Analysis of use of Mobile Telecommunications Networks to Deliver Broadcast Radio in Australia

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KEY FINDINGS

- The findings of this Australian study are consistent with recent European reports which show mobile networks can complement broadcast radio, but are not likely to replace it in the foreseeable future.

- Even with upgraded 4G networks using the most advanced LTE broadcast mode there are technical and economic reasons for radio to use free to air broadcast in both regional and metropolitan areas:

    - the limited range of LTE Broadcast;
    - the significant impact on mobile cell capacity for other user's applications even if LTE Broadcast is used to deliver acceptable radio;
    - this study shows cell capacity reductions from 10% to over 40% in regional areas;
    - there is no handover mechanism from LTE Broadcast to one to one streaming on 3G or 4G resulting in service drop out at the edge of LTE broadcast areas. The listener would need to manually reselect the streamed radio service;
    - business models for radio carriage over LTE Broadcast are still being evaluated but likely impacts are:
        - mobile network operators (MNOs) will need to pay to upgrade each of their networks;
        - broadcasters will need to pay the MNO's for using the capacity required; and,
        - listeners would need to pay to receive radio streamed via mobiles which uses their mobile data plan rather than listening free to air.
    - network neutrality issues & regulation may constrain MNOs from using LTE broadcast to compete with broadcast;
    - data usage and battery drain has been consistently found to be of significant concern to listeners of mobile streamed radio.

- Digital radio has had a quiet evolution particularly when compared to the current fanfare around mobile broadband.

- After only 5 years on air, digital radio has been adopted by almost 3 million or 23.5% of Australians in the metropolitan cities.

- Without broadcast digital radio capability, innovative regional broadcasters will increasingly be constrained compared to metropolitan broadcasters.

EXECUTIVE SUMMARY

Techno-economic analysis demonstrates upgraded mobile broadband communications networks cannot economically substitute for the need for Digital Radio broadcasting in Australia, particularly in regional centres.

Over my 35 years of experience in the telecommunications industry assessing technological innovation and its likely impact, I have developed a now instinctive scepticism of arguments that some 'new' technology platform will immediately substitute for an established alternative technology platform. Even the internet 'revolution' which has been happening over the last 20 years is an exciting 'evolution' for those of us who could see it coming!

As an expert in the evolution of mobile communications over 30 years, the merging of the internet and mobile over the last 10 years to forge the Long Term Evolution (LTE) or '4G' mobile broadband has been fascinating. Some are even tempted to suggest there is no future for a Digital Radio broadcasting model given the ability of a listener to access digital audio content anywhere, anytime they want.

Like the internet although with far less fanfare, the DAB+ Digital Radio standard has been evolving towards a stable open global standard accepted in Europe and increasingly in Asia.

Digital Radio can support the progressive transition from analogue AM and FM radio techniques with greater efficiency, better quality sound, offering greater listener choice and functionality and greater diversity of broadcasters. Hybrid digital radio uses the complimentary capabilities of the internet to add value to the primary broadcast content in a cost effective manner.

In the USA where the internet was invented, a Digital Radio standard known as HD radio has been developed as a simulcast Digital Radio broadcast standard. HD has not been a popular choice for Digital Radio outside the US, due to a number of shortcomings including technical performance and the business model that requires licencing of the technology.

From my experience, unlike the evolution of digital mobile technology standards, the US has not provided a similar technological path for Digital Radio for Australia to follow which would allow us to be part of a global industry.

A number of excellent studies have been conducted recently in Europe to consider the ability of the broadband mobile infrastructure to accommodate demand for audio broadcast content most currently 'inefficiently' supported on expensive AM and FM broadcast facilities, rather than on digital networks.

This report draws from these studies to translate the same question to the Australian context: Can mobile broadband networks deliver Digital Radio to Australians adequately and efficiently? The adoption of Digital Radio by consumers and by motor vehicle manufacturers in Australia, in spite of the lack of regional service, has been beyond forecasts particularly in a market that is second only to Sweden in the per capita adoption of mobile broadband which is available in the regions.

The Australian Communications and Media regulator, the ACMA, needs to plan and allocate the spectrum set aside for digital radio roll out under the recent spectrum restack to allow roll out in regional areas as part of a national plan for Digital Radio.

This report has an Australian focus and considers the potential for mobile networks to be expanded to a point where they are viable to accommodate all free to air radio broadcasting transitioning free to air across at the same high quality as broadcast radio instead of installing DAB+ Digital Radio broadcasting facilities as has been done in our major cities.

The Albury township component of the Albury radio broadcast licence area has been used as a case study which illustrates how even with deployment of LTE broadcast mode extra tower sites would not support the likely local streamed channels.

Mobile networks in regional Australia are even less cost effective compared to DAB+ Digital Radio in regional areas to carry streamed content as:

- only major regional centres and major highways are likely to be provided with 4G LTE with most regional coverage being met with 3G;
- LTE broadcast will require further sites to extend coverage and is unlikely to be deployed outside regional townships;
- listeners to streamed local radio on LTE broadcast would experience interruption when moving to the more extensive LTE or 3G coverage;
- the scenario of the mobile networks carrying all local broadcast radio in the regional centre of Albury is examined in Section 6.

Further there is considerable uncertainty as to a plausible business model to support upgrade of mobile networks from 3G to the most advanced form of 4G LTE Broadcast to cope with streaming all terrestrial radio and in any case where listeners would likely have to pay.

This is particularly the case for regional mobile networks.

The listener to digital content now has greater choice and functionality offered by what is potentially complementary delivery of digital audio broadcast technologies and increasingly ‘hybrid’ solutions are progressively becoming available.

Regional listeners quite reasonably want to have this same greater choice and increasing functionality available to city listeners and still have the choice of receiving the broadcast component free to air and in high quality.

1. INTRODUCTION

Digital Radio using the mature DAB+ standard was launched in 2009 limited to Australia's major capital cities followed by the additional limited regional markets of Canberra and Darwin in 2010. In spite of these coverage constraints due a lack of allocated spectrum in our regions, radio broadcasters represented by Commercial Radio Australia (CRA) have been rewarded for their commitment with the rapid and impressive listener take-up of broadcast Digital Radio.

Digital Radio using the broadcasting standard DAB+ continues to gain acceptance in European and now Asian markets. Australia is the world leader in broadband mobile adoption and yet DAB+ Digital Radio adoption, although restricted in regional coverage compared to mobile broadband, continues to grow!

In parallel to the growth of DAB+ Digital Radio, the increasing availability of Internet Radio (audio-streaming) on 'smart phones' offering people a huge diversity of audio and visual content on their mobile handset has also been stunning.

Mobile broadband technology using 4G or LTE has enabled greater data capacity on mobile networks to be better able to carry the growth in data traffic including audio streaming for Internet Radio on mobile devices. Through streaming online, broadcasters have been able to provide additional services/ content to their listeners and with features and functionality that analogue does not allow.

It is therefore not surprising that some naïve observers ask whether there is a need to expand broadcast Digital Radio nationally given the growth of Internet Radio (audio streaming) on smart phones.

Techno-economic analysis will demonstrate that besides the demand by listeners to have broadcast Digital Radio, our mobile networks are not able to economically accommodate the ongoing demand for quality broadcasting radio. However, this demand can be accommodated by a commitment national expansion of broadcast Digital Radio.

Digital Radio and Mobile Internet Radio are complementary platforms. They can economically meet different listener markets and provide different experiences and points of contact for audiences to enjoy their favourite local stations and talent. Hybrid radio receivers, which will be increasingly available in the market, offer listeners a seamless, connected, feature rich listening experience free to air with click through to online content – the best of both worlds!

2. BROADCAST RADIO AND MOBILE INTERNET RADIO

Broadcast radio and mobile streaming, while both use the radio spectrum, they have had very different histories. With the relentless progress of 'digital technology' from the early 80s convergence as it is termed is accelerating. The digital technology revolution is underpinning the convergence of the broadcast and telecommunications industries so that what were once distinct markets and industry silos are now converged.

The parallel evolution of broadcast radio and mobile radio illustrate this relentless progress towards convergence with lessons for how to interpret and navigate change.

Interestingly, broadcast radio for one to many and mobile radio (audio streaming or simulcast) for one to one communications had a common beginning enabled by 'valve technology' at the beginning of the 1920s. 'The Wireless' the term for the new radio revolution powered a whole new broadcasting industry that transformed pre-war society and was followed after the war by television (ie TV). Thus the broadcasting industry silo within its distinct regulatory framework has evolved. The move from 'analogue' (ie AM and FM) to 'digital' radio began in Europe in the mid 1990's but took 10 years to develop to the current DAB+ standard used in Australia since 2009. The radio broadcasting industry developed very differently in the United States as will be discussed later.

Mobile or 'cellular radio' for public telecommunications first began in the Nordic countries in the early 1980's and then later in the United States where its introductions was delayed until a new regulatory regime was established. Cellular radio then was an extension of the public telecommunications industry that was going through liberalisation around the world. By the late 1980's again beginning in Europe, the digital mobile standard known as GSM (ie 2G) based on TDMA was introduced across Europe. Prior to GSM Europe had a number of incompatible 1G or analogue standards and GSM was a 'revolutionary' new digital mobile standard.

At the same time in the late 1980's, the United States developed what was arguably a superior standard[1] CDMA that was evolutionary in that it enabled mobile operators to mix the 2 standards to meet demand. In spite of Australia using the US 1G analogue standard, we chose[2] the European GSM standard. The GSM standard has now evolved over 20 years to LTE and has now emerged as the global mobile communications standard and is being accepted in recent times by the United States as the global industry goes to 4G based on LTE Advanced.

From the mid 1990s, the internet revolution originating in the United States has been transforming the telecommunications industry. Further developments of the digital mobile 3G standard early this decade coupled with the release in 2007 of the Apple iPhone has ushered in the *mobile internet* revolution. There is no question the United States has been the forerunner of this revolution!

Firstly, what is clear comparing the evolution of the broadcast radio and mobile broadband industries is that they have developed quite separately to date. However, the increasing absorption of digital technology is causing the markets they serve to begin to overlap. Mobile phone users using their smart phones are connected to the internet and so can listen to internet sourced audio content. Secondly, in both industries, the standards development process and increasing globalisation form the critical context to interpret the likely directions of change.

