colour screen of sensible size and resolution, an IP connection, a competent operating system and a broadcast radio receiver.

Candidate devices are smart phones and car infotainment system. These are built by global companies to global technology standards and sold on global markets. The manufacturers expect to sell identical units in large volumes, and want to market a consistent functionality message across all territories. This sits uncomfortably with the recent history of technology divergence in radio.

Radio may not initially appear important to a manufacturer, but the radio industry's scale of reach can drive device adoption and market-share growth. That's an attractive proposition to the manufacturer if the costs of implementation aren't high.

In general terms, requiring specialist technology knowledge drives up the costs of a project. Therefore genericising the implementation of a global radio platform should reduce the costs. Whilst the divergence in radio broadcast systems is an unavoidable issue, the earlier those differences can be abstracted to a single, consistent, platform, the less specialist knowledge is required.

Finally, interoperability, as well as being a defining factor of most successful global technology platforms, allows radio to present a market opportunity that transcends ownership and national boundaries. To be attractive to listeners and manufacturers, the majority of listeners and the majority of listening should be able to benefit from this new experience of broadcast radio.

Considering these factors together, a reasonable conclusion might be:

- There is a good case for including broadcast radio technology in mobile IP devices.
- The process for combining broadcast radio and IP should be consistent regardless of the differences in underlying broadcast technology
- Neither the broadcaster nor manufacturer should not have to invest heavily in new capital to enable it
- Both broadcaster and manufacturer should be able to use widely available software development tools to implement hybrid radio
- Generally skilled software developers should be able to develop hybrid radio applications, without specialist radio knowledge

IMPLEMENTING HYBRID RADIO

The first conclusion requires that the incremental cost of including broadcast radio to an existing device be small in proportion to the overall cost. Recent developments, including advancement in silicon production, and the expiry of patents, mean that the cost of including global broadcast radio functionality is falling. Many smart phones already include FM radio functionality, for example, all Samsung Galaxy smart phones, but it isn't enabled in all markets, notably North America. There are complex business issues involved with enabling that FM radio functionality, which this paper cannot address, other than a broad recognition that an improved experience and consumer demand would influence change.

The remaining conclusions guided the formation of the RadioDNS specification for hybrid radio [5]. The RadioDNS principle involves using similar, existing, identifiers in FM RDS, HD Radio and DAB Digital Radio as the basis of a quasi-domain name, which is translated using DNS (Domain Name System) [6][7] to the broadcaster's actual Fully Qualified Domain Name (FQDN). This FQDN is then used to provide addressing information for specific applications. For example, KSNE in Las Vegas, NV broadcasts on 106.5MHz with an RDS PI code of A4DE, which creates a quasi-domain of 10650.aed3.us.fm.radiodns.org. This is resolved by DNS to ksne.com (Figure 1).

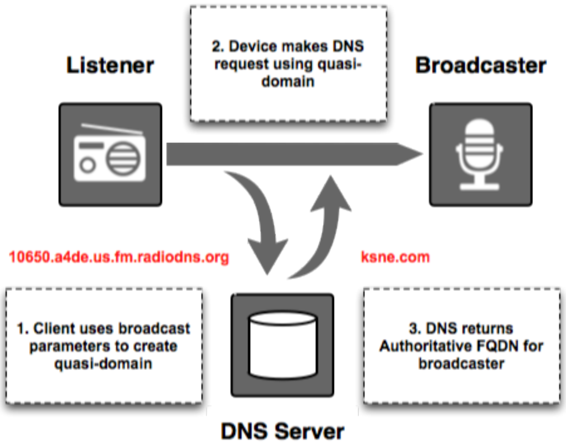

FIG 1 RADIODNS LOOKUP PROCESS

In most cases, this approach requires no change to the broadcast infrastructure, benefits from the scale, speed and robustness of the DNS framework, and the speed, ease and robustness with which the PI code (or similar) can be extracted from the broadcast. DNS software tools are widely available, which makes handling the lookups simple.

