Submission By Broadcast Australia

In Response To The

"Introduction Of Digital Radio Issues Paper" December 2004

27 April 2005

Table of Contents

Section 1 Executive Summary

Broadcast Australia (BA), Australia's leading transmission services company, welcomes the release of the Issues Paper relating to the Introduction of Digital Radio. BA has had a longstanding interest in Digital Radio Broadcasting (DRB) and believes that significant consumer and industry benefit will arise from the short-term introduction of the technology. BA appreciates the opportunity to submit its views on the key technological and regulatory issues that will need to be considered as part of this implementation process.

The Issues Paper raises a range of challenging and inter-related questions. The introduction of DRB needs to be a sensible balance between recognition of the interests of incumbent licence-holders and policy settings that ensures the Australian public receives the full benefits of DRB technology (in the form of new and enhanced services). This means that government should resist calls to impose analogue context constraints and existing structures on the "new digital world". In the long run, this will lead to a superior outcome for all stakeholders.

The key issues to be considered in formulating a DRB framework include:

- Choice of standard (and, within particular standards, the version of that standard);
- Spectrum availability (critical in Australia, due to the shortage of VHF Band III spectrum in many markets);
- Existing government policy (particularly the decision already made to impose a moratorium on new entrants for five years);
- Desirability of providing a mix of existing and new services (international and local research makes it clear that consumers expect DRB to provide 'existing services plus').

In BA's view, based on international experience it is clear that the standard best-suited to Australia is a hybrid Eureka 147 /Digital Radio Mondiale (DRM) model – Eureka has clear benefits over other standards in terms of acceptance and flexibility, whereas DRM will be necessary to provide wide area coverage in large regional/rural licence areas. Further, in view of the decision to exclude new entrants from the DRB market for an initial period, BA considers that there is a strong argument in favour of a 'full conversion' model as necessary to ensure that DRB has sufficient impetus to succeed at a consumer level.

Accepting these key propositions, BA sees the critical and more complex question to be which Eureka variant to select – the 'base' variant (MPEG 1 Layer II, as currently implemented in the UK and a number of other countries) or the substantially more spectrum-efficient 'advanced' variant (based on AAC+ encoding). BA's approach in this response has been to set out the advantages and disadvantages of each variant and the practical and regulatory consequences of each.

The key issues relating to the adoption of Eureka 147 MPEG 1 Layer II can be summarised as follows:

- The standard is mature and is the basis of DRB in the UK and many other leading DRB nations around the world. The range of transmission and consumer reception equipment is substantial and, in this sense, it is a 'safe' choice. Conversely, it could be argued that for Australia to adopt this base

variant would be to select an 'old' technology that does not allow for significant Eureka enhancements that have evolved over the last 10 years;

- Deploying this standard and allocating a minimum of 224 kilobits per second ('kbps') (at UEP Level 3) will mean that there is insufficient VHF Band III spectrum for all primary national and commercial broadcast services in key metropolitan markets;

- While both the 'base' and 'advanced' Eureka variant will require utilisation of L-Band for infill enhancement of VHF primary services (and, indeed, L-Band primary services in adjacent markets), allocation of 224 kbps per incumbent service using MPEG 1 Layer II will mean at least some primary services having to utilise L- Band. This in turn has two significant consequences:

    - It gives rise to a 'picking winners' process in the Sydney and Melbourne markets under which most incumbent broadcasters can convert to VHF primary services, but some must use L-band for their primary services;
    - Using L-Band for the transmission of primary services will involve higher capital deployment and operational costs for affected broadcasters vis a vis those with a VHF allocation. (Presumably on this basis there would be a strong argument for national broadcasters to take precedence over commercial broadcasters in relation to VHF spectrum);

- At 224 kbps per broadcaster, there is some scope for the introduction of new services but probably less so for music-based stations. There is very little scope for introduction of new services at individual broadcaster bit rate allocations of 128 kbps, albeit that this would enable all incumbent national and commercial services to be converted using VHF spectrum.

In contrast, BA sees the following issues and opportunities associated with Australia opting for the 'advanced' Eureka AAC+ model:

- AAC+ is rapidly emerging as the accepted way forward for Eureka and is already incorporated in a range of other consumer electronics platforms. It seems highly likely that AAC+ will be incorporated within the Eureka standard in the near-term. Korea has already embraced AAC+ (albeit in the form of Digital Multimedia Broadcasting, DMB, as opposed to DRB). It is not expected that AAC+ will add significant cost to receivers and that, by the time Australian DRB services are actually ready to roll-out (say, 2007), there will be a significant range and number of AAC+ capable receivers in the international marketplace;

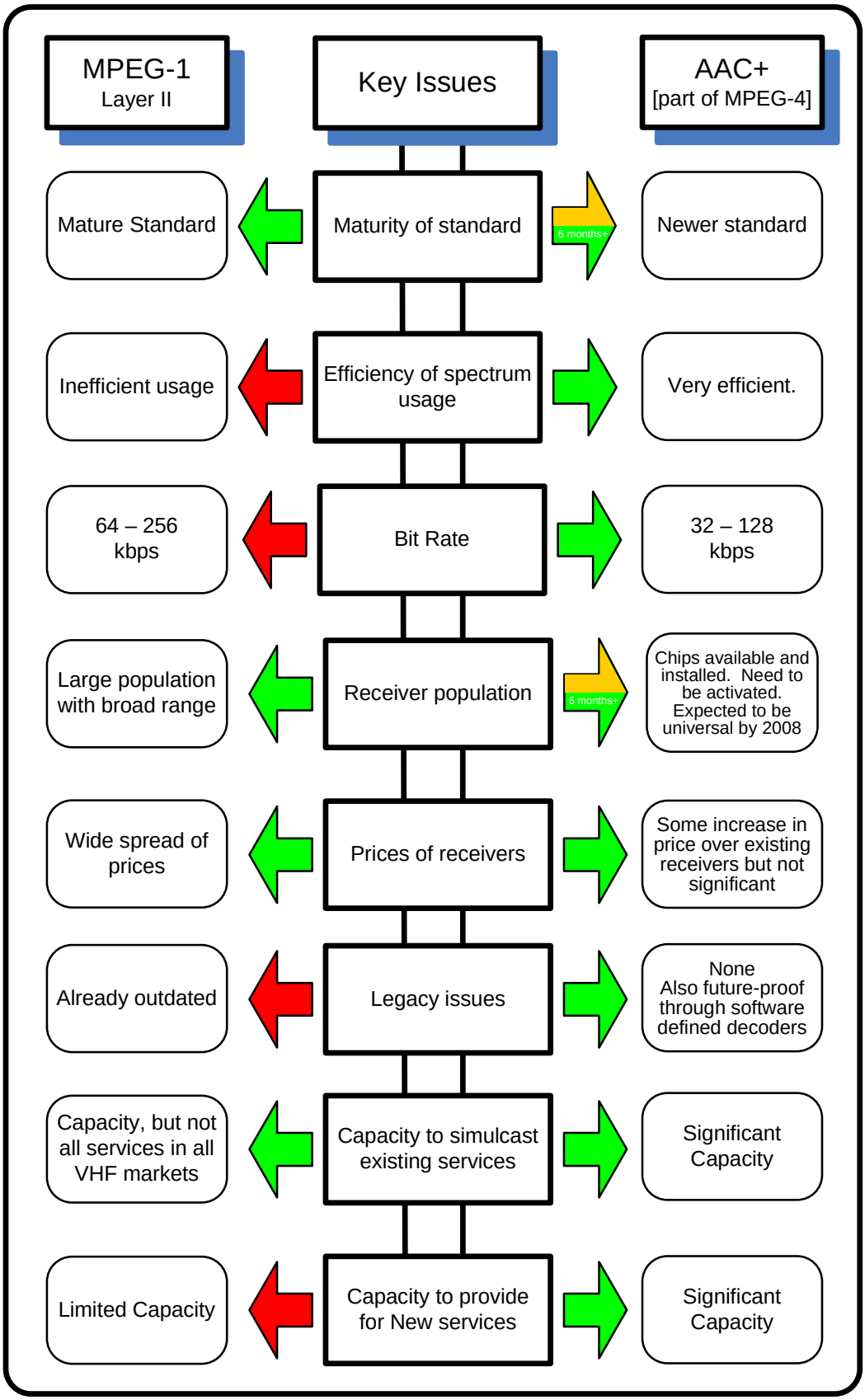
- The great benefit of Eureka 147 AAC+ is that it enables substantially greater spectrum efficiency relative to MPEG 1 Layer II. In short, AAC+ is at least twice as efficient as the base variant, such that a broadcaster bit rate allocation of 128 kbps using AAC+ encoding provides capacity for at least as many equivalent quality services as 224 kbps using MPEG 1 Layer II;

- The AAC+ option would overcome some of the significant and unattractive regulatory problems that would arise under an MPEG 1 Layer II option, namely:

- With a bit rate allocation per national and commercial incumbent broadcaster of 128 kbps, all of these broadcasters' primary services could be accommodated on VHF in the most congested metropolitan markets (although L-Band would still be required for infill). This would avoid the 'picking winners' issue as well as the additional cost impost that would arise for those broadcasters required to provide an L-Band primary service. A significant number of new entrants (post moratorium) and/or community and high-power open narrowcasters could also be accommodated on VHF on an equitable basis;
- This 128 kbps bit rate allocation provides broadcasters with the flexibility to provide both their existing (analogue) services as well as new services.

Diagram 1 seeks to illustrate the key matters government may wish to consider when determining which Eureka variant to select as the appropriate "standard" for Australia.

Diagram 1: Key Issues Associated with Choice of Standard



Whichever Eureka variant is selected, BA believes that the following key positions should be adopted in the regulatory framework that provides for the introduction of DRB:

- Full conversion of incumbent broadcasters (as noted above, but with the likelihood that community broadcasters and high-power open narrowcasters will only commence in digital at some point in the future). Each broadcaster would be allocated a guaranteed bit-rate (ie guaranteed access to spectrum) on a free-of-charge basis for an initial period;

- While simulcasting of analogue programming is highly likely to be an important success factor for DRB take-up, it is probably not necessary to mandate this in legislation;

- Provision of new services is equally likely to be an important contributor to the success of DRB. Given the moratorium that will apply to potential new entrants for at least five years, it is fair and reasonable that strong incentives exist for incumbent broadcasters (national and commercial) to provide new and innovative DRB-only content. BA has a serious concern that a simulcast-only DRB service will fail to convince Australian consumers to adopt the new technology;

- Cross-promotion and consumer education by incumbent broadcasters should be a requirement of all DRB licences;

- No artificial constraints on the quantity of "value add" non-audio services eg data, images etc to be provided by broadcasters as part of their DRB service offerings;

- For the term of the moratorium, the provision of non-audio 'datacasting' services on spectrum not allocated to incumbents should be allowed to provide an additional source of innovative content for consumers;

- The regulatory framework ought to look forward to post-moratorium spectrum allocation. This should include a limitation of the moratorium to five years only and a licence allocation process based on a revenue-based licence fee model;

- The Eureka standard, involving the transmission of multiple programmes within a single channel, provides for the emergence of a multiplex operator in the DRB supply chain. The licensing regime, therefore, ought to be based on the separation of carriage and content, that permits spectrum "ensembles" to be owned and/or managed by multiplex operators, broadcasters individually or in consortia, or independent third parties. In the context of the moratorium, it is envisaged that ensembles will be owned by broadcaster consortia with individual broadcasters entitled to a specific bit-rate allocation (and potentially datacasters) but may be managed and operated on their behalf by a third party multiplex manager;

- Given the difficulty, particularly in regional areas, of overlaying analogue radio and DRB licence areas, there is likely to be aggregation required in at least some areas. These instances, and the most effective options of dealing with them, are likely to become clear following detailed planning. Solutions should

be formulated on a case-by-case basis by the ABA and in consultation with affected broadcasters.