[1]The US in addition to the 'superior' CDMA standard, also developed a narrow band TDMA standard. This TDMA standard was adopted for a time in New Zealand.
[2]The US TDMA standard was also introduced in Australia by Telstra some 10 years later for some time as well to substitute for the analogue service that had to be closed.

3. EVOLUTION TO BROADCAST DIGITAL RADIO

From the early 90's, the evolution of broadcast Digital Radio has been slow compared to mobile technology and mobile broadband in particular due to a combination of factors.

The principle reason for this slow evolution has been the lack of regionally accepted standards to drive down radio costs and lower risks of the necessary investment by the broadcasting industry.

At the same time from the mid 90s, mobile communications, the internet and the Web have merged into mobile broadband internationally standardised 4G transforming the social consciousness. The question addressed by this and overseas reports [Ref 2 and 3], can 4G mobile networks technically and economically substitute for the need for local Digital Radiobroadcast facilities?

The Bavarian study [Ref 3] reflects many local factors, but it exemplifies this comparatively 'quiet' evolution[3] of broadcast Digital Radio compared the 'noisy' revolution of the mobile internet. The critical question the two European studies and this Australian study aim to answer, is at what cost to listeners and what level of performance? The Bavarian comparisons of costs suggest the cost impost by attempting to use mobile internet (eg LTE variants) instead of DAB+ could be as much as five to one!

The radio broadcasting evolution from analogue technologies AM/FM to Digital Radio has been very different across different European countries where Digital Radio began in earnest recently.

Australia is unusual in that we still extensively use AM (48% of radio stations are on the AM band). While generally Australia is a 'technology taker', the Australia industry encouraged the use of modern audio codecs like AAC+ to make the use of DAB more viable for adoption as its future digital broadcast platform.

While DAB+ Digital Radio in Australia is only currently available in the five capital city markets, the growth of the DAB+ Digital Radio market from its 2009 launch has been universally supported by the radio broadcasting industry delivering an increasing diversity, quality and lowering costs of receiver devices which has been an exemplar to the global industry.

The Australian adoption model has been a stimulus to the Europeans who have started to make firm plans for the transition from AM/FM to DAB+ Digital Radio shown [Ref 12] in Figure 3.1 noting Sweden[4] has just moved closer to full transition to DAB+. Now large Asian countries are progressively in the early phase of introducing DAB+ Digital Radio as illustrated [Ref 12] in Figure 3.2.

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[3]From Ref 3: "However, the digital standard initially met with little acceptance as very few programmes only migrated to the new standard. Purchase of new receivers for DAB+ radio also took up very slowly, and as a result, migrating to the new standard was not an option for most broadcasters. Although transmission costs for DAB+ are considerably lower than for FM, simulcast operation would be necessary initially until the majority of listeners has upgraded reception equipment to DAB+ compatible sets. This would involve a considerable financial burden for the content providers".

[4]See http://www.worlddab.org/news/4738/25-dab+-commercial-licences-granted-in-sweden

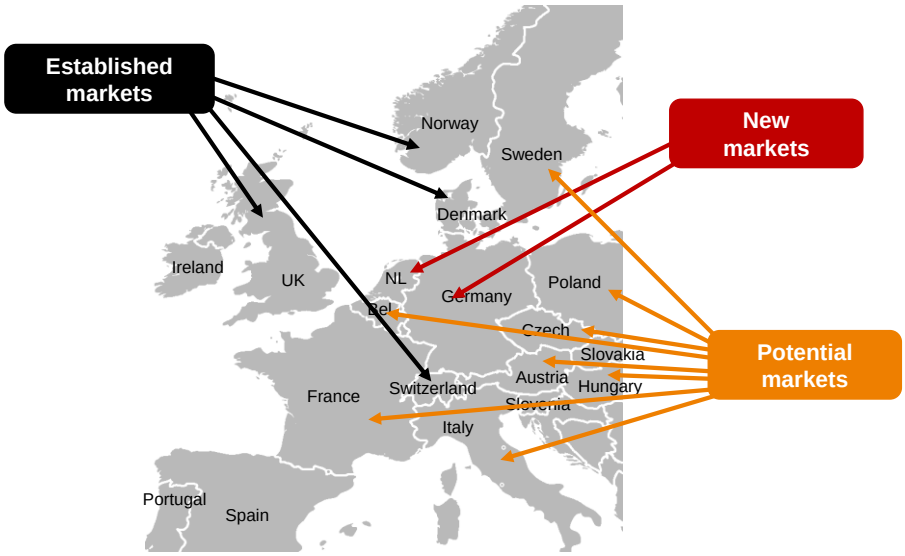


Figure 3.1Adoption of DAB+ in Europe

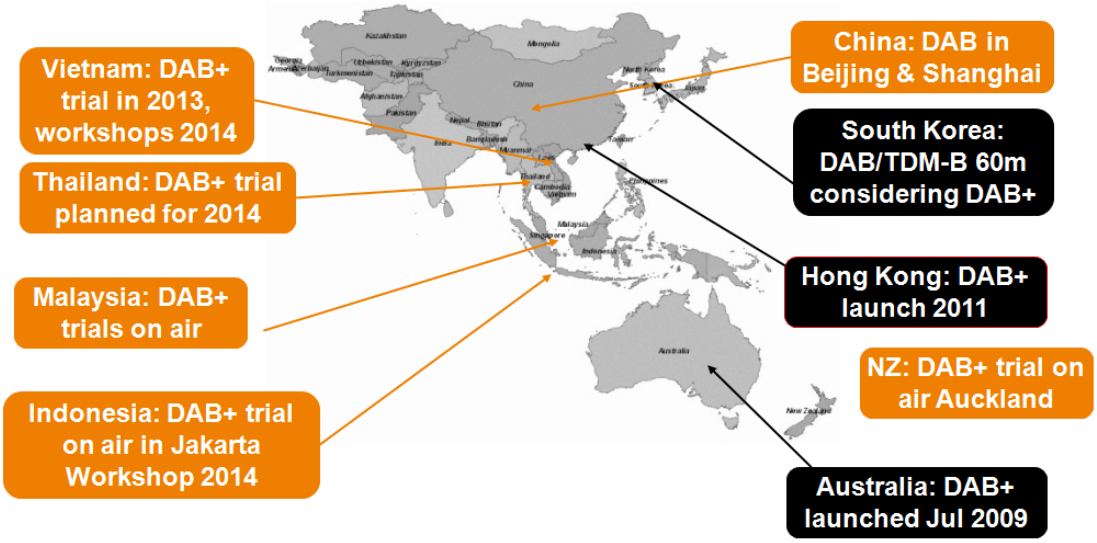


Figure 3.2 – Progressive Adoption of DAB+ in Asia

It is important to note that this rapid adoption of DAB+ Digital Radio in Australia is taking place in a market that is a per capita leader in the OECD for mobile broadband adoption as shown in Figure 3.3.

While both DAB+ and mobile broadband are available in our major regions, it should be stressed that despite regional markets being interested in more free to air local content, DAB+ Digital Radio is not widely available outside the 5 metropolitan capitals and remains so until regional spectrum is made available under a national roll out plan.

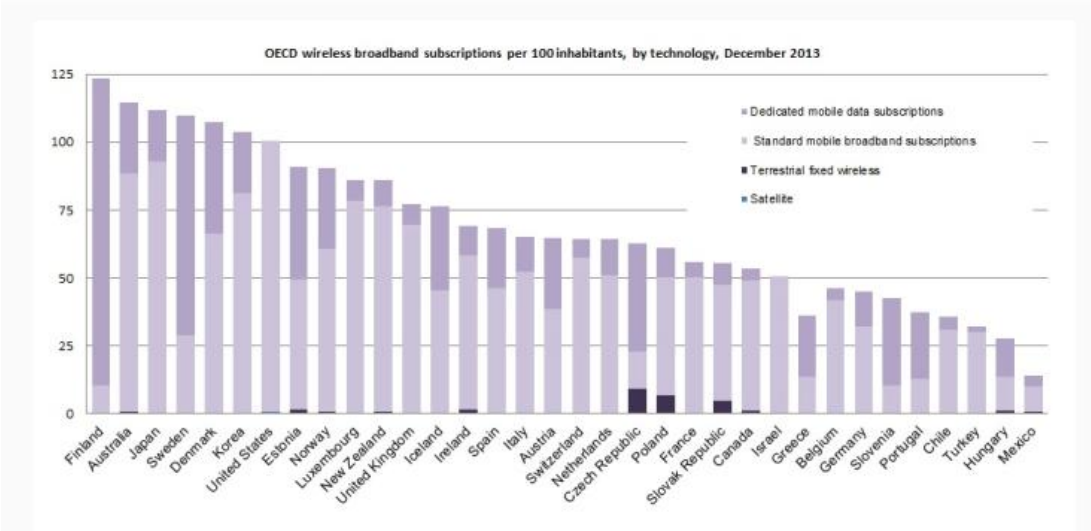


Figure 3.3 – Broadband Penetration in the OECD

3.1 Sources of 'new' Technology

With regard to new technology and technology adoption, Australian policy makers and journalists often look to the United States. In the case of Digital Radio, as was the case for the move to digital mobile communications, the US industry dynamics have retarded the development of the radio broadcasting industry and broadcast Digital Radio in particular.

While Satellite Digital Radio (SDR) is surviving solely due to the merger of XM and Sirius, the auto manufacturers who are major owners and hence will propagate SDR use in vehicles are also crucially driving the market. Note that there are no plans in the USA to remove analogue broadcast radio from car dashboards but HD, the US terrestrial standard for Digital Radio, is struggling to move forward and is primarily only used by Clear Channel stations as they are major investors in Ibiquity the HD IBOC technology patent holder. Unlike DAB+ with Digital Radio, HD IBOC is not an open standard and that constrains competitive supply. Internet streamed audio content was pioneered in 1993 in the US [Ref 8], the birthplace of the internet, has seen explosive growth albeit with surrounding controversy over royalties payment principles for internet radio.

There are many theories as to why digital radio in the US has failed to develop as is happening in the rest of the world [Ref 7], including different channel spacing, licensing fees to use the standard, issues with self interference of the host frequency on FM and long range interference in the MW (ie Medium Wave) band requiring the digital services to switch off in the evening but the greater success of satellite radio is a distinctive feature.