It might also be possible to encapsulate the FQDN in an RDS ODA (Open Data Application) or similar. This would remove the needs for the RadioDNS lookup, but would require standardisation of an ODA through the RDS Forum, the repetition would not be as frequent as PI, and it would consume bandwidth. More strategically, it would still require implementors to understand the specific detail of ODA, whereas existing FM radio silicon provides the PI value directly. It would also create varying approaches to service discovery between FM, HD and DAB.

DELIVERING HYBRID RADIO APPLICATIONS

Having created a standard means of binding broadcast and IP together, it's necessary to standardise the delivery of the user experience. It's this standardisation that ensures interoperability, and allows each broadcaster to tailor their investment in production systems. It's important that a broadcaster willing to invest more is able to create a demonstrably better experience than one investing less, and that the lowest entry point investment allows all broadcasters to participate.

In the RadioDNS approach, each component of the user experience is signalled and delivered separately. This allows broadcasters to choose which elements of it they want to provide, and also allows them to outsource different parts to third party production companies if they wish. It also makes the user experience extensible, allowing new elements of it to be defined at a later stage.

Currently, two applications have been standardised:

- RadioEPG - delivering Service Information and Programme Information [8]
- RadioVIS - delivering synchronous text and image information [9]

These are signalled using SRV records [10], which are also used for applications like Instant Messenger, Voice Over IP and similarly discovered network services. To discover where a radio station's EPG information is located requires a DNS SRV lookup to _radioepg._tcp.<broadcaster fqdn>, which returns the relevant server. This could be one run by the broadcaster, epg.<broadcaster_fqdn>, or one run by a third-party epg.<third-party_fqdn>. Figure 2 illustrates. The process for RadioVIS is similar.

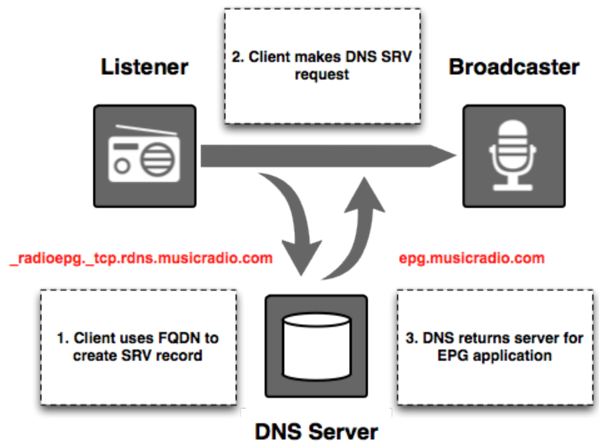

FIG 2 APPLICATION SRV LOOKUP PROCESS

Implementing Service Information

Service Information defines the radio station's attributes, and is primarily used in navigation and search, and to provide access to the radio station's website, social network presence etc.

A typical EPG implementation will use:

- A web-server - Apache, Microsoft IIS
- An application to generate the XML output format - PHP, Python, C#.net, VB.Net
- A data source or database - mySQL, Microsoft SQL, webservices

  OR
- A text editor

A programmer with general skills in manipulating XML documents in their chosen language should be able to produce an EPG service within a few days, assuming they have access to data on the radio stations they are representing.

A typical Service Information document (Figure 3) will contain information on:

- The radio station name, description, genres
- The station logo in various forms
- Various ways the radio station can be received, including indicative time offsets. It's this information that allows a device to switch back to streaming IP if the

broadcast signal is temporarily lost. The time offset information can be used to minimise the intrusiveness of the switching.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<serviceInformation
  xmlns="http://schemas.radiodns.org/epg/10"
  xmlns:epg="http://www.worlddab.org/schemas/epgDataTypes/14"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://schemas.radiodns.org/epg/10 http://schemas.radiodns.org/epg/10 /radioepg_xsi_10.xsd"
  creationTime="2013-01-21T10:23:00"
  originator="Clear Channel Media and Entertainment"
  serviceProvider="Clear Channel Media and Entertainment" xml:lang="en">