Section 2 Introduction

2.1. Background

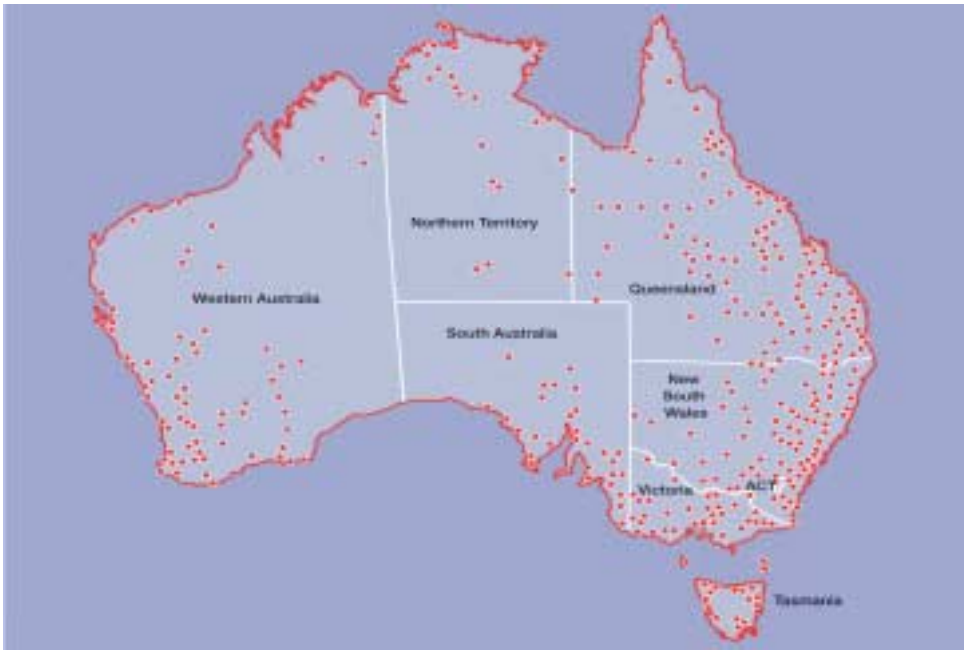
Broadcast Australia (BA) is Australia's leading broadcast transmission provider. BA's core business is the provision of services for the transmission of television and radio broadcasts to audiences across Australia. BA has over 70 years broadcast transmission experience, covering both analogue and digital broadcasting services and aims to provide world class broadcasting solutions to its customers, both now and in the future.

BA was created from the Commonwealth Government's sale of the 'National Transmission Network' in 1999. BA was originally acquired by UK cable and broadcast transmission company, NTL, in April 1999. ntl Australia, was then acquired by Macquarie Communications Infrastructure Group (MCIG) in April 2002. BA is a wholly-owned business of MCIG, an entity that listed on the Australian Stock Exchange (ASX code: MCG) in August 2002 and itself owned by a broad range of institutional and retail investors.

In December 2004, MCIG announced that it had acquired a 54% interest in ntl Broadcast in the UK. ntl Broadcast is the minority shareholder (GWR is the major shareholder) in Digital One, the UK's commercial digital radio multiplex with a licence to broadcast nationally.

2.2 The BA National Network

BA owns and operates the most extensive broadcast transmission infrastructure network in Australia. It provides transmission services from approximately 600 strategically located transmission sites across metropolitan, regional and rural Australia and reaches over 99% of the country's population.



BA's national network is controlled and monitored from a state-of-the-art Network Operations Centre in Sydney. The centre provides 24x7 real-time visibility of the performance of our customers' services.

2.3. BA's Customers and Key Services

BA delivers the national television and radio services of its principal customers are ABC and SBS. The company also provides services and/or co-hosting for commercial broadcasters, the community broadcasting sector, telecommunications companies and radiocommunications users (such as emergency services).

BA's key areas of activity include:

- Analogue Television. Delivery of ABC and SBS television services across Australia, including the significant expansion of SBS television to population areas of 5,000 in 2000 and 2001. BA also serves community television providers.

- Analogue Radio. Transmission for all ABC radio services including Local Radio, Radio National, Classic FM, JJJ and News Radio in Australia, as well as the short-wave Radio Australia service into South-East Asia. For SBS, BA delivers three multicultural and multilingual national networks, and also provides transmission services to a number of commercial and community radio broadcasters in various parts of Australia.

BA is also instrumental in rolling out digital television throughout Australia. BA has been contracted by the ABC to undertake a national roll-out of ABC digital television services which now reach 99% of the population and the staged roll-out of over 107 SBS digital television services since 2001.

2.4. New Digital Services

BA is a strong advocate of the potential benefits offered by digital services and has already made substantial investments in Digital Television to support ABC and SBS service establishment. BA established a Digital Radio Broadcasting (DRB) Trial in Melbourne from its Mt Dandenong site launched November 2003 in association with national, community and commercial broadcasters. Under the trial arrangements, BA provides the digital transmission infrastructure, including encoding and multiplexing, while content/data/video is being provided by its content providers: the Australian Broadcasting Corporation (ABC), the Special Broadcasting Service (SBS), WorldAudio, Sport 927, the Community Broadcasting Association of Australia (CBAA) utilising the Eureka 147 system.

Based on its deep understanding of international developments in digital broadcasting, BA has consistently held the view that digital technology offers the potential for:

- governments to utilise available spectrum more efficiently;
- to provide the Australian consumer the potential for greater choice, better and innovative new services;
- to allow for new services and for the entry into the market of new service providers.

BA is committed to the full exploration of the possibilities of digital technology and is vitally interested in the public policy framework within which these services can be established.

Section 3 Key Principles

In BA's view, DRB is a "once-in-a-generation" development in the evolution of radio services and will offer consumers a range of additional benefits and services not available in analogue.

The key issue to be addressed by Australia's policy makers is to ensure that the policy framework and implementation model maximises actual realisation and delivery of the potential benefits from this "new" technology.

Experience in other international markets is indicating that consumers are embracing the availability of additional audio services, new data services and higher audio and reception quality (particularly relative to AM analogue services) that can be provided in digital mode. With substantial growth in services and receivers in the United Kingdom and elsewhere in Europe (indeed, in the UK, the leading electronics retailer, Dixons, reports that sales of digital radios outstrips the demand for traditional sets) BA believes that the next 12 month period represents the appropriate juncture for Australia to adopt and begun to implement this new technology.

BA has a serious concern that if Australia does not move to introduce DRB in the short-to medium-term, radio's position as a primary media source will erode in favour of new converged technologies. These include 3rd generation mobile (3G), handheld digital broadcasting devices (DVB-H), iPod and radio via subscription television etc. DRB can, therefore, properly be seen as a technological advance that will assist the industry (national, commercial and other broadcasters) secure its future in an era where consumer expectations are rapidly changing in relation to services on mobile devices (i.e. more than simply audio) and the functionality of these devices. Commercial and listener loyalty benefits will result as market research both in Australia and overseas confirms that listening time increases with the introduction of digital radio.

BA welcomes the decision by the Government to plan for the introduction of DRB in Australia. We also acknowledge the policy decision taken by the Government in relation to a moratorium on new DRB entrants for five years following the determination of the model for the introduction of DRB services. This decision has considerable ramifications for the key elements of the regulatory model for the introduction of DRB. With this in mind, we believe that the DRB introduction model should be based on the following principles:

a. We strongly believe Australia should take advantage of lessons that can be drawn from experiences in countries who have already introduced the technology (e.g. UK, and countries in Europe and Asia) and take advantage of any technological developments since. Our view is that Australia can and should take advantage of new encoding and compression technologies, audio quality enhancements and receiver technology which allows some of the thorny issues of scarce VHF spectrum to be addressed. Australia should seriously consider adopting Eureka 147 AAC+ as its standard;

b. DRB policy must ensure a viable model for the emergence of quality digital radio services in regional and rural Australia. Widespread rollout of DRB services in metropolitan, regional and rural markets is in the public interest given the benefits relating to audio quality, enhanced services and spectrum efficiency offered by the technology;

c. Key policy parameters should, as canvassed in the Issues Paper, take account of lessons learnt from Australian DRB trials in Sydney and Melbourne. The market research and technical trials conducted by these trialists is of particular relevance;

d. The parameters for the introduction of DRB should be a sensible balance between:

    i. A full recognition of the interests of, and investments made by, incumbent national, commercial and community radio broadcasters and narrowcasters; and
    ii. Ensuring that the benefits of digital technology in the form of new and enhanced services can be delivered to the Australian public without being constrained or impeded by simply replicating the analogue context and structure on digital services;

e. The regulatory model for the introduction of DRB, while accommodating the five year moratorium on new entrants, should also anticipate the end of the moratorium and the potential for services to be provided by new entrants at that time. BA proposes that the model from the outset provides that both incumbent broadcasters (either individually or in consortium), as well as third parties, can hold spectrum and act as multiplex manager. This would provide a model that on expiry of the moratorium would facilitate the emergence of new entrants by incentivising the multiplex manager to become the catalyst for the introduction of innovative new services at that time;

f. Simulcasting of analogue services in digital is likely to be an essential requirement for the successful introduction of DRB in Australia. Overseas research indicates that listeners wish to obtain their 'normal' suite of services as well as new services on the digital medium;

g. The policy framework needs to be designed to encourage the introduction of innovative new services – by incumbents and 'datacasters' (i.e. data-only service providers) from the outset and during the five year moratorium period or by incumbents and new entrants at the end of the five-year moratorium. Incentives may be appropriate to encourage the development and provision of new, innovative services. The international experience (confirmed by local research as part of the Melbourne DRB trial, led by BA) is clear in showing the importance of new services as a key motivation for consumers to purchase DRB receivers following the deployment of digital services;

h. The need to broadcast analogue services (i.e. simulcast) and new services in combination to drive the successful introduction of digital radio means that to the extent possible it is desirable that broadcasters be provided with sufficient spectrum to enable them to achieve both whilst ensuring there is adequate spectrum "reserved" for new entrants following the moratorium.

i. The national broadcasters, the ABC and SBS, should and must play an upfront and vital role in the introduction of DRB in Australia. National broadcasters have played a central role in encouraging DRB take-up in other nations (particularly the UK). The ABC and SBS have already

demonstrated a strong commitment to the new medium and, significantly, already have new content (eg dig, dig JAZZ and dig COUNTRY which are currently broadcast via the web) and innovative services that are likely to be attractive to consumers. National broadcaster radio services in Australia are at least as important to consumers as national broadcaster television services and, arguably, even more highly valued outside Australia's capital cities where there are less commercial radio services;

j. The DRB introduction model will need to utilise both VHF and L-Band spectrum to ensure that spectrum is available for all incumbents (including L-Band for in-fill services in large built-up areas, particularly in Australia's capital cities). The allocation of major portions of Band III spectrum to digital television means that remaining Band III spectrum is limited, in most cases to the 6MHz channel 9A block. The Sydney and Melbourne trials have demonstrated that, with good technical planning, DRB can be operated in spectrum shared with analogue and digital television services.

k. Australia should pursue a 'full conversion' model for the introduction of DRB, as opposed to the other options outlined in the Issues Paper. In the context of the five year moratorium decision, BA has a strong concern that anything other than a conversion model presents the real risk that DRB will lack the momentum to succeed and will fail. A full conversion model requires an early rollout of DRB services in metropolitan and major regional centres (say, 2007/2008) and over a longer but defined period in regional/rural Australia with analogue switch-off to occur once consumer adoption has reached an acceptable percentage of the population.

l. With Eureka AAC+ all primary broadcasters can be allocated VHF spectrum within Ch9A in each market. Careful consideration of the appropriate spectrum to allocate to community and HPON broadcasters is required by the government with our preference being either a lower bit-rate allocation in VHF or an L-Band allocation.

m. Allocated spectrum to include a "use it or lose it" provision associated with new services. Each broadcaster should have a requirement to achieve same coverage of their existing service in each market as their analogue services within a given time period say 2 years and a **phased obligation** to provide new services within 5 years. This obligation could be phased in with the percentage of simulcast product or time - shifted product counting towards the new services quota to progressively reduce during an appropriate transition period.. This would ensure that the spectrum which has been provided to broadcasters exclusively for a period of 5 years is used productively with one of the key drivers for take up in place. Should a broadcaster fail to either provide same coverage or new services within this time period, then the "use it or lose it" rule should be applied and a percentage of the bit-rate allocation be relinquished and reserved for use by other users.

n. Digital Radio Mondiale (DRM) be used to provide wide area local services in rural Australia by those broadcasters for whom it would be a viable option (e.g. ABC) given that Eureka 147 VHF and/or L-Band services will be unable to replicate wide area AM coverage. DRM might also be used by regional broadcasters in areas with difficult topography where VHF and L-Band coverage would be limited, or be significantly more costly.