There may be more emphasis in the USA to be a "user pays" market, which was established well before digital and satellite radio by Cable TV in the USA, so while Australia has similar distribution of population to Canada and the US, satellite radio has not been successful here due to smaller population, high cost and other factors.

This 'US anomaly' is another factor that has skewed the perception of some policy makers as to the distinct value of broadcast Digital Radio. Audio streaming from the Internet complements the power of broadcast radio but does not replace it.

3.2 Internet Radio Evolution

Internet Radio [Ref 8] began in the United States in about 1993 at the very beginning of the rise of the internet offering a huge variety of audio content such as music and public broadcasting content available to users anywhere in the world. For the remainder of the 1990s IR saw a plethora of start up ventures most of which proved unsustainable as they could not prove a viable business model.

These early ventures were 'free' to users, never paid for copyright and were of insufficient scale to attract advertising revenue. In 1998, the Digital Millennium Copyright Act (DMCA) was introduced. Performance royalties had to be paid for satellite radio and Internet radiobroadcasts in addition to publishing royalties compared to traditional radio broadcasters who only had to pay only publishing royalties and no broadcast performance royalties to the record companies at least as these are paid in Australia[5].

From 2000 onwards, most Internet Radio Stations increased their stream quality as bandwidth became more economical. Today, most stations stream between 64 kbit/s and 128 kbit/s providing near CD quality audio. Over the last 14 years Internet Radio has matured to complement local broadcast radio. Understandably, radio broadcasters are keen to make their local content available for audiences who want to access and engage with that local content over a mobile or connected device.

It is important to note than even though internet radio seemed to appear over night in Australia, it has had a lengthy gestation in the US market from 1993 to the present where clear market segments are now established. Other clear examples of markets for streamed content are:

- overseas radio broadcasters content for expatriates, e.g. BBC;
- specialist IR aggregator services like Pandora, Apple iTunes-radio, Spotify that enable users to navigate the plethora of music genre and format choice (see Figure 3.4 examples)

From 2007 with the release of the Apple iPhone 'smart phone' in the United States and the growth of Apps, internet radio on user's mobile handset delivered a plethora of content Apps has become increasingly popular. These Apps are often branded by individual broadcast services or by consortia to make their content more widely available growing their audience reach to become platform agnostic, such as the UK's iPlayer or iHeart Radio in the US and Australia.

[5]Whilst the vast majority of radio listening in Australia still occurs in the traditional sense, a small number of Australians listen to their stations via simulcast streamed radio services over the internet for convenience or when the broadcast signal is not strong .

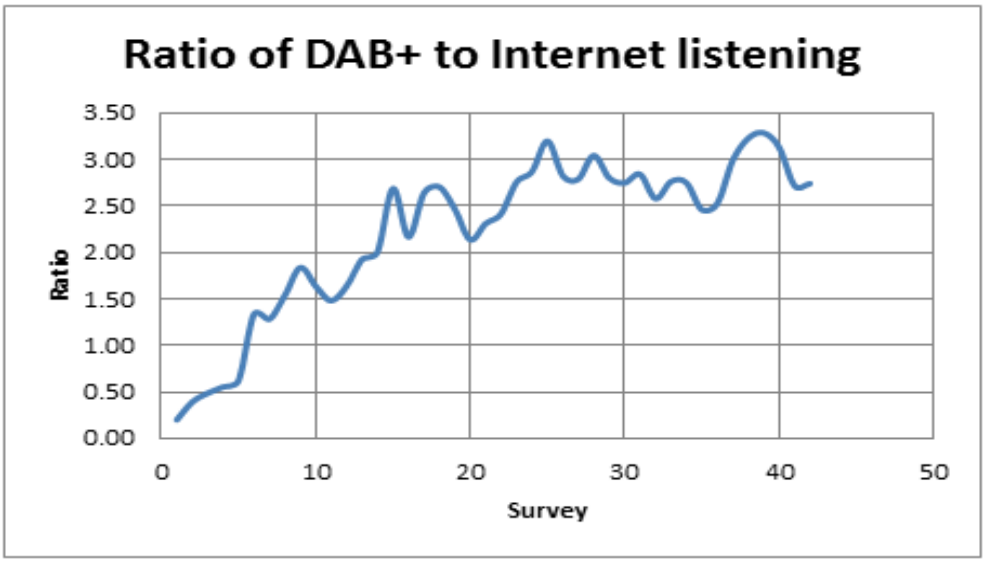


Figure 3.3 – Ratio of DAB+ Listening to Internet Streamed Listening

From surveys commissioned by CRA in the cities where DAB+ digital has been available since its launch in 2009, the ratio of DAB+ Digital Radio listening to internet radio listening has stabilised at about three to one as seen in Figure 3.3 in favour of Digital Radio reflecting a myriad of listener market factors.

A recent report [Ref 13] has highlighted the very large difference (ie 800%) in the listening to internet radio on mobile devices between North America and the rest of the world. This difference is shown in Figure 3.4, I would suggest in part that a significant reason for this difference is that the US broadcast industry has not developed an industry strategy to move to broadcast Digital Radio. What is further interesting from Figure 3.4 is that several of the 'popular internet radio sites' (eg iHeart Radio) are consortia of Radio broadcasters. One of the several reasons for this disparity in North America in my view is that the US radio broadcasting industry has not developed an effective digital transition strategy including an open technology standard.

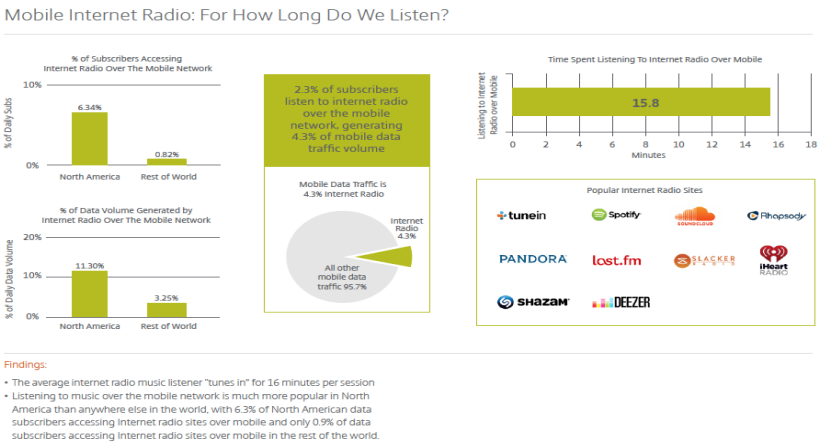


Figure 3.4 Mobile Internet Radio Listening

4. STREAMING RADIO OVER MOBILE NETWORKS VERSUS BROADCAST RADIO

The mobile internet revolution has allowed internet radio to be streamed on the users mobile phone stimulating some to pose the question whether mobile internet radio is an alternative to broadcast Digital Radio. This proposition that internet radio presents an alternative rather than complement to Digital Radio has been assessed by the Bavarian study[6] [Ref 3] and a Swedish study [Ref 2].

Fundamentally, the limiting factor of mobile internet radio compared to Digital Radio is that streamed audio content from a website is sent to users on their mobile as a unicast (ie one to one transmission) rather than multicast (ie one to many as in broadcasting). Thus streamed content is sent separately to each mobile listener within the service area thus consuming additional capacity for each listener! As a result the effective 'cost of transmission' does not scale whereas for broadcast Digital Radio the transmission cost is independent of the number of listeners. It is also more spectrum and energy efficient than analogue as many radio services can be transmitted over DAB+ Digital Radio on a single radio frequency, using shared infrastructure.

Further, audio streaming to a mobile phone, unlike free to air broadcast to a radio or DAB+ enabled handset, is not free as the streamed data contributes to use of the listener's data cap of their mobile service contract. For travel within Europe or across countries in the Asia Pacific mobile internet radio costs would be further impacted by mobile data roaming charges.

4.1 Coverage

The mobile network coverage design is very different from that for broadcast coverage and these differences have consequences for users. A more detailed discussion is in Section 5.

Mobile networks are designed to provide wide area coverage for users using hundreds of low power, low tower base stations of variable coverage extent so that users can make calls or have data sessions that can be transitioned between adjacent base stations when on the move.

For high traffic areas base stations can be every few kilometres extending to 10s of kilometres in outer suburban and regional areas. On the other hand broadcast operators use less frequent high power comparatively tall base stations often in simulcast/SFN mode to cover a licence area. The consequence for mobile internet radio users is a potentially widely variable coverage which will affect the quality of services, particularly in regional areas.

[6]Quoting from Ref 3"As an alternative to DAB+, radio could be transmitted via the stationary and the mobile internet. For mobile web radio which is of special significance for this analysis, two differing transmission technologies appear to be particularly suited. LTE as a standard for mobile telephony builds on the GSM/EDGE and UMTS/HSPA network technologies and allows for an increased rate of data transmission. LTE operates the "unicast" principle under which an end device (e.g. smartphone) demands a specific content from a content delivery server that is then supplied. As a consequence, the number of end devices that can be supplied with content via a radio station is limited. By contrast, eMBMS builds on the LTE standard, but it is constructed like a broadcasting service. The standard can be used to transmit IP data from one radio station to several end devices"

While mobile networks generally allow seamless handover between 'cells' using different technologies (eg 3G and LTE) including streamed traffic, this is not always the case. It is my understanding that such handover between LTE broadcast and LTE/3G is not possible which poses a challenge for the application of LTE broadcast for radio.

4.2 Mobile network characteristics

Mobile network design is very dynamic, which generally manifests as slowly expanding service coverage but rapidly increasing capacity in many base stations throughout the service area.

This allows network operators to keep pace with the increase in volume and diversity of demand. Mobile broadband demand in the last few years has been escalating rapidly, as new applications and data hungry devices like the explosion of smartphones (such as the Samsung Galaxy in 2013), which relentlessly increase the use of mobile data creating inevitable 'demand hotspots' which cause packet loss and variable delay.

Under these heavy mobile data traffic conditions there can be complete loss of the session. Even in non-congested times, receipt of an email on a smart phone can cause an interruption when listening to internet radio. This does not occur on a broadcast Digital Radio transmission that does not need to scale to the number of users or other activities on the network and is therefore very robust.

Such 'demand hotspots' particularly if combined with a moving mobile user can be particularly challenging for listening to a streamed internet radio service. The streaming software protocol for particular forms of content such as music will repeat packets requiring additional buffering. On the other hand, the user movement does generally not affect broadcast Digital Radio and users certainly do not experience 'demand hotspots'.