 <services>
  <service>
    <epg:shortName xml:lang="en">KSNE</epg:shortName>
    <epg:mediumName xml:lang="en">Sunny 106.5</epg:mediumName>
    <epg:longName xml:lang="en">Sunny 106.5</epg:longName>
    <mediaDescription>
      <epg:shortDescription xml:lang="en">
        Sunny 106.5 Las Vegas The Best Variety of Yesterday and Today
      </epg:shortDescription>
    </mediaDescription>§
    <mediaDescription>
    <epg:multimedia url="http://www.ksne.com/template/masthead/sunny-106-51.jpg"
                    type="logo_unrestricted"
                    width="180" height="138" />
    </mediaDescription>

    <epg:genre href="urn:tva:metadata:cs:ContentCS:2004:3.6.4.5">
      <epg:name>Classic/Dance/Pop-rock</epg:name>
    </epg:genre>
    <epg:genre href="urn:tva:metadata:cs:ContentCS:2004:3.1.1.11">
      <epg:name>Local/Regional</epg:name>
    </epg:genre>

    <keywords xml:lang="en">
        ksne, radio, fm, sunny, 106.5, 1065, lasvegas, music, vegas, sunny 106.5,
        ksne, fm, lasvegas, nv, radio, listen, live, iheart, iheartradio,
        ac mainstream, best, variety, of, yesterday, today, main
    </keywords>
    <link url="http://www.ksne.com" mimeValue="text/html" xml:lang="en" />
    <link url="http://www.twitter.com/sunny1065lv" mimeValue="text/html" />

    <serviceID id="fm:10650.a4de.us.fm" cost="10" />
    <serviceID id="fm:10650.a4de.aa0.fm" cost="10" />
    <serviceID id="fm:10650.14de.us.fm" cost="10" />
    <serviceID id="fm:10650.14de.1a0.fm" cost="10" />
    <serviceID id="http://www.ksne.com/streams/ksne" cost="20" bitrate="128"
               mime="audio/mpeg" offset="10000" />

     <radiodns fqdn="www.ksne.com" serviceIdentifier="sunny" />

   </service>
 </services>
</serviceInformation>
```


FIG 3 EXAMPLE MINIMAL SERVICE INFORMATION FILE

Even this simple level of static information can dramatically improve the station's presence on a hybrid radio device. At its very simplest level, the XML can be written in a text file and saved on the radio station's website.

A more advanced solution would include information on Programmes, and links to on-demand content.

Implementing Visual Information

Visual Information enhances the listening experience, and enables interactivity through inclusion of context sensitive links. Audio commercials can be turned into multi-media commercials with click-links through to advertisers.

A typical RadioVIS implementation might be:

- A webserver - Apache, Microsoft IIS
- An application to generate a COMET webservice - PHP, Python, C#.net, VB.net
- A source of data from a playout system

A general programmer should be able to produce a basic VIS service of text and images, giving playing now information, within a week. A more complex integration might include CD covers from a third party service, and also provide a STOMP interface using Apache Message Queue.