Section 4 Threshold Issues for Digital Radio (Part A of Issues Paper)

4.1. Digital Radio Platforms

Eureka 147 is now a mature technology having been in operation in Europe and the UK since the mid 1990's. Eureka 147 is the only mature standard which offers a relatively risk-free environment for the introduction of digital transmissions. Alternatives such as IBOC have yet to gain widespread acceptance and do not offer the significant benefits of Eureka 147.

Eureka, in its basic form (known as 'MPEG 1 - Layer II', the version implemented in the UK, for example) provides spectrum efficiency through the multi-channelling of services and the potential for the introduction of new services including the transmission of data and limited multimedia. Eureka has also evolved considerably over the last decade and new Eureka variants now incorporating advanced compression technology and the incorporation of improved audio coding (known as 'AAC' and 'AAC+') have been developed[1]. These advances enable substantially more spectrum efficient delivery of content and highly-developed multimedia services.

The introduction of Digital Multimedia Broadcasting (DMB) in Korea is a particular example of the introduction of a more advanced Eureka variant. WorldDAB has adopted DMB with some changes and supports its ratification by the European Technical Standard Institute (ETSI) giving the option to use either of two advanced encoding standards AAC+ or BSAC; ETSI approval is expected during 2Q2005. It is our understanding that BSAC will be used in Korea only and AAC+ elsewhere. The DMB standard in effect "cherry picks" the best of the Eureka 147 standard – the robustness of the radio frequency transmission component in a portable/mobile environment - whilst providing more efficient encoding standards for both audio (AAC+ and BSAC) and advanced video compression (MPEG-4/H.264).

In contrast to Eureka, the USA's IBOC standard utilises existing channels, simulcasting the analogue and digital services but only provides for limited data and does not support video. IBOC does not in itself encourage the introduction of new services as it is fundamentally a simulcast model. The digital information is carried in additional sidebands to the analogue signals, so increasing the bandwidth of the analogue-only transmission. Furthermore, the application of IBOC in the MF band is based on a 10kHz channel system (unlike the 9kHz channel plans adopted in Australia and Europe); no IBOC system has been developed based on 9kHz channel spacing, and recent inquiries indicated that there are no current plans to develop such a system. Compared with Eureka, IBOC offers very limited capacity for data or service enhancements; additionally, our web-based research indicates that IBOC receivers in the US are expensive and of limited manufacture compared with the variety and pricing of DRB receivers in the UK and European markets.

In BA's view, the best path for Australia to take is to utilise the base Eureka standard and, to the extent practicable, incorporate enhancements to the standard which provide better quality sound and/or greater spectrum efficiency through advanced compression and encoding technology. The deployment of an advanced Eureka variant would substantially increase the capacity of the limited VHF spectrum currently available, (i.e. Ch9A) particularly in metropolitan markets (i.e. the ability to

[1] While WorldDAB have yet to incorporate AAC into the Eureka 147 standard, the precedent has been set by the inclusion of DMB which incorporates AAC audio coding

accommodate all national and commercial broadcasters in these markets is one of the issues that would be solved by taking this approach). The advanced Eureka standard would also provide maximum scope for the most attractive consumer value proposition – a mix of simulcast and new services. BA recognises that this approach is dependent on the availability of appropriately–priced, mass-produced receivers.

For the purposes of this paper, BA has presented two implementation options for DRB in Australia, one utilising the base version of Eureka (MPEG 1 – Layer II) and the other an advanced version of Eureka (incorporating AAC+) and analysed the benefits, costs and regulatory implications of both. This analysis can be found at Appendix 1.

While the introduction of DRB using the Eureka standard would provide a good basis for broadcasting most AM and FM services across metropolitan and regional Australia, wide area services such as those provided by the ABC in rural and remote Australia would be more suited to delivery via DRM. Based on its overview of technological developments and the market, BA makes the following observations about DRM and its potential role in Australian DRB implementation:

- DRM is primarily suited to operation in the MF and HF bands (although the specification is currently being expanded to incorporate frequencies upwards of 120MHz, this expanded specification is still very much in its infancy, having only been announced in March 2005). At MF, DRM adopts all the advantages of the propagation characteristics at these low frequencies (e.g. range extends over-the-horizon, less affected by screening effects) whilst overcoming the impacts of noise and distortion on the signal path;
- In terms of comparison, DRM quality comes close to that of a good FM signal.
- Although DRM can in theory be operated in an IBOC mode, its capabilities in this mode are limited and largely untested in practice;
- It is expected that DRM will operate in a stand-alone digital mode, requiring an additional MF frequency during the simulcast period. DRM also has the capacity for some data applications;
- Currently, DRM is being increasingly used for transmission in Europe, albeit still small in number, and mostly for international broadcasting (as an aside, it is worth noting BA is currently installing DRM capable transmission equipment at the Brandon HF site for Radio Australia);
- DRM use will increase significantly in the near future, with plans by RTL[2] to relaunch its international services into France, Germany and the UK using DRM;
- DRB receivers capable of receiving DRM and Eureka (VHF and L-Band) will come to the market later in 2005 and early 2006 and, therefore, should be available within key timeframes for Australia given that the actual rollout of DRB in regional Australia will not commence for at least 2 years. RTL is currently working closely with UK company Radioscape to develop receiver product in readiness for the commencement of their targeted international broadcasts into France, Germany and the UK (see above) and this is expected to have a significant impact;

[2] RTL Group is Europe's largest TV, radio and production company. The Luxembourg-based media group operates TV channels and radio stations in Germany, France, Belgium, the Netherlands, UK, Luxembourg, Spain and Hungary. RTL Group is a pioneer in European radio - in 1933, Radio Luxembourg was one of the first free private radios to be launched in Europe and was broadcast for several decades. Refer www.rtlgroup.com for more information.

- Radioscape have already announced plans to launch a DRM/DRB/FM/AM receiver in late 2005; a range of DRM capable products is expected to be on sale in the UK by Christmas 2005;
- The European industry view is that DRM take-up will be faster than has been the case for Eureka for reasons of lower price point and the diversity of product – both factors deriving from the greater abundance of modules, multi-mode chip sets with software defined capabilities;

4.2 Model for Implementation of DRB

The Issues Paper outlines three potential models for the introduction of DRB – Full Conversion, a Market-based Approach and Managed Introduction. BA believes there are a number of interconnected issues which must be considered when determining the most appropriate model for Australia. These include:

a. Essential role of **new and existing (simulcast)** services in promoting take-up of DRB

Market research undertaken by BA as part of our Melbourne DRB trial confirms worldwide experience that take-up of DRB is dependent on the provision of improved sound quality and **new** radio services. BA believes that any model introduced by government **must** include the delivery of new services to the public in the short-term. Experience from the introduction of digital television in Australia suggests that unless the provision of new services is either mandated or "encouraged" through the provision of sufficient bandwidth and clear incentives, then take-up of DRB will be slow.

Equally, it is clear from research in the world's most advanced DRB market, the UK, that consumers expect, as a baseline, the availability in digital mode of those services already provided in analogue. In other words, consumers seem to have the expectation that DRB will be an 'existing services plus' model.

The UK DRB model incorporates the conversion of incumbents and the delivery of services already available on analogue, new digital-only audio services and data services. This model has proved very successful over the last two to three years in particular, having been constrained initially by the embryonic state of the industry and lack of receiver availability at affordable prices, given that the UK was one of the first countries to introduce DRB. The UK experience and that of other leading DRB markets is overviewed in more detail in Appendix 2. Significantly, Australia now has the benefit of a well-established international receiver industry (including the entry of top-tier global electronics manufacturers into the DRB market) and significant overseas experience.

b. Spectrum availability

Ultimately there will be the opportunity to reclaim the VHF Band III spectrum (174 – 230MHz) allocated primarily for analogue television broadcasting purposes. Eureka (and its variants) as 'new spectrum' systems (i.e. require new spectrum allocations vs IBOC which uses existing spectrum) may be able to take advantage of this spectrum in the future.

One of the key difficulties facing the introduction of DRB into Australia (particularly in the major capital cities Sydney and Melbourne) is the scarcity of available VHF spectrum. VHF spectrum is prized because of its superior propagation

characteristics when compared with L-Band and hence is more suitable (and cost effective) for mobile DRB services.

While the Eureka standard accommodates the use of VHF or L-Band spectrum, spare VHF spectrum has been almost fully utilised in Australia, with the rollout of digital television services. This is particularly the case in the largest metropolitan markets of Sydney and Melbourne. The only VHF channel available in these key markets is Ch9A which is a 6 MHz rather than a standard 7 MHz television channel, thereby restricting its capacity (i.e. the number of potentially available DRB 'ensembles' is 3, or a total 3.45 Mbps of effective capacity – using error protection level 3 (UEP3). This has the effect of limiting the number of DRB services which can be accommodated on VHF in these particular markets (refer Table 1 below in relation to the Sydney market), the number of actual services being dependent on the bit-rate allocation per broadcasting service. This capacity could be increased by one full ensemble (i.e. increase capacity from 3 to 4 ensembles) with the relocation of Ch10 "up the band" by 1MHz to the 'new' allocation of 209-216MHz, although this would obviously require the agreement of Ch10 and implementation would entail significant practical steps.

Furthermore, even for those DRB services that are provided over VHF spectrum, BA's technical view is that 'infill' (i.e. to cover gaps in VHF propagation in particular areas) will need to be provided utilising L-Band spectrum in virtually all markets, at least until the switch off of analogue television when further VHF channels would become available. In other words, the 'primary' DRB service for a particular radio station may be provided using VHF but this will need to be complemented by L-Band infill services in the same market to cover those areas which do not receive satisfactory service quality from the VHF transmitter. The requirement for L-Band in-fill is dependent on topography and building density and will differ between markets. While relatively more VHF spectrum may be available in some parts of regional Australia (i.e. a full 7MHz channel as opposed to a 6 MHz channel in the metropolitan markets), its use may be constrained by the potential for interference to adjacent markets.