Unlike broadcast radio coverage, mobile coverage is done through an overlapping mesh of cells where data traffic (eg downstream audio streaming) to listeners within a cell need to contend (ie compete) for limited radio resource available for that cell. The cell design (ie the effective bandwidth[7]) generally assumes the unicast data streams to users within a cell are independent. This is clearly not the case for broadcast Digital Radio where significant audiences often listen to the SAME content at the same time.

To overcome this shortcoming of a 4G mobile network's ability to operate in a one to many mode, eMBMS (in this paper referred to as LTE broadcast) has been developed to allow simulcast of streamed content to multiple users in a particular area at the same time.

Both the Bavarian and Swedish studies [Ref 2, 3] have considered the potential of LTE broadcast to improve the 'effective' capacity needed to allow mobile networks to handle broadcast content on the scale that would be needed to service large radio audiences.

[7]Effective bandwidth for mobile broadband fundamentally means that within a cell of multiple users/listeners the available spectrum is shared (ie. contestable) and depends on many factors that vary with time, location and load. Effective bandwidth is an average that indicates the point of congestion.

4.3 Developments in LTE for Broadcast Content

Increasingly 'eMBMS' also known as LTE Broadcast will be deployed by mobile network operators (MNOs) within their 4G or LTE coverage areas.

These are usually located within their wider 3G service area to allow 'broadcast video and audio content' to be 'simulcast' to users wanting the same content rather than the usual 'unicast' method which is wasteful of network capacity. The LTE broadcast mode is designed to cope with a few thousand users wanting to view the same video or stream the same audio without congestion – on New Year's Eve in places of mass gathering for example.

LTE Broadcast[8] is well summarised [Ref 12] as being the next wave of mobile broadband technology. It is being actively trialled at the moment in Australia and around the world offering the opportunity for MNOs to differentiate their service offerings and reduce unprofitable demand spikes enabling the network to cope with predictable video (and audio) content.

While still in early phase of deployment, this technology[9] and the planned business models are still to be assessed through commercial roll out. Whilst the technology will undoubtedly succeed for many uses, the likely impact on the capacity needed by LTE mobile networks to carry internet radio needs to be realistically considered. More relevant an observation is that 4G or LTE is not deployed seamlessly across a mobile network/ 3G coverage area but is concentrated in data intense areas.

LTE Broadcast to better carry broadcast content requires the segmentation of effective bandwidth thus reducing the capacity in those cells in the designated area to carry non-broadcast content, such as voice calls, emailing or web browsing.LTE broadcast area coverage is likely to be designed for areas which are a subset of the wider 4G LTE mobile coverage area where can be configured for predictable audio/video streaming demands in those areas.

For example, an MNO with LTE Broadcast capability could negotiate a commercial agreement for broadcasting 'valuable content' (eg football highlights) over a specific coverage zone (eg in and around the football stadium).

[8]"LTE Broadcast is a single-frequency network (SFN) in broadcast mode that is part of the series of 3GPP LTE standards known as evolved Multimedia Broadcast Multicast Service (eMBMS). It extends existing LTE/Evolved Packet Core (EPC) systems with an efficient point-to-multipoint (PMP) distribution feature, enabling multiple users to receive the same content simultaneously. LTE Broadcast functionality is available for commercial launch, beginning with Release 9 and with additional enhancements continuing in future 3GPP releases. LTE Broadcast is supported for all defined bandwidths and formats of LTE, including FDD, TDD, and carrier aggregation (CA) [3]. SFN technology is used to distribute broadcast streams into well-defined broadcast areas where all cells contributing to an SFN send the same data during exactly the same radio timeslots and appear as a single large cell. The area covered by the LTE SFNs can be small, spanning just a few cells; or it can be very large, covering an entire country. Broadcast and unicast radio channels coexist in the same cell, sharing capacity, while the subsets of available radio resources are dynamically assigned to either broadcast or unicast radio channels. The LTE network can be upgraded by software, and a new media service layer offers a dedicated network element for the implementation of end-to-end LTE Broadcast services. LTE Broadcast provides a more flexible and lower deployment cost compared with previous mobile-broadcast options by leveraging OFDMA (Orthogonal Frequency-Division Multiple Access) and wider bandwidths available in LTE. On user devices, LTE Broadcast requires no separate device chipset and can use common middleware….

[9]From [ref 2] " Mobile operators would need to invest in software licenses to upgrade all radio base stations (eNodeB) in their LTE network to support eMBMS functionality as well as investing in new hardware and software for new devices in LTE networks, such as BM-SC (Broadcast Multicast Service Center), eMBMS gateway and MCE (Multi-cell/Multicast Coordination Entity).

The MNO could charge a premium rate for customers within the coverage zone to receive such content! Most of the commercial interest by mobile network operators is in video content rather than audio as it commands greater commercial opportunity to differentiate from unplanned shared video downloads which are generally poor quality and are very disruptive of mobile network performance.

In regional areas in particular, less effective bandwidth is made available in line with lower data traffic demand so that even if 4G LTE is deployed at regional 3G sites, the LTE data coverage is patchy at the cell edges particularly with larger cells (ie>10km) in regional areas. In my view a mobile operator is unlikely to deploy LTE Broadcast in regional areas due to the limited effective bandwidth available at the regional site.

This observation is supported by the Albury study in Section 6.

4.4 Broadcast Data Traffic Growth

The growth in mobile traffic even over the next 5 years is expected to be huge but the extent is very debatable. For example Ericsson [Ref 11] predicts video content to be >50% of mobile broadband by 2019 whereas Ericsson in another study [Ref 9] predicts video content to be >70% by 2016!

This large uncertainty in the growth in video for mobile broadband is therefore a very important strategic issue for mobile network operators and their suppliers.

The same report [Ref 11] notes the increase in other mobile data traffic[10] noting in particular music streaming but confirms video is the main demand driver and is silent on supporting broadcast radio content.

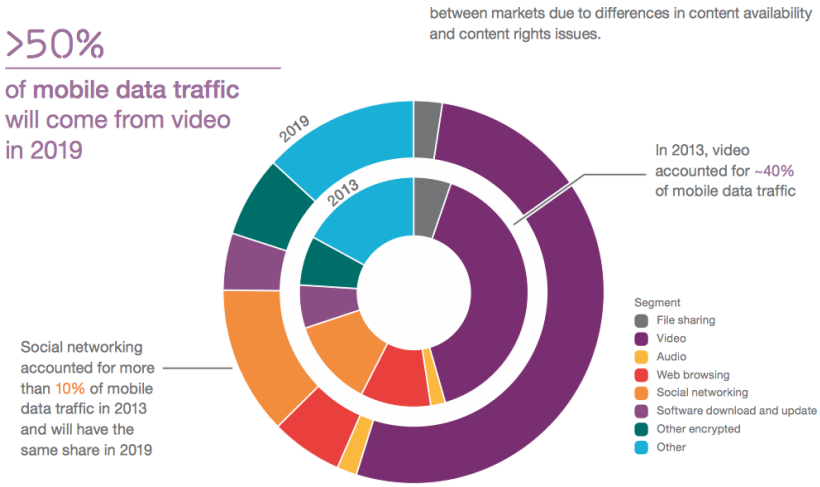


Figure 4.2 – Increase in Mobile Data (Source: 2014Ericson Mobility Rep

[10]Music streaming is gaining popularity, but functions such as caching of content and offline playlists limit the impact on traffic growth. Audio traffic is still expected to increase 8-fold by 2019. Web browsing is predicted to grow 6-fold over the same period. Its relative share will however decline by 2019 from today's 10 percent as a result of stronger growth in other categories, such as video and social networking.

4.5 Network Neutrality Issue

The Swedish and Bavarian analyses [Refs 2 and 3] argue 'network neutrality' regulation will constrain MNOs from using LTE broadcast to compete with broadcasters. The 'network neutrality' issue continues to rage in the US and to some extent in Europe but not in Australia to any degree. The authors argue [Refs 2 and 3] that 'network neutrality' regulation will prevent mobile network operators from discriminating between sources of data (eg content types and or content providers). Mobile network operators argue that this form of 'network management' is necessary to assure fair carriage of content over their networks.

However, developments like LTE broadcast, can be regarded as a sophisticated 'network management' tool to prevent certain types of content 'unfairly' compromising the quality of other types of content unless of course the content owner pays.

Large content owners such as Google argue for 'network neutrality' so that notionally all bits are treated equal. A number of the references [Ref 2,3] align the interests of broadcasters with the call for network neutrality in their opposition to mobile Internet Radio.

With LTE Broadcast, mobile network operators will be able to actively market to key content owners (eg a Sports broadcasters) to pay a premium to have assured delivery in multicast mode (ie broadcast over IP) the content to users who could ALSO pay a premium for such content access on their LTE broadcast enabled smartphone.

This option being initially[11] only available for a preconfigured coverage area (eg cells surrounding an arena, or event).

It is important to note that not all video (or audio) traffic is the same in terms of its demand for network resources where the role of LTE broadcast by MNOs is 'network management' for foreshadowed (ie open for negotiation) special content management.

This issue is still in debate both in the US and to some extent Europe but I don't believe the ACCC, the competition regulator in Australia will be persuaded that specific network neutrality regulation is required in Australia.

4.6 Latency

All digital systems including broadcast Digital Radio and mobile internet radio exhibit 'latency' in that the received audio is delayed compared to real time, as is to a lesser extent also the case with AM or FM broadcasting.

In this respect broadcast Digital Radio exhibits lower latency at 3-4 seconds, compared within internet radio where necessary buffering across all services can cause more significant delays of over 10-20 seconds,

Latency is a particular problem where the content is an intrinsic part of a live sports experience making digital radio more suitable for sports crazy Australians.

[11] Dynamic separation of streamed traffic between LTE and LTE broadcast is likely in the near future. [Ref 14]

4.7 DAB+ Compared to LTE

The advantages and disadvantages of DAB+ and LTE can be illustrated in Table 4.1 that is adapted from the Bavarian study [Ref 3]for the Australian context.