```json
{
  "url": {
    "RadioVIS-Destination": "/topic/fm/us/a4de/10650/image"
    "RadioVIS-Link": "http://www.ksne.com/iplaylist/playlist.html?last10=1",
    "RadioVIS-Trigger-Time": "NOW"
  },
  "body": "SHOW http://www.ksne.com/template/masthead/sunny-106-51.jpg"
}
```


FIG 4 EXAMPLE MINIMAL VISUAL INFORMATION JSON FILE

Alternatively, the most simple service can be created using a text editor to create a .json file stored on the radio station website, and linking to a single 320 x 240pixel logo.

ABSTRACTING THE RADIO PLATFORM

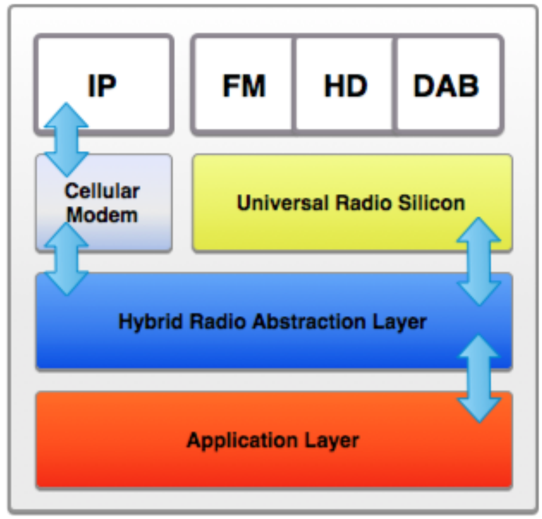

FIG 5 CONSTRUCT OF HYBRID RADIO ARCHITECTURE

The abstraction of the detail of how each radio system works makes developing an application much simpler. As well as providing primitive methods to manipulate the specifics of each radio system, the silicon manufacturer or operating system provider can provide more abstract API calls that work regardless of the locally available radio systems. (Figure 5). Examples of these API calls might be:

- Scan - will find radio services across different systems
- Service List - will create a list of all those services, supplementing the basic information detected through scanning with additional information acquired over IP, typically using RadioEPG. The developer doesn't need to know this; they are simply presented with a list object that has station names, descriptions and references to logo images.
- Event Information - will update with information received in real-time, either through broadcast or IP, such as artist experience images. The developer doesn't need to know how this information is arriving, and it's presented to them consistently.

This standardisation of APIs is a further piece of work in the standardisation of hybrid radio, and one that needs involvement from broadcasters, standards bodies such as WorldDMB, iBiquity and RadioDNS, silicon providers and device manufacturers.

OPEN STANDARDS

Making standards documents open and publicly available enables investigation and development. All the RadioDNS documents and discussions are public, and there are open developer forums on the themes of lookup, EPG and VIS, where people can explore ideas and look for solutions to problems. This collegiate approach is common in mobile development, particularly around Android, and is reassuring familiar to manufacturers.

This open environment operates differently to proprietary system. The participants broadly support the concept that an open approach can build a valuable market from which all participants will benefit, and build it faster and to a larger scale than a proprietary approach.

RadioDNS is modestly funded by its members, who want to support the creation of new value for radio. Each company engages in a different way, from creating open source code examples to speed adoption, contributing to specification constructions, and implementing services.

Interest in hybrid radio has grown substantially as smart phone manufacturers and the automotive sector have understood the prevailing benefits of broadcast radio, integrated sympathetically into an IP and app driven environment.

CONCLUSION

- Broadcast still has strong technological and economic benefits for radio
- IP is a complementary technology that can enhance the presentation and use of broadcast radio
- Using standard IP tools and abstracting the differences between radio platforms reduces the cost of development
- An open and standardised hybrid radio system benefits all participants
- The barriers for broadcaster and manufacturer implementation are low
- A key factor in manufacturer adoption is the proportion of broadcasters providing hybrid services

REFERENCES

[1] ETSI TS 102 386 v1.2.1 (2006-03) Technical Specification - Digital Radio Mondial (DRM); AM signalling system (AMSS)

[2] IEC 62106 ed2.0 (2009-07) Specification of the Radio Data System (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 MHz to 108,0 MHz

[3] Vinton G. Cerf, Robert E. Kahn, "A Protocol for Packet Network Intercommunication", IEEE Transactions on Communications, Vol. 22, No. 5, May 1974 pp. 637–648

[4] TIA-856-A, cdma2000® High Rate Packet Data Air Interface Specification (2004)

[5] RDNS01 v1.0.0 (2012-02) Technical Specification - A centralised lookup for radio services, RadioDNS Project

[6] RFC 1034, Domain Names - Concepts and Facilities, P. Mockapetris, The Internet Society (November 1987)

[7] RFC 1035, Domain Names - Implementation and Specification, P. Mockapetris, The Internet Society (November 1987)

[8] REPG01 v1.0.0 (2012-04) Technical Specification - RadioEPG, RadioDNS Project

[9] RVIS01 v.1.10 (2012-04) Technical Specification - RadioVIS, RadioDNS Project

[10] RFC 2782, A DNS RR for specifying the location of services (DNS SRV), A. Guldbrandsen, P. Vixie, L. Esibov (February 2000)