Significantly, even where VHF spectrum can be used to deliver DRB services in a particular market this will have the knock-on effect of excluding the use of VHF in neighbouring markets, forcing primary DRB services onto L-Band in those adjacent areas (e.g. NSW Central Coast will use L-Band where the adjacent Sydney primary transmissions are in VHF). There are also further restrictions on the use of VHF spectrum in order to protect existing analogue television services from interference – refer Section 4.4.

L-Band spectrum is relatively more plentiful throughout Australia. The use of L-Band for DRB in Australia was foreshadowed in 1992 when the World Administrative Radio Conference (WARC-92) made allocations for terrestrial and satellite digital radio in that band. In the interim, some temporary assignments have been made for point-to-point services and would require clearing should L-Band be required for the introduction of DRB in Australia. L-Band is suitable spectrum for the introduction of DRB in Australia as it is available in sufficient quantities to satisfy expected demand.

However, it is important to recognise that digital radio, because it is a mobile service and is being delivered at a higher frequency (particularly compared with existing AM services using MF spectrum, together with the need for L-Band infill transmissions), will require more transmission sites to obtain 'equal coverage' than are currently used to deliver analogue services. This increase in transmission sites will be further exacerbated in areas where L-Band spectrum is used as the primary service medium

instead of using the lower frequency band VHF (where spectrum is available), making an L-Band solution more expensive to deploy.

c. Government policy: five year moratorium

BA believes that the Government's policy commitment to impose a five year moratorium on the entry of new DRB service providers is also a significant determinant of the most appropriate model for the introduction of DRB in Australia. The implications of this decision are that the primary consumer value proposition for DRB, for at least five years, will have to be provided by incumbent operators (national and commercial), rather than from any new DRB-only audio service provider. There is substantial political and public interest in a successful introduction and adoption of DRB in Australia which leads us to conclude that there is a very strong case for an objective of full conversion of mainstream operators from day one (i.e. national and commercial broadcasters). The case for full conversion is reinforced by the fact that national and commercial radio broadcasters all now seem to possess a high level of commitment to DRB.

As noted elsewhere it is our belief that the 5 year moratorium places responsibilities on incumbent broadcasters to do the "right" things to achieve a successful introduction of DRB. In our view appropriate obligations and incentives are needed to ensure the rollout within defined timeframes to specific markets is achieved and that analogue simulcast and new services are delivered in digital mode within specified timeframes.

It is difficult to see how a market-based approach would work in the context of the moratorium decision (eg it is not clear how the government would create market tension in any spectrum auction process in the next five years). In relation to a managed approach, BA has a serious concern that a voluntary, 'opt in' model for incumbents-only may well result in a DRB consumer offering that is incomplete, patchy and lead to very low uptake of DRB receivers.

4.3. Options for Implementation of a Full Conversion Model

This model would result in the conversion over time of **all** incumbent radio broadcasters from analogue to digital transmissions with the eventual switch-off of analogue services (as in other international markets, there is no need for Australia to specify a date for switch-off in legislation but provide an ability to review the position in the future). Inherent in the model is the likely simulcast of existing services in analogue and DRB. This will result in the conversion of commercial and national broadcasters, community and high power open narrowcasters (the latter two classes probably commencing some years after the primary commercial and national broadcast services).

The amount of spectrum required to effect this conversion will depend on the bit-rate/CU allocation to each broadcaster. (NOTE: The precise allocation of capacity between services in a DRB multiplex is most precisely calculated in 'capacity units', or CUs, rather than the more simplistic allocation by kbps but the latter is adopted for the ease of reference in this submission).

Table 2 below sets out the potential spectrum requirement for the Sydney market which, together with Melbourne, faces the greatest demands for VHF spectrum from primary broadcast services compared with other metropolitan (and regional) markets.

Table 2a: Conversion of National and Commercial Broadcasters in Sydney Metropolitan Market using Ch9A (3.45 Mbps Useable Capacity)

	No. of Services	MPEG 1 – Layer 2 224kbps allocation per service**		AAC+ 128kbps allocation per service**	
		Required Channel Capacity (Mbps)	Cumulative Totals (Mbps)	Required Channel Capacity	Cumulative Totals (Mbps)
Commercial	11	2.464	2.464 (needs 2.14 muxes)	1.408	1.408 (needs 1.224 muxes)
ABC	5	1.120	3.584 (needs 3.12 muxes)	0.640	2.048 (needs 1.78 muxes)
SBS	2	0.448	4.032 (needs 3.5 muxes)	0.256	2.304 (needs 2 muxes)
SUB TOTAL	**18**	**4.032**		**2.304**	

Table 2b: Conversion of HPON and Community Broadcasters in Sydney Metropolitan Market

	No. of Services	MPEG 1 – Layer 2 128kbps allocation per service**		AAC+ 64kbps allocation per service**	
		Required Channel Capacity (Mbps)	Cumulative Totals (Mbps)	Required Channel Capacity	Cumulative Totals (Mbps)
Community*	15	1.920	1.920 (needs 1.67 muxes)	0.960	0.960 (needs 0.83 muxes)
Special Interest Licences	9	1.152	3.072 (needs 2.67 muxes)	0.576	1.536 (needs 1.34 muxes)
SUBTOTAL	**24**	**3.072**		**1.536**	

Table 2c: Conversion of All Broadcasters in Sydney Metropolitan Market – Total Picture

TOTAL ALL CATEGORIES	**42**	**7.104**	**7.104** (needs 6.18 muxes)	**3.840**	**3.840** (needs 3.34 muxes)

Table Assumptions:
*Assumes half bit-rate for Community and Special licences
^As a 6 MHZ channel, VHF channel 9A comprises three viable multiplexes or ensembles, each of 1.15Mbps useable capacity at level UEP 3 guard interval.

**Figures based on the adoption of UEP3 (Error protection level 3)

The above table demonstrates the spectrum requirements and demand for multiplexes under each of the two technologies. ie

- Using MPEG 1 Layer II at 224kbps for primary broadcast services, there is a requirement for 3.5 multiplexes to convert to digital radio. When HPONS and community broadcasters are included (using a bit-rate of 128kbps) this requirement increases to 6.18 multiplexes;
- Using AAC+ at 128kbps for primary broadcast services, there is a requirement for 2.3 multiplexes to convert to digital radio. When HPONS and community broadcasters are included (at a bit-rate of 64kbps) this requirement increases to 3.34 multiplexes.

It should be noted that use of VHF Band III Ch9A as currently situated (with a 6Hz rather than 7MHz channel bandwidth) has capacity for only 3 multiplexes However, 4 multiplexes can be achieved if the Ch9A bandwidth could be increased to 7MHz.

The adoption of a full conversion model could be achieved a number of ways:

a. Use of L-Band only

As indicated above, there is sufficient spectrum to convert all incumbents to DRB using L-Band. Such a conversion would allow orderly conversion without any of the potential difficulties associated with "picking winners" (i.e. selecting those who will be primarily accommodated on VHF and those on L-Band) in an MPEG 1 Layer II environment. It would also overcome the need for dual-band receivers and adjacent VHF channel interference.

Reception testing has indicated that in-building coverage by L-Band can be accommodated by the use of higher-power transmitters (further information in Appendix 3.) However, the exclusive use of L-Band will result in additional expense for broadcasters given the more limited reach of transmissions at 1.5 GHz. Testing of coverage from BA's Melbourne trial and subsequent modelling indicate that up to 50% more sites will be required in an **all** L-Band solution (compared to the use of VHF sites for primary services, plus L-Band gap-fillers) to ensure adequate in-building and mobile coverage.

b. Use of VHF and L-Band for Primary Services (Hybrid Model)

The use of both VHF and L-Band spectrum for primary services is another option for government. As stated previously, use of VHF for primary services will inevitably require L-Band infill in many markets (particularly capital cities). In a Hybrid Model, L-Band could also be used for primary services as well as infill in those areas with more broadcasters than VHF capacity. Any model utilising VHF spectrum will raise the issue of which broadcasters are allocated what is considered the "prime" VHF spectrum for primary services and which broadcasters will be required to utilise L-Band (unless the Eureka AAC+ variant is adopted which enables (in our view at least) twice the number of services to be carried in the available VHF bandwidth).

The capacity of the ensembles in Ch9A, and hence the number of services which can be accommodated, will depend on a number of factors - most importantly, the bit-rate allocated per service, band allocation decisions for HPONs and community broadcasters and whether Ch10 remains at its 'old' location (i.e. 208-215MHz). For example, as per Table 1 above, a bit-rate of 128kbps using MPEG1 Layer II would

allow the transmission of a minimum of 8 primary services per VHF ensemble providing for a total of 24 conversions. Alternatively, a bit-rate per service of 224kbps would mean only 5 services per ensemble could convert (i.e. a total of 15 services).

An additional DRB ensemble could be accommodated on Ch9A should 'old' Ch10 of 208-215MHz be moved up the band by 1 MHz to the 'new' allocation of 209-216MHz (i.e. thereby creating Ch9A as a full 7MHz channel). The current position of Ch10, and the consequences this has for spectrum planning, is a well-known issue in the industry – the reassignment of the broadcasts in the metropolitan markets to the 'new' Ch10 frequency block would, subject to Channel Ten agreement, create the opportunity to introduce a 4th DRB ensemble ("9D"), however, there are significant practical dimensions for government to address...

On the basis of the above, BA believes that the following scenarios exist for the introduction of a full conversion model covering national and commercial broadcaster services in capital city markets using both VHF and L-Band spectrum:

- **Scenario 1** - assuming 224 kbps/broadcaster across three ensembles utilising Eureka 147 MPEG 1 Layer II encoding. The three ensembles in Ch9A will accommodate 5 services each (a total of **15 services**). In the Sydney market, for example, there are 18 national and commercial broadcaster services to be accommodated. BA presumes that there would be a strong presumption in favour of national broadcasters being accommodated on this spectrum (particularly because the government-funded conversion cost will be somewhat less than for an L-Band primary service), which would amount to approximately 1.4 ensembles (i.e. 5 x ABC + 2 x SBS) This would then leave the question as to which commercial broadcasters would be allocated to the eight VHF primary service slots and which three will have L-Band primary service slots. Options in this regard might include a competitive financial process or a requirement upon those benefiting from a VHF primary service to provide new content within an agreed timeframe. While this 'picking winners' process clearly presents some regulatory and practical difficulties, the benefits associated with a per broadcaster allocation of 224 kbps is that this provides some scope for broadcasters to provide new DRB-only audio and data services;

- **Scenario 2** - assuming 256 kbps/broadcaster across three ensembles utilising Eureka 147 MPEG 1 Layer II encoding. At this higher bit-rate, each of the three ensembles in Ch9A will only accommodate 4 broadcasters (a total of **12 services**). Using the Sydney market again as an example, this would then leave the question as to which commercial broadcasters would be allocated the remaining five VHF primary service slots and which six will have L-Band primary service slots. While this scenario again presents the difficulty of 'picking winners', the benefits associated with a per broadcaster allocation of 256 kbps is that this provides greater scope for broadcasters to provide new DRB-only audio and data services than is the case for an allocation of 224kbps (Scenario 1 above). This would allow sufficient capacity for a music genre station to create a second music genre service, (i.e. 2 services at 128 kbps) but with limited data capacity. If one or both services are talk genre, then there would be significant capacity for data and other applications;