	DAB+	LTE
Advantages		
Live – real time content	✔	✖
Wider diversity of content as it includes non-local services	✔	✔
More than just audio experience - new features and functions	✔	✔
New revenue opportunities	✔	✔
Minimal signal disruption even at high speeds	✔	✖
No costs incurred for listening other than initial radio purchase	✔	✖
Meets industry expectations	✔	
Full coverage of service area	✔	✖
Greater local content which is important to regional listeners	✔	✖
Greener and more spectrum efficient	✔	✖
Ease of setup/mobility	✔	✖
Low cost of entry - ubiquity	✔	✖
Use of existing studio infrastructure	✔	✔
Currently offers (greater) interactivity options for listeners on smartphones and tablet	✖	✔
Radio receiver (mobile handset) already owned (by most!)	✖	✔
No local restrictions for programmes	✔	✔
Disadvantages		
Costs for ‘radio consumption’ need to be borne by listeners	✖	✔
Minimal interactivity options to listeners but much work is going on to address this deficiency	✔	✖
Need to grow radio base	✔	✖
Traditional device manufacturers unable to support screen based devices given current cost and margins	✔	✖
Variable coverage	✖	✔
Potential vulnerability to streaming constrictions (no network neutrality!)	✖	✔
Contractual link restrictions to particular to service provider	✖	✔
Need a smartphone for LTE which is LTE broadcast capable – timeframe	✖	✔
Significant delay	✖	✔

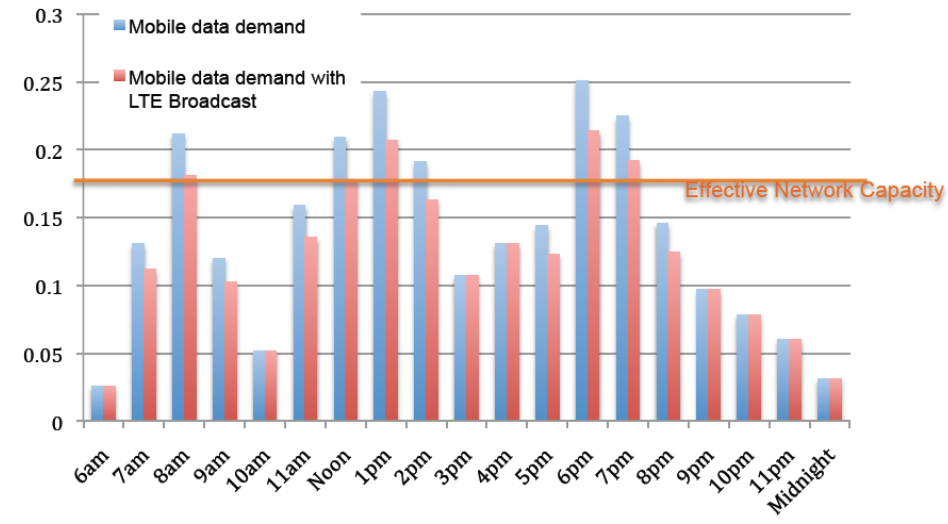
Table 4.1 – Advantages and Disadvantages of DAB+ and LTE at a glance

The study[12] [Ref 9] estimates the impact of LTE Broadcast on reducing the data traffic load on LTE networks.

Figure 4.3 [Ref 9] shows the 'effective' reduction in mobile network resource is greatest in high data demand times reducing to zero during low data demand periods such as overnight.

The broad observation based on the same theory is that allocation of SFN LTE broadcast in regional areas would require additional network investment to retain sufficient minimum effective bandwidth for unicast data traffic and will have minimal impact on reducing 'effective' demand.

Figure 6: *iGR* Model of Potential Impact of LTE Broadcast on Mobile Data Demand (U.S. metro market in 2016; GB/Hour/Pop)



Source: *i*GR, 2012

Figure 4.3 – Impact of LTE Broadcast on 'effective' demand

Thus LTE Broadcast deployment in urban service areas during peak times of demand but would be a business case balance.

However, LTE Broadcast would not be an economic solution to reduce 'effective' demand for data streaming (eg simulcast internet radio streaming) in regional service areas with larger cells and minimal radio resource.

Note that a simulcast IP stream from a terrestrial radio broadcaster has the potential to be carried on LTE Broadcast to multiple users whereas personalised internet radio services such as Spotify and Pandora always require a point to point (unicast) connection and cannot be carried on LTE Broadcast.

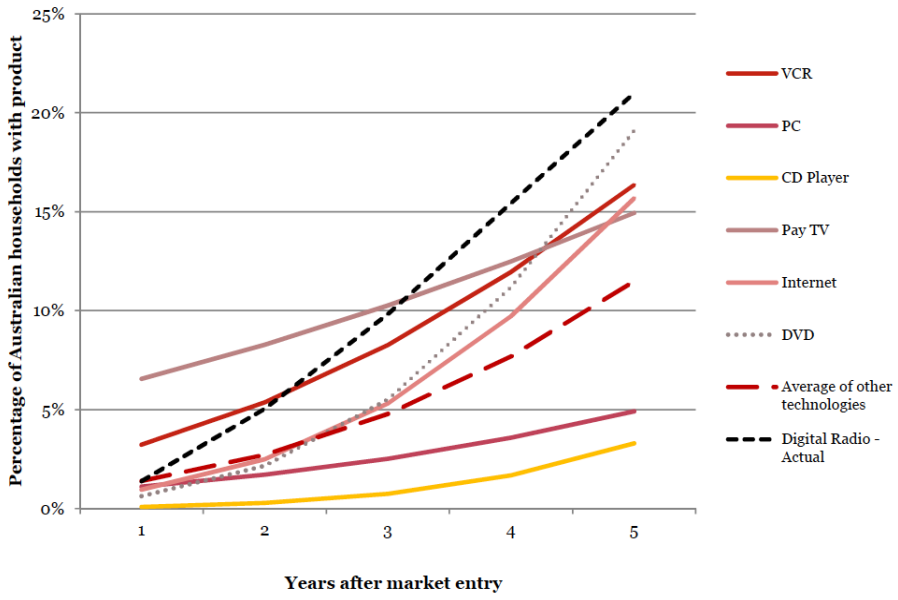
[12]Ref 9 "To assess the impact of LTE Broadcast on the metro market, iGR assumed that the amount of video traffic will continue to grow and will reach just over 71 percent of total mobile data network traffic in 2016, while audio will comprise 9 percent. iGR's calculation then shows that LTE Broadcast can off-load 12.5 percent of the video data traffic from unicast overall and 15 percent during peak hours. Similarly, iGR's model shows that much of the audio demand in 2016 will be for streaming music services and that LTE Broadcast would off-load 30 percent of the total mobile data network traffic attributed to audio overall and 45 percent during peak hours".

5. RELEVANCE OF OVERSEAS EVALUATIONS TO AUSTRALIA

5.1 Digital Radio Adoption Rate in Australia

Before examining the relevance of overseas studies comparing LTE Broadcast as an alternative cost effective platform to broadcast Digital Radio, it is useful to reflect on the comparative rapid adoption of Digital Radio in Australia since its launch in 2009. In Europe the adoption of Digital Radio has been greatly delayed due to the slow agreement of global or even regional standards. Equipment using the DAB standard in Europe only became available commercially in some European countries in1999. The DAB+ standard was published in 2007and in 2009 there were only 20 DAB+ enabled receivers, where there are now more than 400 device types.

Figure 1: Actual diffusion path of DAB+ compared to other technologies (previous methodology)



Source: Ironmonger, C. Lloyd-Smith and F. Soupourmas 2000, 'New products of the 1980s and 1990s: The diffusion of household technology in the decade of 1985-1995', Prometheus, vol. 18, no. 4, pp. 403-415; PwC analysis.

Figure 5.1 – Relative Adoption Rate of DAB+

5.2 User Context – In vehicle use

The user context is very important to understanding the comparative user preference for particular forms of content and the likely preferred listening platform. Awareness of broadcast Digital Radio particularly as a standard in cars is very strong particularly amongst youth.[13]

A key user context for radio broadcasting and therefore broadcast Digital Radio, is in the car where 32% of listening takes place. The audience numbers peak in the morning and the drive sessions. The content could be music, news, sport or discussion with regular live traffic updates.

[13] 44% of those aged 18-24 years are aware that DAB+ digital Radio is now available in car audio systems – figures from Commercial Radio Australia

Twenty vehicle manufacturers in Australia now offer DAB+ Digital Radio, either as a standard or an optional feature. Manufacturers offering DAB+ Digital Radio line fitted include: Aston Martin, Audi, Bentley, BMW, Ferrari, Ford, Fuso Trucks and Buses, Hino, Infiniti, Isuzu Trucks, Jaguar, Lamborghini, Lexus, Land Rover, Maserati, McLaren, Mercedes Benz, Mini, Nissan, Porsche, Toyota.

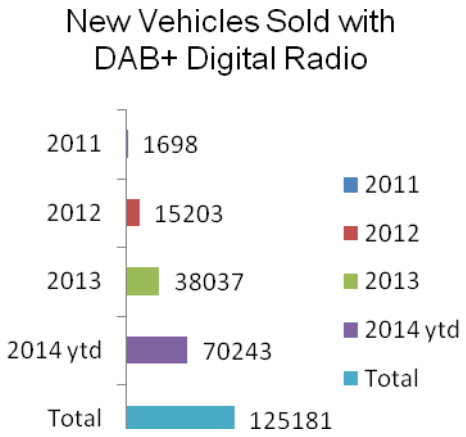
This figure has more than doubled in the past two years, with further announcements expected within the next year.

DAB+ Digital Radio is now available as standard in popular vehicles such as Toyota Camry, Aurion, Ford Focus and Nissan X Trail. More than 70,000 new vehicles were sold in the first three quarters of 2014 with DAB+ Digital Radio fitted. This figure already exceeds the number of vehicles sold with DAB+ Digital Radio in 2013.

Manufacturers have reported that over 125,000 vehicles have been sold in Australia, since the adoption of DAB+ Digital Radio in vehicles in 2011.

This figure is expected to grow considerably, as more vehicle manufacturers adopt DAB+ Digital Radio technology.

It is estimated that almost half (46%) of heavy goods vehicles in Australia now support DAB+ and the growth is shown remembering Digital Radio is only available in the city markets.



Source: Glass's Automotive Business Intelligence 2014. Total sales figures supplied by vehicle manufacturers in Australia supporting DAB+ digital radio Q3/2014

Figure 5.2 Vehicles Sold with DAB+ in Australia

The take-up of DAB+ Digital Radio in vehicles will also be enhanced now that a range of aftermarket solutions for DAB+ are available from manufacturers including Alpine, JVC, Kenwood, Orion, Pioneer, Sony and Pure.

5.3 Coverage of Digital Radio Compared to Mobile

Currently mobile coverage is extensive in Australia and claimed to be of the order of 95% of the population though the physical coverage is less than 10% of the land area. Telstra with the most extensive coverage aims to provide 4G or LTE coverage most relevant to Internet Radio to 87% of the population.

In contrast broadcast Digital Radio is currently limited to the major capital cities, and whilst VHF Ch 9 and 9A have been mainly cleared and provisionally set aside for digital radio under the recent spectrum restack, no official detailed channel planning or licencing for broadcast Digital Radio has been done to roll out coverage to regional Australia. Including Digital Radio trial sites such as Canberra, the population coverage is at 64%.In Figure 5.3 is shown the broadcast radio coverage in Australia inclusive of AM/FM and Telstra's mobile coverage.

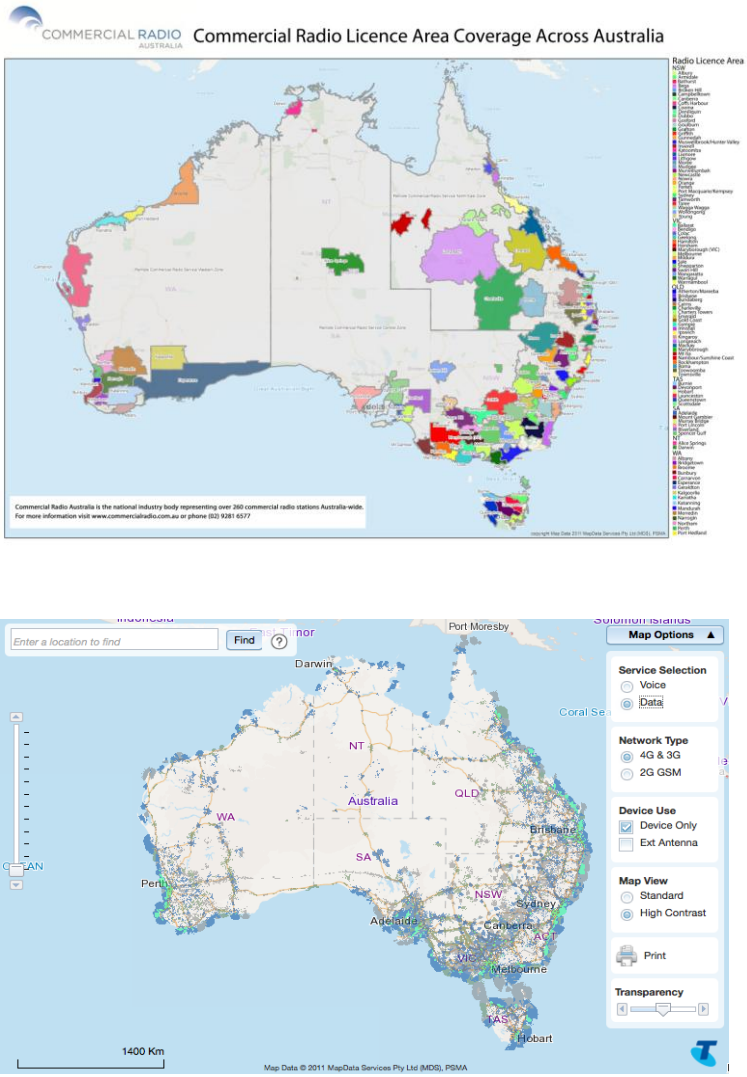


Figure 5.3 – Coverage Comparison for Broadcast Radio and Telstra Mobile

As discussed earlier, in spite of the more limited coverage access for Digital Radio compared to mobile LTE, the market for Digital Radio has grown significantly and there are already more than 1.33 million more listeners using DAB+ in Australia than using internet streamed services.

6. COST COMPARISONS

The Bavarian study [Ref 3] in particular compares the costs of supply in Bavaria through DAB+ or LTE also considering the impact of LTE broadcast on reducing potential network congestion (and thus required network investment) to handle content such as audio streaming to multiple users in particular service areas.

The cost models for DAB+ Digital Radio and mobile Internet Radio are in general very different[14] reflecting the business model in addition to the technology. The Swedish study [Ref 2] summarising the difference in the structure of the cost of transmission:

- for DAB+ Digital Radio, a number of programmes that can be supported remain constant, independently of the number of listeners;

- for mobile Internet Radio, the cost of transmission is not 'free' to the user in that it depends on their data consumption:
  - for example, for an average of 18 hours listening per week and a 64kbit/s stream, the user will consume an average of 2.2GB of capacity per month that is more than the typical user data cap of 2GB;
  - consumption overall increases with the number of programmes. The use of LTE broadcast potentially enables containment of the required radio resource if the same programme is delivered over a service area.

Essentially this means that the costs of meeting data streaming demand for radio broadcasting over mobile phone networks does not scale with greater programme choices.

LTE broadcast offers some reduction in effective demand requirement in urban service areas but cannot be expected to cope with radio broadcast content in regional areas.

The Bavarian study [Ref 3] is consistent with this assessment.

6.1 User Costs

Considering user cost comparison, they are similarly different:

- for broadcast Digital Radio listeners, the user cost assuming that DAB+ Digital Radio is not already included in their car is the cost of a suitable radio whereas there is no charge for listening;

- for mobile Internet Radio, assuming the listener has a newer mobile phone (eg smart phone) there is a charge for listening in that the audio streaming contributes to the user's data cap as mentioned earlier

[14] Quote: Ref 3 "Transmission costs for radio programmes present a major factor in the decision as to which route of transmission to opt for. The following analysis therefore looks at the transmission costs for mobile radio consumption through DAB+ and through the mobile internet - both via the LTE unicast standard and via eMBMS (evolved Multimedia Broadcast Multicast Service)".

6.2 Mobile Network Operator Costs

The Swedish study [Ref 2] in particular estimates that to accommodate the broadcast audio content currently delivered using FM on mobile broadcasting networks to a regulated broadcasting level of performance[15] would require the investment by the MNOs of over A$500 million dollars even utilising LTE broadcast technology to carry current FM broadcast content.

In the Australian context, A$500 million represents about 5% of the LTE investment by the 3 MNOs. The Bavarian study[16] [Ref 3] undertakes a detailed evaluation of relative costs of DAB+ versus mobile broadband (including the use of LTE broadcast) demonstrating DAB+ Digital Radio (ie no analogue broadcasting) annualised costs are less than 3% of the necessary upgrade of the mobile networks. The problem in Australia is the ongoing[17] high cost of maintaining of simulcast on AM and FM which are an order of magnitude more expensive to operate than Digital Radio as shown later in Table 6.1.

What is particularly relevant to the Australian focus on regional demand being accommodated by MNOs,is that the Swedish study [Ref 2 page 21] estimates that unlike urban/metro markets, rural LTE mobile networks would require a 20% expansion in the number of new sites to introduce LTE broadcast. The increased capital requirements on regional mobile to carry audio streaming will be examined in more detail for the specific regional market of Albury that has mobile coverage but no spectrum is allocated for Digital Radio.

To compare Sweden with Australia, the relevant land areas and population distribution, Australia[18]will probably require a larger LTE expansion than for Sweden and AMTA have estimated at over $10 billion with comparable performance [Ref 15]. The Telstra mobile network covers 99% population in 30% of the land area whereas Sweden's MNO's cover the same population in 100% of the land area.

6.3 Broadcaster Costs

From various sources but well summarised in the Harris presentation [Ref 1] there are very large capital and operational costs advantages from using DAB+ compared to FM for regional areas the focus for this report. These figures are summarised in Table 6.1.

	FM	DAB+
Number of Transmitters	18	1
Capex costs ($US1000s)	900	80
Opex costs ($US 1000s/pa)	925	98
Transmitter Power (kW)	10 peak	2.5rms

Table 6.1 – Comparative Broadcaster Costs (Regional Case)

[15]The Australian broadcasting regulator the ACMA does not regulate technical performance in this way.

[16]"The Bavarian study [Ref 3] in particular on the relative transmission costs for DAB+ and mobile IR show that Digital Radio total annual costs across Bavaria are less than 5% of total annual costs for mobile internet radio even with the inclusion of eMBMS".

[17]Norway is the first of a likely number of European countries to stipulate acessation date for analogue broadcasting. (ie FM in this case)

[18]Australia has a population of 23.6 million and a land area 7.69 million km^2 whereas Sweden has a population of 9.7 million and a land area of 0.450 million km^2

Given the order of magnitude differences between FM and DAB+ in terms of both Capex and Opex, there are significant advantages in a speedy transition to DAB+ but this can only happen if their listener audience has Digital Radio. In Australia which has a high number of listeners on AM[19] (compared to Europe) and FM and where there are no dates been set by Government to transition before analogue radio is turned off as was the case for broadcast TV, broadcasters need to continue to operate multiple broadcasting platforms.

This problem is further frustrated in Australia where no spectrum is allocated for Digital Radio outside of the capital cities unlike the spectrum replanning process for transition to digital television.

6.4 Albury Regional Market Study

To better understand the way a mobile network is designed to potentially meet data demand, the regional example of Albury can be used noting that spectrum for Digital Radio is not currently available in the Albury region. The network design details can be provided where only broad observations are covered in the main report.

For this example, Australia's mobile network operator, Telstra will be used as the example MNO and it is assumed the current sites 16 sites listed on the spectrum regulator's (ie the ACMA) data base will be used to examine the use of LTE. We will also assume that these 16 sites are upgraded to include LTE broadcast to more efficiently carry broadcast data traffic to users/listeners in Albury. The distances between the Telstra sites is from 2km to 8km and it will be assumed for this example, the distance at the coverage edge will be less than 10km.

For upgrade to LTE broadcast to accommodate broadcast traffic, the cell size is understood needs to be less than 5km and therefore more sites would be required which would require investment in infrastructure and site leases.

The LTE coverage area as calculated is shown in Figure 6.1. When LTE broadcast is deployed to more efficiently carry simultaneous broadcast programs, the overall LTE network will require increased investment in both the number of sites and the radio resource (throughput capacity) per site but up to a limit on the number of channels that can be allocated per site.