- **Scenario 3** - assuming 128 kbps/broadcaster across three ensembles utilising Eureka 147 MPEG 1 Layer II encoding. On this basis, the three ensembles in Ch9A will accommodate 8 services each (a total of **24**

services). In relation to Sydney and Melbourne as the most congested markets, this would comfortably accommodate all national and commercial broadcasters, but have the disadvantage of offering limited scope for individual broadcasters to offer new services to listeners particularly for those services where audio quality is of primary importance (i.e. music format stations). The impact would be less on talk-based programming and 128 kbps would still provide such broadcasters the capacity to provide more than one 'talk' service, but would not really allow capacity for additional data services, and would be insufficient for one talk plus one music genre mix;

- **Scenario 4** - assuming 224 kbps/broadcaster across four ensembles (i.e. Ch10 moves up 1 MHz) utilising Eureka 147 MPEG 1 Layer II encoding. The four ensembles on Ch9A would accommodate 5 services each (a total of **20 services**), again comfortably housing all national and commercial broadcasters in the busiest two markets. The same capacity restraints per broadcaster apply as those set out at Scenario 1 above, in that 224kbps would not be sufficient to accommodate two music genre services;

- **Scenario 5** - assuming 128 kbps/broadcaster across three ensembles utilising Eureka 147 with AAC+ encoding. The efficiencies associated with the use of advanced AAC+ encoding would mean that an allocation of 128 kbps to each broadcaster would actually provide a greater degree of useable capacity for each broadcaster than the Scenario 2 example of 256 kbps per broadcasters using MPEG 1 Layer II encoding. This option would provide at least **48 services** across the three ensembles in Ch9A. Under this Scenario 5, a 128kbps AAC+ scenario would enable each broadcaster to deliver two high quality music genre services, (i.e. potential to use 128 kbps to provide a simulcast of an existing analogue service plus an additional DRB-only service) together with additional data services; it is also possible to deliver a single 5.1 surround sound service within this 128 kbps capacity. From a capacity and capability perspective, Scenario 5 provides the greatest flexibility of all. In addition, there is no need to implant a 1MHz shift for Channel Ten TV services.

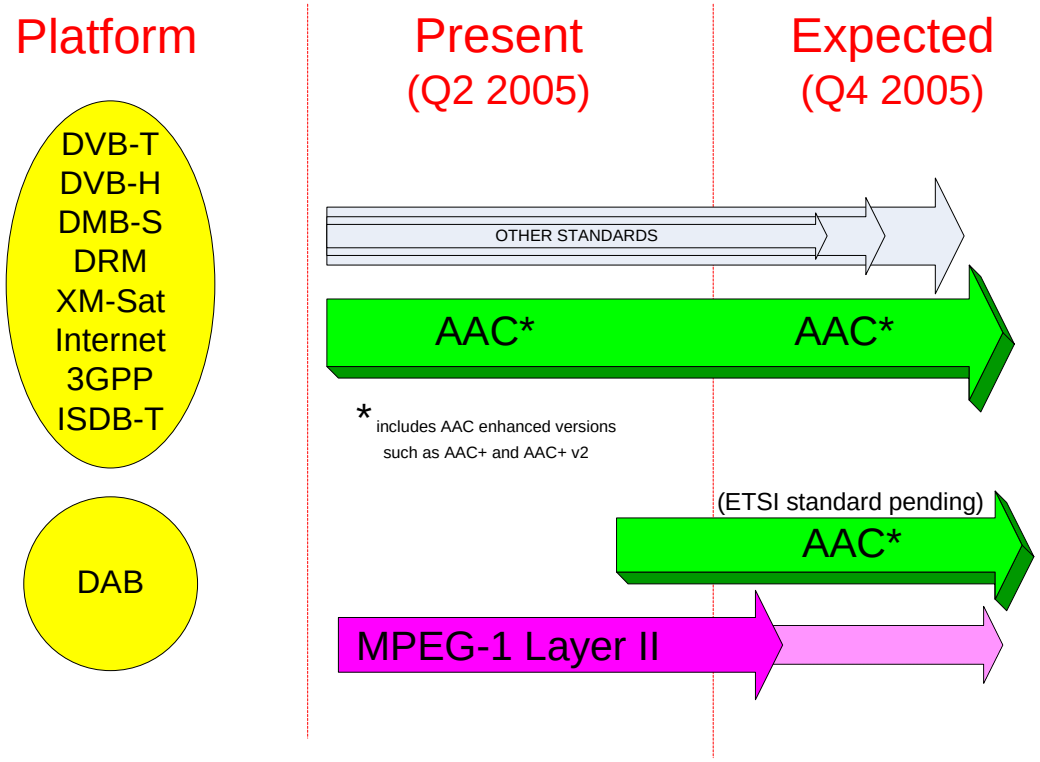
As is clear from these scenarios, the issues of **bit-rate allocation** per broadcaster and **Eureka variant** (i.e. AAC+ versus MPEG 1 Layer II encoding) are critical in terms of the implementation of a full conversion model. For this reason, BA along with other trial members undertook significant research into this matter and hosted an "Audio Testing Day" in March 2005 during which industry participants and government representatives were invited to experience the quality of sound at different bit-rates using different encoders. Both MPEG 1 Layer II and AAC+ were tested. Key results of the existing published research and BA's recent Audio Test are as follows:

- The typical bit-rate being utilised overseas is 128 kbps for stereo music-based services and 64 kbps for mono (speech-based) services using MPEG1 Layer II base standard. Higher bit-rates are used on a case-by-case basis particularly for fine music;
- While some improvements have been made in encoders utilising the base Eureka standard (MPEG 1 Layer II) the efficiency improvements have been incremental and they do not compare to those provided by the use of AAC+ which demonstrated a "quantum leap" in terms of efficiency and listener experience relative to MPEG 1 Layer II audio;

- Listeners found it very difficult to differentiate between AAC+ codecs[3] functioning at 48kbits per sec and MPEG 1 Layer II codecs operating at 128kbps and in fact ranked the AAC+ codec in preference to the MPEG-1, Layer 2 codecs;
- Pre-testing indicated that there was no difference between AAC+ encoders at 64kbps and MPEG1 Layer II at 256kbps.

Use of AAC+ encoding would allow significantly reduced bit-rates, effectively more than doubling the capacity of the spectrum and is therefore an attractive proposition for Australia going forward. The adoption of AAC+ encoding, coupled with the adoption of software-based decoding in the receiver devices (instead of an inflexible hardwired solution) has the potential to avoid many of the pitfalls of other digital platform legacies as seen both in Australia and overseas. However BA recognises that the government and industry will not move to adopt AAC+ unless they are convinced that there will be sufficient receiver population at the "right" prices available at the time of conversion. There is an increasing predominance of AAC+ in a wide range of standards (and their respective CE products) as set out in Diagram 2 below:

Diagram 2



In summary, discussions with manufacturers and industrialists in Europe suggests that although AAC+ and its variants have yet to be adopted into the Eureka standard by WorldDAB and ETSI, this is probably only a matter of time. One manufacturer, Radioscape, is already developing an AAC+ module for use in a "Eureka" application; with the imminent release of multi-standard DRB/DRM receivers, the AAC+ capability becomes increasingly straightforward to implement (the DRM standard uses AAC+).

[3] A codec is the technical shorthand term used to describe the combination of an en**cod**er and **dec**oder pair, which are used back to back to initially compress and code the audio into a digital form, and the subsequent process of extracting the audio information for listening purposes.

4.4 Spectrum availability and performance

Appendix 3 provides an analysis of the differences in propagation between VHF Band III and L-Band. The key points are that VHF Band III is preferable due to reduced obstruction and clutter loss relative to L-Band.

a. VHF

The VHF spectrum reserved for DRB internationally is 174 – 240MHz. In Australia, the spectrum between 230 – 240MHz is reserved for Defence purposes. We have previously been advised that this spectrum although highly suitable for DRB will not be available for broadcast use in the foreseeable future.

- Metropolitan

  In the five major Australian metropolitan areas, there is only 6MHz readily available within Band III which could be used for DRB – Ch9A. This would allow three ensembles to be provided from sites close to the existing Band III television transmission site.

- Regional

  With the likely use of at least three ensembles within television Ch9A, it is apparent that there will not be any available VHF spectrum in regional areas immediately adjacent to the metropolitan areas at least until analogue television is switched off in those regions.

  Further afield, availability varies significantly depending upon the ABA's approach to providing VHF spectrum for DTTB services from one area to the next.

  We expect the ABA will be able to comment on the availability of Band III spectrum outside the metropolitan markets.

b. L-Band

The internationally reserved spectrum for DRB is 1452 to 1492MHz although L-Band spectrum has yet to be formally allocated for broadcasting in Australia. The most significant limitation on the use of this spectrum in Australia is existing users - particularly the Telstra Digital Radio Concentrator System (DRCS) and several fixed links.

There is, however, a "mid-band gap" which could be usefully used initially. This covers ensembles L15 to L21. This spectrum does not currently have non-DRB services operating, and could be used Australia-wide.

- Metropolitan

  There is sufficient capacity for each of the metropolitan markets to establish sufficient (6+) ensembles to allow the existing broadcasters to transition to DRB.

- Regional

The DRCS services are primarily used in regional areas, therefore, the number of ensembles available will need to be addressed on a case-by-case basis

c Use of Single Frequency Networks (SFN's)

The use of SFNs provides some significant advantages and this is addressed in more detail in Appendix 3:

Section 5 PART B: Regulatory Issues

Section 3 sets out the key principles that BA believes should underpin the introduction of DRB into Australia and these have been expanded in the Section 4 analysis of key technology issues. BA acknowledges that numerous challenges (by no measure insurmountable) are present in terms of the regulatory and policy framework that needs to be created to facilitate the successful introduction of DRB. In BA's view, this framework is likely to involve a combination of legislation and policy that provides sufficient definition and certainty for broadcasters and consumers as to what DRB will actually encompass, together with flexibility and choice within a set of basic parameters. There are clearly some learnings that can be taken from the introduction of digital television in Australia recognising, of course, that the two media and their respective market structures are quite distinct.

BA believes it essential that "radio" or audio services remain as the basis for DRB (data or video services should not predominate over audio services). To this end, BA supports the introduction of enhanced Eureka 147 rather than DMB but believes that government policy setting must go further to ensure that radio remains a relevant sector into the future. By this we believe it is essential that policy settings determined now, ensure that the full functionality of digital radio technology is enabled as part of the DRB offering to the public (i.e. high quality audio, data and image and importantly choice and diversity).

To this end, BA believes that the regulatory and policy model should incorporate the following elements:

- adoption of the Eureka 147 base or variant (AAC+) standard as canvassed above with enhanced encoding and compression;
- adoption of full conversion model;
- incentives on broadcasters to actively promote digital radio;
- incentives for broadcasters to rollout services within a defined period in exchange for the moratorium on new competition for an initial five year period;
- depending on bit-rate allocation, capacity for broadcasters to simulcast existing services and introduce **new** services during the moratorium period, with incentives provided for the introduction of 'new' services (which will require some definition);
- allocation of spectrum on the basis of a defined number of bits per incumbent broadcaster during the moratorium period;
- the financial basis of spectrum allocation to incumbent commercial broadcasters during the moratorium period should be free-of-charge for an initial period, after which time revenue-based licence fees ought to levied by government;
- the principle of separation of carriage and content, where the allocation of spectrum automatically incorporates access to carriage;
- any spectrum (i.e. capacity; CU's) spare following the initial allocation to broadcasters be reserved for providers of non-audio (e.g. data) services during the moratorium and/or new entrants post-moratorium;
- a model that provides for new entrant opportunities post moratorium, which requires identification and reservation of appropriate spectrum for this purpose from the outset;
- allocate spectrum post-moratorium on a per ensemble basis to either new entrant broadcasters or an independent ensemble/multiplex manager;

- spectrum for new entrants post-moratorium be allocated on a revenue-based licence fee model, recognising the start-up nature of the medium;
- precedence for national broadcasters in relation to access to VHF spectrum, with spectrum allocated on a national basis; and
- Equity of treatment between existing broadcasters and new entrants post-moratorium.