An increase in the allocation of LTE Broadcast will mean a reduction in the capacity for non broadcast (ie unicast or general data) traffic. We note that while the LTE-Broadcast capacity is less efficient use of the spectrum in terms of bit/s/Hz it is not dependent on the number of listeners. This trade off is examined using a number of scenarios.

With LTE-Advanced the throughput of a unicast service is dependent on the distance from the base-station and the propagation path allowing efficiencies per connection as high as 4bit/s/Hz close to the base-station and as low as 0.5bit/s/Hz at the cell boundary which may be up to 10kms or so distant.

[19]The author understands the approximate AM costs are 2x the FM OPEX based on discussions with broadcasters.

LTE-Broadcast on the other hand has to be consistent for all paths to the listeners in the cell and hence adopts a lower efficiency in a trade-off with robustness for delivery of the data to a specific maximum design distance.

When LTE broadcast is deployed to more efficiently carry simultaneous broadcast programs, the overall LTE network will require increased investment in both the number of sites and the radio resource per site but up to a limit on the number of channels. While the allocation of LTE Broadcast will mean a reduction in the capacity non broadcast (ie unicast) traffic this allocated capacity which is less efficient of the spectrum is not dependent on the number of listeners. This trade off is examined using a number of scenarios.

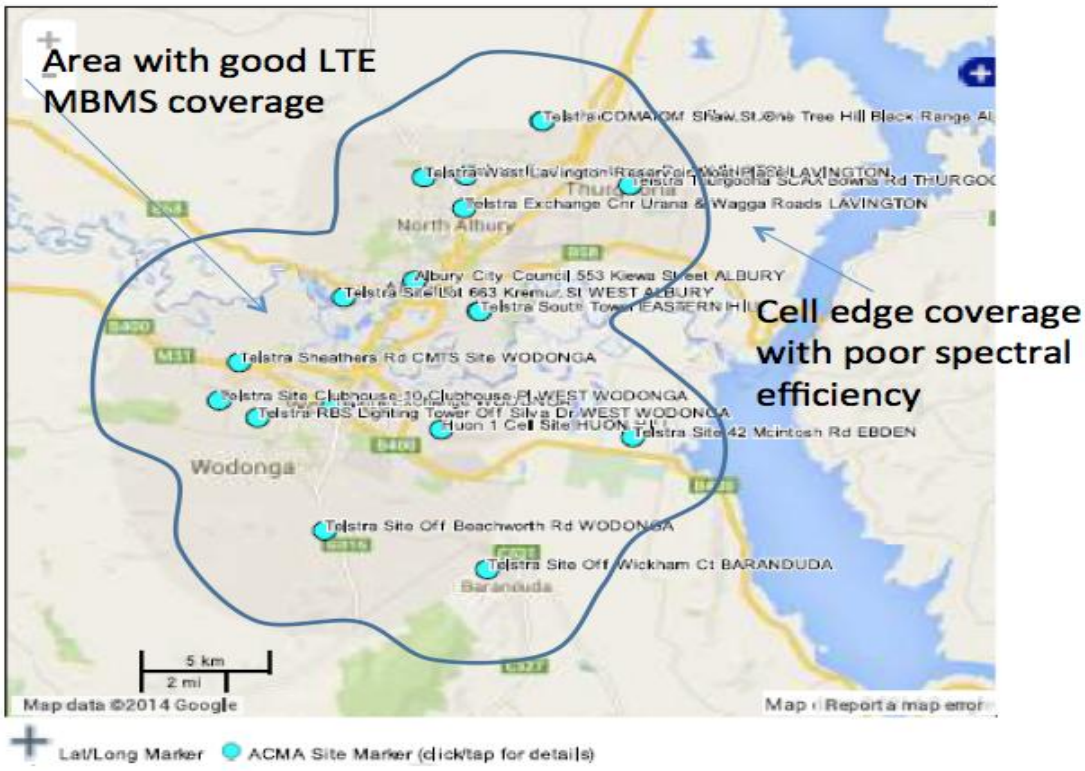


Figure 6.1 An Example of LTE Mobile Coverage in Albury

For this regional market example, three scenarios are considered:

- No LTE Broadcast where audio data streaming traffic can be assumed as both local broadcast channels and/or random as it makes no difference. Without LTE Broadcast, capacity depends on the number of simultaneous listeners as discussed earlier in an essentially linear fashion and shown in Figure 6.2 from the Albury example design..
- With LTE broadcast, capacity up to a limit is independent of the number of simultaneous listeners but does slowly decrease with the number of sources of content.
- The third scenario considered is where LTE Broadcast is used to carry local broadcast streamed content and the random streamed content is carried in unicast mode on the LTE network. We will later assume that these two sources are 50/50.

Before examining practical cases, it is instructive to consider the number of likely practical situations for Albury. Currently Albury / Wodonga listeners have access to 3 commercial services, 5 ABC, 1 SBS and 2 community radio station giving a total of 11 services.

A single DAB+ ensemble typically delivers between 18 and 24 services. We note that in metropolitan areas the number of services on DAB+ is typically 2 to 3 times the number of AM and FM services combined.

Using more realistic numbers of listeners where based on Sydney >20% of the population are listening in the morning peak period, then the further analysis in Attachment considers the potential of 500 users/listeners per cell.

In terms of the required investment by the MNO to accommodate audio broadcast traffic in Albury if LTE Broadcast isnot made available, both the random audio content as is for the case for most Internet Radio and local radio content would be subject 'best endeavours' delivery standards likely to be unacceptable to some listeners in certain usage contexts.

Because the capacity is directly dependent on the number of users/listeners there is no way the mobile network can cope with what amounts to 32Mbit/s to some likely 500 listeners as can be seen in Figure 6.2.

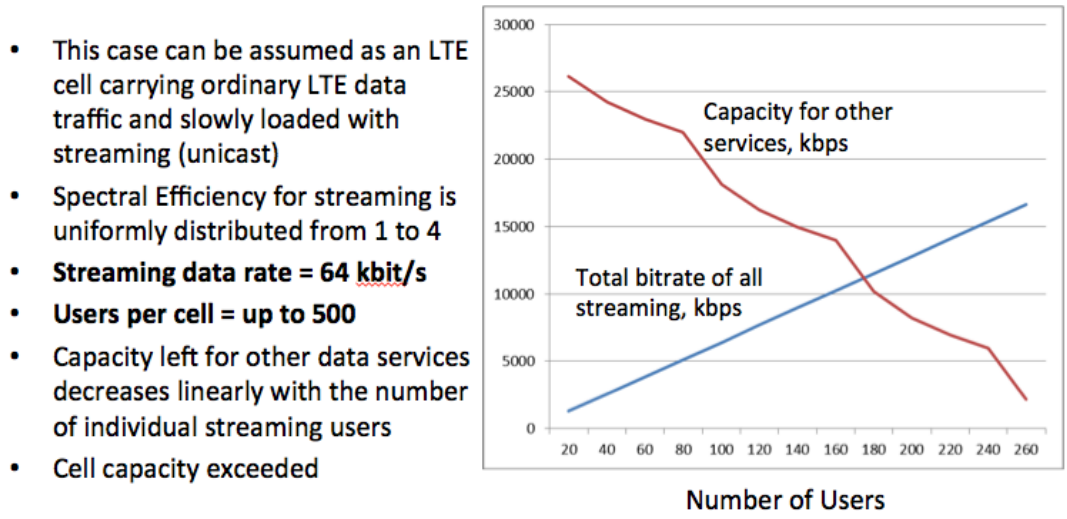


Figure 6.2 – No LTE broadcast Case

If LTE broadcast is made available to accommodate audio broadcast traffic in Albury, the results are shown in Figure 6.3 on the next page.

In terms of the required investment by the MNO considered, the MNO would need to invest in more sites (eg about 3 more sites) to maintain the same coverage and would also realise the necessary increase (ie 10% estimated) in radio capacity.

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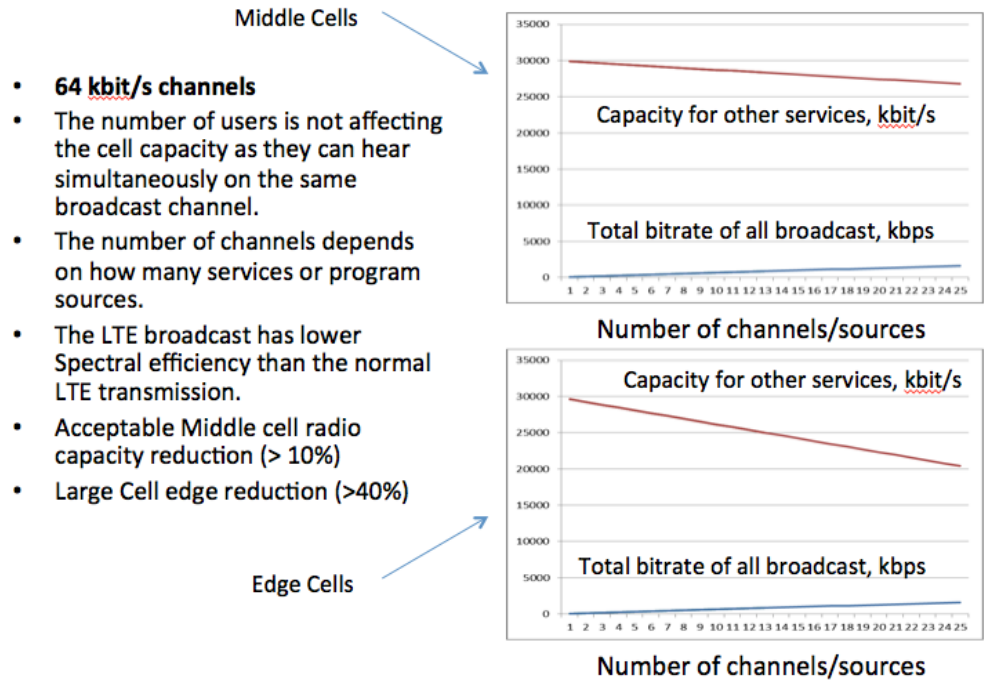

Figure 6.3 – Pure LTE Broadcast Case

The case shown in Figure 6.3 shows how the performance is not affected by the number of listeners but does depend on the number of channels.

In practice, even with LTE broadcast deployed to local radio content a third case can be assumed where 50% of the likely listeners are listening to random streaming. This case is shown in Figure 6.4.

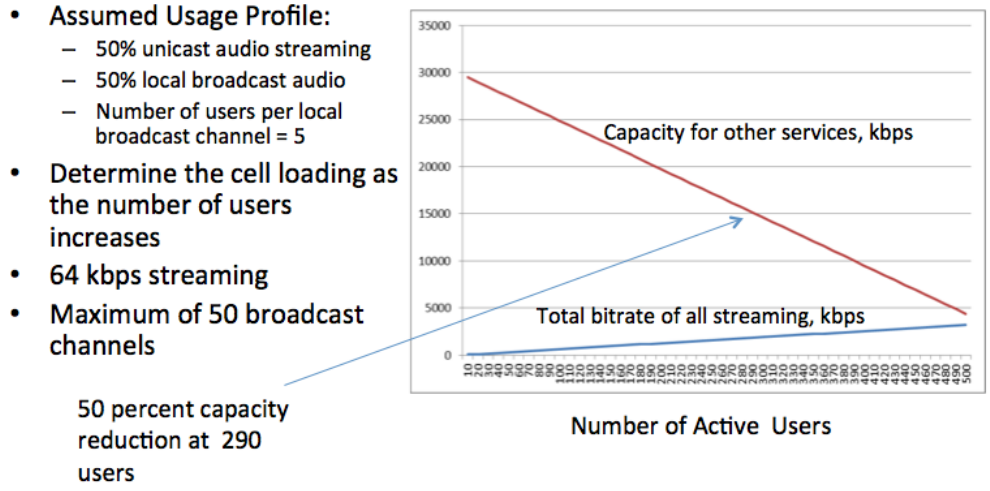

Figure 6.4 – Mix of Local Radio and Random where LTE broadcast is deployed

What this shows is that the mobile capacity is quickly degraded by the random content listeners.

LTE broadcast can only make a significant difference in effective capacity where the majority of the streamed traffic can be directed to the LTE broadcast.

The analysis shows that the deployment of LTE Broadcast within an LTE Coverage Region, in this case Albury, requires a balance dependent on the number of broadcast channels to accommodate local radio and will require significant investment by the MNO both in new sites and some radio resource under some business arrangement with the regional broadcaster. However, if more than 50% of the audio content is random then the mobile network will be degraded! Of particular note is the reduction of the effective coverage area (ie edge cells) with deployment of LTE broadcast. A further cell sites (approx. 3 sites) would be required to maintain adequate coverage of the Albury town area.

In summary, the decision to deploy LTE Broadcast will be decided by MNO's based on a business case where as the overseas studies indicate would expect content owners (ie broadcasters) to pay to use the regional mobile network operator to carry their content in the 'fast lane' so to speak. Broadcasters would need to compare this potential payment to MNOs as an alternative to providing digital broadcast facilities assuming spectrum was available.

Conversely if spectrum was not available to broadcasters to meet regional market demand with more efficient Digital Radio delivery compared to AM or FM, then regional broadcasting listeners will be further disadvantaged for choice and adequate quality.

6.5 Additional Factors

The study shows the issues for the area immediately around Albury-Wodonga. However, if we consider the Albury LAP there will also need to be coverage of the rest of the LAP there is an additional 17,000 people would then be using internet and mobile where only 3G coverage would be available and even there with variable quality.

This study for simplicity only considers 1 MNO whereas there are 3 MNOs in Australia who would each make their own decisions regarding LTE broadcast deployment dependent on their business priorities. While it could be argued multiple MNOs could spread the load it could be envisaged a particular MNO could provide LTE Broadcast (ie better performance) for a 'premium' audio broadcast and so differentiating from the other MNOs.

In general the likely business practice options for the deployment of LTE broadcast are only speculative but I would suspect regional areas are not the immediate priority for MNOs in Australia. Thus for the Australian context, the MNOs are extremely unlikely to deploy LTE broadcast as part of LTE expansion in regional areas. Audio streamed content over the mobile networks would be unicast and would lead to network congestion if Digital Radio broadcast were not an option meaning unhappy listeners AND frustrated mobile users in the area who experience unnecessary congestion especially during peak listening times.

7. BUSINESS MODEL EVOLUTION

Increasingly the business models of broadcasters and mobile operators are likely to merge and while the extent and timing of this overlap is impossible to predict, the impact can be explored.

For example a recent survey [Ref 14] with respect to video streaming indicates that consumers are increasingly prepared to pay for content on their device of choice when they want to consume. While radio broadcasting is free to air, there is evidence that some market segments are prepared to pay for content.

Increasingly mobile network operators are developing technologies and revised business models that allow them to discriminate between forms of content and manage (and charge) accordingly.

LTE Broadcast is a technology that will allow mobile operators to charge for niche content (eg a special event) to deliver to users in broadcast mode in a more reliable way. These alternative business models are illustrated [Ref 6] in Figure 7.1

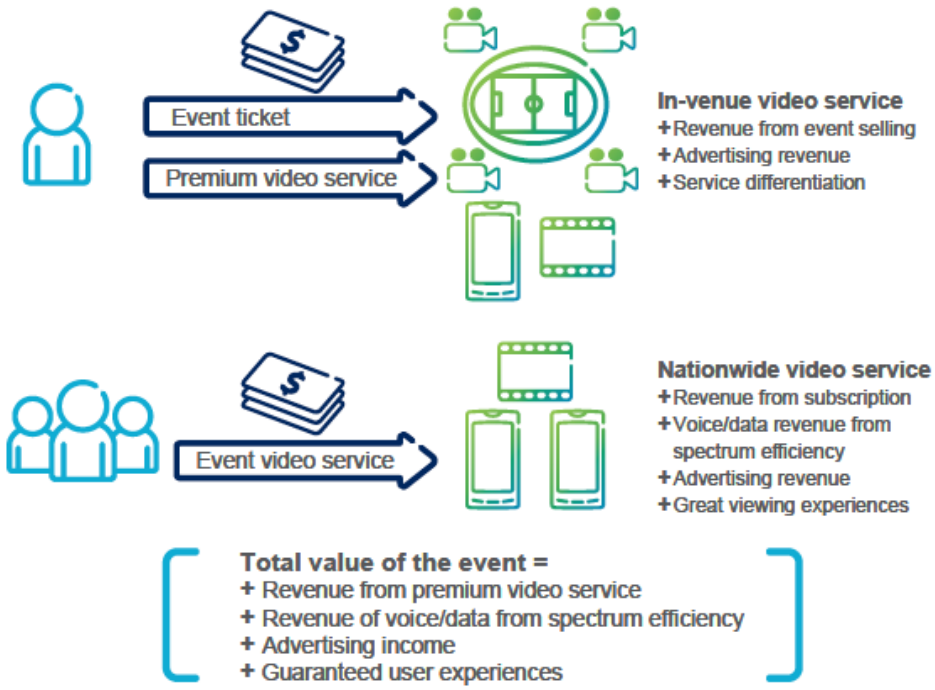

Figure 5: An example of a business case for MNOs: GBP 12 million (EUR 14 million) in revenue from a video service during the London 2012 Olympic Games.

Figure 7.1 – New Business Models for MNOs using LTE broadcast

For example, MNO's can offer 'special deals' on specific streamed content[20] as announced recently by Vodafone Australia where their customers get preferential access to music streaming from Spotify.

[20]Comms Day 14th October 2014 - "Vodafone Aust scores content coup with Spotify deal."

On the other hand, commercial broadcasters rely on advertising revenue as the basis for their business model where broadcasters pay for content and earn revenue from advertisers targeting the broadcaster's audience. Broadcasters increasingly want to allow direct interaction with their audience using direct features (eg Tagging, broadcasting live links or clicking the likes of a 'Red Button') or by social networking. This enables broadcasters to enhance the value of their content as well as provide better targeting for their advertiser clients.

The hybrid and interactive features of DAB+ provide such features using the combination of broadcast content free to listeners and interactivity through the internet, whether mobile or fixed.

8. CONCLUSIONS

Techno-economic analysis demonstrates upgraded mobile broadband communications networks cannot economically substitute for the need for DAB+ Digital Radio in Australia.

Generalising to regional Australia, mobile networks are less cost effective compared to DAB+ Digital Radio in regional areas to carry broadcast radio content as:

- only major regional centres and major highways are likely to be provided with 4G LTE with most regional coverage being met with 3G;

- the use of LTE broadcast will require further sites to provide regional coverage and is unlikely to be made available outside regional townships;

- listeners to streamed local radio on LTE broadcast would experience loss of service when moving to the more extensive LTE or 3G coverage.

Further there is considerable uncertainty as to a plausible business model to support upgrade of metropolitan and regional networks from 3G to the most advanced form of 4G LTE Broadcast to cope with streaming all terrestrial radio.

This is exacerbated by the fact that listeners would likely have to pay for radio services they currently get for free.

The market adoption of DAB+ Digital Radio while currently restricted in use in Australia to the urban centres, has been rapid in part due to the increasing provision of DAB+ in new cars.

Over the same period, mobile broadband coverage in Australia has not been constrained to urban markets as has Digital Radio and yet in spite of this advantage has not met the pent up demand for broadcast radio.

It is an irony that the regions that have the most to gain from Digital Radio are being currently denied service.

The report demonstrates that mobile broadband networks generally, and in regional areas particularly, cannot substitute as an alternative platform for broadcast radio delivery by broadcasters.

The deployment of LTE broadcast by the MNOs in regional areas is unlikely because of the less effective use of bandwidth in the regional mobile networks and it will be extremely unlikely to provide adequate listening experience for regional audiences.

A more spectrum efficient and cost effective approach for digital radio is to extend DAB+ Digital Radio spectrum allocations to regional Australia..

Again while not able to foretell the future, innovative hybrid solutions of both Internet Radio and broadcast Digital Radio now available are consistent with a future increasing innovation to meet a greater diversity of desires of users who are rightly determined to be ignorant of these sectoral supply perspectives.

Digital content available over a diversity of digital delivery channels is powering a one device approach.

There is a need for both the broadcasting industry and telecommunications industry to be open to both technology innovation and different business models and work together for mutual business benefit and the general benefit to the whole population.

Innovative regional broadcasters are at increasing business risk if they cannot incorporate such hybrid digital solutions currently only available to metropolitan broadcasters.

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