These elements have been expanded below:

5.1 Key Drivers for Take-up and Content Regulation

As mentioned above, overseas experience and research together with data from BA's DRB trial in Melbourne indicate that there are a number of key drivers for take-up. These include:

i. Improved quality of reception and sound
ii Availability of existing and new services in digital mode
iii Price point of new receivers
iv Cross promotion of the new digital service by incumbent broadcasters[4].

a. Results from Melbourne DRB Trial Market Research

As part of its Melbourne Trial, BA and its content partners commissioned Millward Brown to undertake market research to report on the response of listeners to digital radio. Millward Brown recruited a panel of 200 listeners and has undertaken two surveys: a Benchmark survey and a Post Benchmark Survey. The results of the Post Benchmark Survey are still being collated and will be provided once available, however, we are advised that they broadly confirm the Benchmark survey results.

i. Improved quality of reception and sound

The Melbourne trial market research indicates that respondents were highly impressed with the improved quality of sound delivered by DRB with 82% of respondents liking digital radio. Further 7 out of 10 panel members agreed that DRB reception is excellent, very good or good. This perception translated into a willingness to purchase a digital radio.

ii Availability of existing and new services

The market research also confirmed that purchase intentions improved once the availability of new stations was offered. This intention increased to 4 out of 5 panel members. Panel members were also very interested in new features offered by

[4] Finland provides a very clear example of the importance of DRB promotion. Despite enjoying 40% population coverage (approximately 2 million people) and a total of 12 public DRB services, there remains a scarcity of available product for consumers in Finland to buy. This, combined with a lack of marketing and promotional commitment, especially from commercial broadcasters, has conspired to keep the message of Finland's strong DRB portfolio away from consumers. Unlike in other countries, where government support, regulatory parity and active incentives encouraged private broadcasters, the Finnish regulator has taken a passive role in the development of a commercial DRB market. Faced with few inducements, no licences and no chance to compete for market share with the public broadcaster; it is no surprise that commercial operators found the DRB prospects in Finland unappetizing. Source WorldDAB Website.

digital radios including store and replay functions, larger colour screens with images and data.

iii Price point of new receivers

The market research also provided an indication of the price point for new digital radios. The indifference point for the price of a digital radio moved between the first and second survey but provided a range of pricing options between $100 and $190. There was no indication that the listeners were reluctant to pay for digital radios.

iv Cross promotion of the new digital service by incumbent broadcasters.

A key finding in the market research was the uptake would depend on public education. Results indicated that listeners had difficulties understanding the value of extra services but once provided with more information about features and new services their understanding and interest in DRB increased.

b. Overseas Experience

A significant body of market research has been undertaken in the UK which identifies the key drivers for take-up confirmed in the Australian market research. UK market research also suggests that the quality of data services is also an important factor in contributing to the digital radio experience.

As indicated above, information from Finland indicates that unless commercial broadcasters support and promote DRB then there is the risk that it will fail. The situation in Finland appears to have been exacerbated by a scarcity of receivers.

For these reasons BA believes it essential that government policy encourage the simulcast of existing services and the introduction of new services as well as a promotional requirement to ensure the success of DRB take-up.

5.2. Spectrum allocation

a. Bit-rate allocation during the moratorium period

As set out in Section 4, the issue of bit-rate allocation is totally dependent on the basic technological and spectrum choices that Australia makes in relation to the introduction of DRB. Assuming that a hybrid VHF/L-Band full conversion model is selected, this gives rise to at least the five bit-rate scenarios set out in the previous section. Based on the premise that it is critical for broadcasters to have access to sufficient spectrum to be able to provide both a simulcast of their existing analogue service plus new digital-only services, the two most viable of these options are as follows:

1. Bit-rate allocation of 224 kbps per incumbent national and commercial broadcaster using the base Eureka MPEG 1 Layer II format. Under this scenario (Scenario 1, above), not all incumbent primary services can be accommodated on VHF Ch9A in the Sydney and Melbourne market unless it is possible to do either of the following (we recognise these propositions may not be palatable to the affected parties, but they should be considered as possible ways to address the VHF spectrum issue):

    - move Ch10 by 1 MHz as described in section 4, or

- provide differential bit-rate allocations – for example, 128 rather than 224 kbps to talk-format stations.

(Under Scenario 2, above, with a 256 kbps allocation per incumbent using the base Eureka MPEG 1 Layer II format, it may be necessary to adopt both of the above measures).

If neither of these options is feasible, Scenario 1 will require the Government or ABA to make a determination (ie select "winners" and "losers") of those broadcasters that will need to utilise L-Band for their primary services. If national broadcasters are given precedence on VHF this will require three commercial incumbents to provide their primary service on L-Band (or six if the 256 kbps Scenario 2 is adopted). BA sees the options for dealing with this issue will include:

- A beauty parade process among commercial incumbents such that VHF spectrum is provided to those with the most compelling digital service offering, particularly in terms of new services (audio and other);
- Provision of a licence fee 'holiday' to those broadcasters providing their primary service on L-Band, in recognition of the increased transmission costs these operators will incur. This holiday may relate to analogue licence fees or the point at which broadcasters become liable for DRB licence fees;
- Provision of structural adjustment payments to L-Band broadcasters in view of the increased transmission costs they will incur.

2. Bit-rate allocation of 128 kbps per incumbent broadcaster using the enhanced Eureka AAC+ standard. This option would give rise to considerably fewer regulatory complications in terms of spectrum allocation to incumbent national and commercial broadcasters (albeit that at least some community and special interest licensees may be required to utilise L-Band for their primary services, depending on the timing of their conversion and bit-rate allocation).

It is BA's view that spectrum should be allocated free-of-charge by government for an initial period representing a DRB 'establishment' phase for incumbent commercial broadcasters – a minimum of 5 years – after which point a revenue-based licence model ought to be implemented. BA believes that a revenue-based model (as opposed to an up-front capital sum) is appropriate given the start-up nature of the new medium and the likely costs associated with increasing public awareness to encourage take-up.

In addition, BA believes that the well-accepted principle of 'use it or lose it' ought to apply in relation to DRB spectrum allocation, such that broadcasters who do not actually provide digital services on a predetermined basis and timeframe should lose access to the spectrum.

On balance, however, BA does not believe that rigid, legislated requirements ought to be put in place in relation to the mix of programming provided in digital. BA's analysis of the evidence is that both material that is a simulcast version of the broadcaster's analogue programming as well as innovative digital-only programming will be required to attract consumers to take up DRB. Individual broadcasters are probably best-placed to reach a view on the balance between simulcast and new services – however, as discussed further in sub-section 5.4b, below, BA does believe

incentives ought to exist for broadcasters to introduce and gradually increase the percentage of new digital-only content they provide.

Any unused spectrum in VHF or L-Band (i.e. 'spare' or unallocated capacity within an ensemble or unused ensembles) should be reserved by the government for either non-incumbent data service providers during the moratorium or for future new entrants at the end of the moratorium period. Alternatively, should an incumbent broadcaster seek to obtain more spectrum in addition to its allocation prior to the end of the moratorium, BA proposes that this could be the subject of negotiations with other broadcasters within the multiplex or through purchase from the government under an agreed commercial arrangement.

It should be noted that any data service licence allocated either during or post moratorium should be for a minimum term of 10+5 years.

c. Bit-rate/capacity allocation post the moratorium period

BA proposes that the government should reserve unused spectrum for new entrants and this should be allocated on the basis of a revenue charging model on a per ensemble basis post-moratorium to potential broadcasters or third party multiplex managers. Where small amounts of spectrum are unused within a multiplex, these should be made available by the multiplex manager (whether a consortium of broadcasters or a third party manager) on a commercial basis to broadcasters or data service providers operating within that multiplex

5.3. Multiplex licensing

The ability of Eureka 147 to deliver a large number of different services through a single channel challenges the existing analogue planning model whilst providing the opportunity, with the introduction of a multiplex manager into the service delivery chain, to separate the licensing of content from carriage.

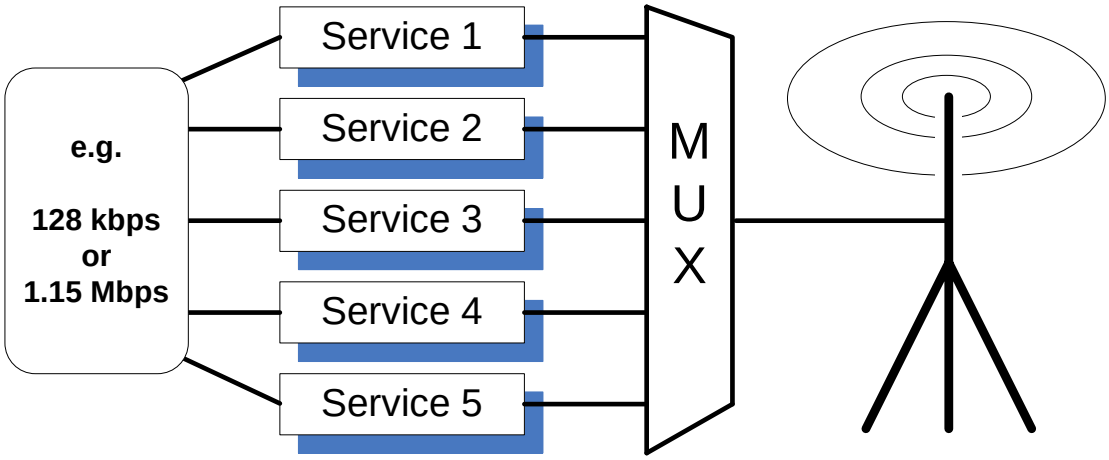
BA supports a two-tier licensing regime which separately licenses content providers from multiplex operators as set out in Diagram 3. Depending on the licensing regime and regulatory access provisions, this approach is likely to maximise the use of unallocated or unused bandwidth in the multiplex as the multiplex operators have the ability to manage the bit-rate capacity between services in response to demand.

In BA's view, selection of a Eureka 147 or a hybrid Eureka 147/DRM model inevitably introduces the need for a multiplex operator to manage each channel or ensemble. We recognise that the identity of the multiplex operator is a highly sensitive issue for the incumbent broadcasters. Our approach to this issue is that the multiplex operator for a particular ensemble should be the most appropriate party (whether that is an individual broadcaster in the case for example of the ABC, a consortium of broadcasters, a third party or a third party appointed by the broadcaster(s)) in light of policy decisions made in (at least) the following matters:

- Eureka 147 MPEG 1 Layer II or MPEG 147 AAC+, which dictates a combination of national and commercial and or community broadcasters within a single multiplex;
- The appropriate "guaranteed" bit-rate allocation for particular genres, which determines the business case for the multiplex;
- The utilisation factor on each ensemble in each market, which determines the economic viability of the multiplex;

- The potential value of the unallocated spectrum to the multiplex manager taking account of related commercial and/or regulatory constraints such as a moratorium expiry date, access regime provisions. This again impacts on the potential viability an independent multiplex manager.
- The distribution and transmission costs.

Diagram 3



BA recognises incumbent broadcaster concerns in relation to either ownership/control over a guaranteed portion of DRB spectrum or guaranteed access to a particular bit-rate. We further understand the rationale for incumbent operators' desire to own/control the spectrum directly or in consortium. Our concern with this outcome is only to ensure efficient use of available bandwidth on the multiplex from the outset and to ensure that access to unused spectrum be guaranteed on equitable terms and conditions for new services and/or data services whether before or following the end of the moratorium period. This can be achieved either through an access regime or through an independent multiplex operator who is subject to "must-carry" obligations. Either proposition is workable. However, it is likely a "must carry" model that allows the multiplex operator sufficient unallocated bandwidth to make a commercially viable business by maximising the use of the whole channel will deliver the greatest benefits to consumers.

a. Guaranteed spectrum access licensed on a per broadcaster basis

Under this arrangement a broadcaster would be allocated access to a defined quantity of spectrum eg 128kbps, within a particular ensemble or multiplex. This would provide the broadcaster with the legal right to transmit a service via that ensemble's multiplex.

A guaranteed spectrum allocation could also be provided to new entrant data service providers during the moratorium period.

b. Must Carry Obligation on a Multiplex Licensee

In our view, must carry obligations for particular services at guaranteed minimum bit-rates on predetermined commercial terms, is eminently workable. It ensures that the multiplex operator cannot act as "spectrum

gatekeepers" for those guaranteed access, which is one of the main concerns of incumbent operators.

In BA's view, the key characteristics of this model would be to:

- Provide for the separation of content and carriage by implementing a two-tier licensing regime in the same way as datacasting operates under the Broadcasting Services Act;

- Allow for new services/roles to emerge as either new content licence holders (post moratorium), new data service providers or as multiplex operators holding full ensemble spectrum licensees;

- Through the multiplex operator, allow incumbents/new entrants to trade spectrum within the multiplex;

- Cater for situations where there could be a mix of different types of broadcasters (operating at different bit-rates) requiring an independent multiplex manager such as in rural Australia where there is insufficient commercial broadcasters to warrant a separate multiplex;

- Identify new "ensembles" now that are ear-marked for release for new entrants post moratorium expiry, both before and following analogue television switch-off.

BA accepts that competition concerns in relation to multiplex licensing arrangements may require the ability for fair access terms to be determined through an independent mechanism, where the parties cannot resolve relevant terms and conditions.

5.4. Legislative/policy requirements and incentives

BA proposes that the government must implement legislative or policy measures to ensure that there is sufficient flexibility and incentives for broadcasters to optimise DRB services and for the public to take up the new technology.

BA proposes the following:

a. Simulcasting

Overseas research indicates that it is important for broadcasters to both simulcast existing services and introduce new services as a way of ensuring take up of digital radio. Simulcasting allows listeners to utilise digital radio to access programming of interest already provided plus digital 'value add' services (e.g. programme associated data, "PAD" and non-programme associated data, "NPAD") as well as new services hence driving use of the digital radio as the prime listening device rather than splitting the listener between digital and analogue services. It is for this reason that BA has recommended that broadcasters be provided with sufficient spectrum to allow for **both** simulcast and new services.

b. Provision of New Services

Spectrum should be allocated free to the commercial and national broadcasters on the basis of "lose it or use it" provisions. These should include the requirement:

i to rollout a service within one year of spectrum allocation and obtain equal coverage within two years

ii to provide a minimum level of new services from day 1 of transmissions.

iii. to provide new services within 5 years.

New services should be genuinely "novel" and not just reconstituted or time-shifted analogue programming. While it is recognised that some time-shifting will be attractive to listeners, new services which only constitute full time-shifting are unlikely to achieve the desired result. This obligation could be phased in with the percentage of simulcast product for the new service being reduced progressively to say a maximum of 40% at the end of year 5. BA believes that the definition of new services should be given particular attention. One option may be to oblige broadcasters to lodge a 'digital-only content plan' with the ABA on an annual basis and for incentives to be provided for the introduction of increased levels of these new services. These incentives could, for example, take the form of an extension to the period during which spectrum is provided free-of-charge to broadcasters.

Alternatively, should the broadcaster fail to provide a new service there should be the capacity for the ABA to reissue that spectrum to another broadcaster (e.g. community broadcaster) or hold in reserve for a new entrant post moratorium.

c. Data-only services

It is BA's view that (independent) data services should be available to new entrants from commencement of DRB transmissions (i.e. during the moratorium). A minimum of 128 kbps of spectrum should be made available in each multiplex for this purpose. This would ensure that new services are introduced which exploit the additional functionality of digital radio and, in so doing, assist the consumer value proposition and take-up.

5.5. Subscription services

BA believes that a healthy free-to-air radio sector is in the public interest and is essential moving forward. For this reason, BA does not support the allocation of spectrum for subscription services as it would have the potential to undermine the success of the free-to-air industry through the diversion of resources and activity. This would not preclude broadcasters providing content to other services such as for DVB-H or subscription TV platforms which could offer subscription services bundled with alternative services.

5.6 National and Community Broadcasters

a. National broadcasters

National broadcasters should be allocated spectrum and commence services as part of the overall commencement of DRB in Australia but with the same requirements

relating to simulcasting and new services as commercial broadcasters. As stated above, BA believes that national broadcasters will play a vital role in the introduction of DRB into Australia, as they have in other jurisdictions. The national broadcasters play a vital community role in the analogue domain (even more so in regional and rural areas where there are fewer commercial broadcasters) and the successful commencement of DRB will require the participation of the nationals from day one. It is apparent to BA that the national broadcasters already have a significant commitment to the digital medium and, equally importantly, significant new content to deploy.

In a base level Eureka model (i.e. MPEG 1-Layer II), there is a strong case on cost grounds alone for national broadcasters to be provided with VHF spectrum proportional to the number of their services, given the higher transmission costs associated with L-Band primary services.

b. Community broadcasters

Community broadcasters should be allocated spectrum in proportion to their existing arrangements eg limited power or market. This may mean for example, that they obtain less bandwidth than the higher power commercial broadcasters but given the need to drive take-up also be required to provide new services.

c. Other broadcasters

As for community broadcasters.

5.7. Other Regulation Issues

BA does not hold any strong views on Foreign and Cross Media ownership rules. .

b. HPON licence holders and Community broadcasters

BA believes that both community broadcasters and HPONs are an essential part of the radio industry and should have the capacity to convert to DRB. BA believes that the more mainstream DRB becomes the wider, its application and content offering, the more likely it is to be successful.

Section 6 PART C: Digital Audio Services

6.1 Satellite delivery

Australia is currently provided with satellite delivered radio services via subscription television. BA does not believe that any additional L-Band spectrum should be allocated to subscription radio services delivered by satellite as there is currently sufficient demand for L-Band spectrum for terrestrial broadcasting and telecommunications services. Currently satellite subscription services from overseas have very little Australian coverage. It is our view that Australia will be sufficiently serviced with subscription radio services via existing or new platforms services eg subscription television, DVB-H.

Appendix 1 Overseas markets - current experience and future trends:

(i) UK Multiplex model – why successful

The relative success of the UK multiplex model is largely the result of a combination of factors including: the high take-up of digital TV, which offers digital radio; the spectrum allocation for DAB, balanced between commercial players and the BBC and also between local and national multiplexes; the broad build-out of transmitter networks by Digital One, the BBC and local commercial multiplex operators; a DAB licensing regime which provided incentives for analogue stations to go digital be extending their analogue licences; the commitment of the industry, both the BBC and the commercial sector, to marketing by the Digital Radio Development Bureau (DRDB) and individually; and innovation and risk-taking by a number of smaller UK radio manufacturers which has helped to kick-start the receiver market.

In the future, it is expected that the market will also be driven by moves towards digital switch-over in television and exciting new multimedia services which will make digital radio more attractive to consumers – eg adding text, downloads, graphics and video clips to complement radio services.

Over 400 local and regional stations are now broadcasting on DRB digital radio around the country. [Using the hyperlink in the CD version of the report, CNTL+Click Link on each area name below will reveal more details about the multiplex and the services being broadcast.

Ofcom is currently considering the release of a further 5 ensembles (of contiguous Band III spectrum) and a consultation document has sought comment in respect of licensing arrangements.

List of UK Multiplexes and Licence Award

Area	Licence Award	On-air
Aberdeen	Switchdigital	Yes
Ayr	Score Digital	Yes
Birmingham	CE Digital	Yes
Bournemouth	Now Digital	Yes
Bradford/Huddersfield	TWG Digital	Yes
Bristol/Bath	Now Digital	Yes
Cambridge	Now Digital	Yes
Cardiff & Newport	Capital Radio Digital	Yes
Central Lancs	Emap Digital Radio	Yes
Central Scotland	Switch Digital	Yes
Coventry	Now Digital	Yes
Dundee/Perth	Score Digital	Yes
Edinburgh	Score Digital	Yes
Exeter/Torbay	Now Digital	Yes
Glasgow	Score Digital	Yes
Greater London I	CE Digital	Yes
Greater London II	Switchdigital	Yes
Greater London III	The Digital Radio Group	Yes
Humberside	Emap Digital Radio	Yes
Inverness	Score Digital	Yes
Kent	Capital Radio Digital	Yes
Leeds	Emap Digital Radio	Yes
Leicester	Now Digital	Yes
Liverpool	Emap Digital Radio	Yes
Manchester	CE Digital	Yes

North-East (region)	MXR				Yes
North-West (region)	MXR				Yes
Northern Ireland	Score			Digital	Yes
Norwich	Now			Digital	Yes
Nottingham	Now			Digital	Yes
Peterborough	Now			Digital	Yes
Plymouth/Cornwall	South	West	Digital	Radio	Yes
Reading & Basingstoke	Now			Digital	Yes
Severn Estuary (region)	MXR				Yes
Southend/Chelmsford	Now			Digital	Yes
South Hampshire	Capital	Radio		Digital	Yes
South Yorkshire	Emap	Digital		Radio	Yes
Stoke-on-Trent	TWG	Emap		Digital	Yes
Sussex Coast	Capital	Radio		Digital	Yes
Swansea	TWG	Emap		Digital	Yes
Swindon & West Wilts.	Now			Digital	Yes
Teesside	Emap	Digital		Radio	Yes
Tyne & Wear	Emap	Digital		Radio	Yes
West Midlands (region)	MXR				Yes
Wolverhampton	Now			Digital	Yes
Yorkshire	MXR				Yes

Canada

DAB Coverage

Background

Since the publication of the Digital Radio Study Group Technology report was published in March 2004 only one further station is operating in digital mode, bringing to 73 the number of licensed digital stations in five Canadian markets.

Canada was instrumental in early research and development and work on international standards for DRB. In particular, the basic studies on the most appropriate frequency band for this service were carried out at which resulted in ratification of use of the 1.5 GHz band for DRB by the International Telecommunication Union (ITU) World Conference of 1992.

DRB is deployed entirely at L-band in Canada using Eureka 147 in Mode II. The CRC is currently researching signal processing techniques to allow for the switch to mode IV which will allow greater separation between transmitters for SFN operations which can significantly reduce coverage costs.

CRC are also developing more advanced software tools (CRC-COVLAB & PREDICT) for terrestrial RF coverage planning.

Status of DAB

(08/03/2005) There are currently a total to 73 licensed Digital Audio Broadcast DAB stations in Canada. Fifteen stations in Ottawa (11 commercial and 4 public), 25 in Toronto (21 commercial and 4 public) 15 in Vancouver (11 commercial and 4 public), 12 in Montreal (8 commercial and 4 public) and 6 in Windsor (2 commercial and 4 public). The Stations operating in these five cities provide service to some 11 million potential listeners or more than 35% of the population.

7 DAB stations (4 commercial and 3 public) are field testing in Halifax, Nova Scotia.

The new DAB only station licensed for Toronto was scheduled to start operation in autumn 2004. Additional applications have been made for new DAB only stations in Toronto but no hearings have been scheduled. The operational dates for the private stations licensed in Ottawa have not been announced.

In autumn 2002 RadioShack Canada Ltd. became the first retail chain in Canada to carry a line of DAB products for the home and portable markets. DAB products will be available in approximately 250 Radio Shack stores. While the initial receivers were handheld portable devices (with and without MP3 capability) additional DAB products of various types as expected to become available in 2004.
The marketing activity continued in 2003 with a presence at various consumer events, on-air promotions, articles in various press, etc. 'DAB' is used in all the marketing material, from the consumer handout material to the 'On-Air' promotional spots. The Canadian website "digitalradio.ca" continues to draw an increasing number of hits.

The Canadian DAB platform organisation is 'Digital Radio Roll-Out (DRRI) Inc.' The 'official' launch of Digital Radio in Canada took place on 1st November 1999 during the Canadian Association of Broadcasters Convention in Montreal. Stations in Toronto, Montreal and Vancouver have been operating since early 1999; Windsor, Ontario since early 2000, and Ottawa since March 2003.

Available DAB Services]

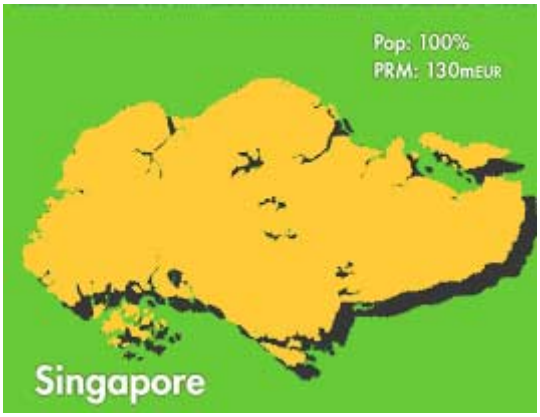
Regions: Montreal, Toronto, Vancouver, Windsor, Ottawa

Region	Service Name	Service Description	Public/Commercial	Launch Date
Montreal	CKMF-FM	French Speaking channel	commercial	01/11/99
	CITE-FM	French Speaking channel	commercial	01/11/99
	CKAC	French Speaking channel	commercial	01/11/99

	CHOM-FM		commercial	01/11/99
	CKGM		commercial	01/11/99
	CBF-FM	French Speaking channel	public	01/11/99
	CBFX-FM	French Speaking channel	public	01/11/99
	CBM-FM		public	01/11/99
	CBME-FM		public	01/11/99
Toronto	CFMX-FM		commercial	01/01/01
	CIRV	Broadcasts in Portuguese	commercial	01/01/01
	CIAO	Broadcasts in Italian	commercial	01/01/01
	CJMR	Broadcasts in Portuguese	commercial	01/01/01
	CHOW		commercial	01/01/01
	CHUM		commercial	07/10/99
	CHUM-FM		commercial	07/10/99
	CFTR		commercial	07/10/99
	CHFI-FM		commercial	07/10/99
	CFNY-FM		commercial	07/10/99
	CFRB		commercial	07/10/99
	CKFM-FM		commercial	07/10/99
	CJCL		commercial	07/10/99
	CJEZ-FM		commercial	07/10/99
	CJRT-FM		commercial	07/10/99
	CJBC	French speaking channel	public	07/10/99
	CJBC-FM	French speaking channel	public	07/10/99
	CBLA-FM		public	07/10/99
	CBL-FM		public	07/10/99
	CHIN	Broadcasts in Cantonese	commercial	07/10/99
	CHIN-FM		commercial	07/10/99
	CISS-FM		commercial	07/10/99
	CHOG		commercial	07/10/99
	CILQ-FM		commercial	07/10/99
Vancouver	CKZZ-FM		commercial	01/01/01
	CISL		commercial	01/01/01
	CKVX-FM		commercial	01/01/01
	CHQM-FM		commercial	01/01/01
	CFUN		commercial	01/01/01

	CBXF-FM			public	01/11/99
	CBU			public	01/11/98
	CBU-FM			public	01/11/98
	CBUF-FM	French station	speaking	public	01/11/98
	CFOX-FM			commercial	01/11/98
	CKNW			commercial	01/11/98
	CFMI-FM			commercial	01/11/98
	CKWX			commercial	01/11/98
	CKLG			commercial	01/11/98
	CHMG			commercial	01/11/98
Windsor	CKLW			commercial	03/01/00
	CIDR-FM			commercial	03/01/00
	CIMX-FM			commercial	03/01/00
	CKWW			commercial	03/01/00
	CBE			public	03/01/00
	CBE-FM			public	03/01/00
Ottawa	CBO-FM			public	01/04/03
	CBOQ-FM			public	01/04/03
	CBOF-FM			public	01/04/03
	CBOX-FM			public	01/04/03

Singapore



DAB Coverage

Status of DAB

(24/02/2005) Regular digital radio services in Singapore were launched on 19th November 1999, making Singapore the first country in the world able to provide DAB services nationwide. The MediaCorp Radio Singapore Pte Ltd (formally known as Radio Corporation of Singapore (RCS), who received their DAB broadcast service licence in January 1999, dubbed their service SmartRadio.

With 6 audio stations from its FM services on Ch.7B at the beginning, it now carries 7 audio stations, 6 of which can be heard exclusively on SmartRadio. The six unique DAB services are Cruise (oldies and Jazz), Chinese Evergreens (Chinese classics), JK-Pop (Japanese and Korean pop), Planet Bollywood (top Indian songs), Club Play (dance music) and Bloomberg (news and financial information). Audiophiles can also tune to Symphony (classical music on FM simulcast) can also be heard on Ch.7B. On its trial service on Ch. 7C, another 6 audio stations on FM simulcast can be heard on SmartRadio. All audio services are enhanced by textual and graphical up-to-date information on its DLS, PAD and NPAD services such as song titles & artistes' names, weather, traffic, news headlines, financial news and other multimedia applications.

Apart from MediaCorp Radio, Rediffusion Singapore - a subscription radio service, received its DAB broadcast service licence in January 2001 and simulcasts its Gold and Silver channels on DAB, offering a mixture of English, Chinese and dialect programmes.

The inaugural issue of the SmartRadio e-NewsLetter was launched in June 2003 with the objective to disseminate timely information about its SmartRadio service and to help promote DAB. To promote DAB in a fun way, MediaCorp Radio has also been running a weekly SmartRadio SMS Quiz since 16 Feb 2003. The quizzes are posted on its DLS service and SmartRadio website where listeners can submit their entries via SMS using their mobile phones.

MediaCorp Radio and MDA have been working very closely with the local DAB car radio distributors and car dealers to help promote DAB. In 2002, four different models of the Hyundai cars were pre-fitted with DAB car radios. In June 2003, the new

Mitsubishi Lancer & Mitsubishi Colt cars were launched equipped with DAB car radios.

Asia DAB Committee of the World DAB Forum (*http://www.asiadab.org*) - The Singapore Broadcasting Authority (now the Media Development Authority or MDA) and the World DAB Forum signed a Memorandum of Understanding to establish the Asia DAB Committee of the World DAB Forum on 7 June 2000. As of 30 June 2003, it has 16 members from Australia, Brunei, Korea, Malaysia, Singapore and Taiwan.

Available DAB Services

MediaCorp Radio Singapore (SmartRadio Service on Ch.7B at 190.640 MHz)

Region	Service Name	Service Description	Public/Commercial	Launch Date
National	Cruise	A mixture of Jazz standards & Jazz fusion and oldies from the late 50s and 60s.	commercial	28/02/02
	Club Play	A variety of dance music from trance, deep house to techno.	commercial	28/02/02
	Symphony	A classical music station on FM simulcast	commercial	28/02/02
	JK Pop	A mixture of the latest Japanese and Korean pop	commercial	28/02/02
	Planet Bollywood	Indian hits such as Hindi, Punjabi & Tamil	commercial	28/02/02
	Bloomberg	Up-to-date news and financial information	commercial	28/02/02
	Chinese Evergreens	Chinese classic hits from the 60s to the 80s	commercial	28/02/02

MediaCorp Radio Singapore (SmartRadio Service on Ch.7C at 192.352 MHz)

Region	Service Name	Service Descrption	Public / Commercial	Launch Date
National	Class 95 (FM simulcast)	An adult contemporary station which entertains listeners with hits from the 70s, 80s and 90s.	commercial	On Trial
	YES 933 (FM simulcast)	A contemporary music station that keeps its listeners entertained with top hits and entertainment news from the Chinese music industry.	commercial	On Trial
	Perfect 10 (FM simulcast)	The No.1 hit music station that plays top 40 hits from the USA, UK and Singapore.	commercial	On Trial
	Gold (FM simulcast)	Plays easy-listening favourites from the 60's to 90's.	Commercial	On Trial

Love (FM simulcast)	An adult contemporary music station, plays English and Mandarin golden hits from the 80s and 90s.	Commercial	On Trial
NewsRadio (FM simulcast)	Keeps listeners updated and entertained with up-to-the-minute news bulletins.	Commercial	On Trial

Taiwan

DAB Coverage

Status of DAB

(01/02/2005) On 24 January 2000, Taiwan's Directorate General of Telecommunications (DGT) proposed to begin pilot trials using the Eureka-147 DAB system, using 5 channels in Band III.

It was announced on the 1st March 2000 that the Ministry of Transport and Communications would issue ten DAB trial licences. Two nation-wide licences would go to the private Broadcasting Cooperation of China (BCC) & a team led by government-sponsored Central Broadcast System (CBS).

On the 10th March 2000 the BCC became the first DAB broadcaster in Taiwan, broadcasting DAB programs in Taipei, capital of ROC, covering 2,800,000 of the country's population. BCC, uses an ensemble carrier frequency 220.352MHz (one of the 5 channels in VHF) to broadcast 6 programs. They have since installed more than 10 stations throughout the country following the success of DAB. The remaining eight regional licences will be issued to teams formed by private stations.

The CBS team consists of three other government-sponsored stations, including the popular police radio system featuring real-time reports of the traffic conditions of highways and major cities in Taiwan.

A fourth DAB ensemble in on-air in Taiwan. PC Radio is broadcasting five services on Block 10C, including e-learn, which is a University learning broadcasting service. PC Radio has a national concession like the other three ensemble operators, BCC, CBS and UFO. Regional concessions are expected to follow. BCC broadcasts a Buddhist sect, which is broadcasts around the clock on DAB and has more than 3 million members. There are 5 trial broadcasting groups, the fifth one is formed by Voice of Taipei and Best Radio.

There are about 20 Taiwanese manufacturers actively involved in the development of DAB receivers, and Taiwan has achieved the largest receiver module supplier worldwide since 2003.

Taiwan has been looking at Eureka 147 since 1995. It was after a detailed study and comparison between the Eureka-147 and IBOC systems that DGT decided to adopt the Eureka- 147 system for Taiwan.

Belgium

DAB Coverage

Status of DAB

(24/01/2005) Digital Radio launched in Belgium in September 1997 with a multiplex operated by the Flemish public broadcaster VRT. Today, VRT has a multiplex covering 98% of the Flemish Community (expected to rise to 100% in 2005) and the French public broadcaster, RTBF, has a multiplex covering 98% of the French Community.

The VRT ensemble carries ten audio stations. Four channels are unique to DAB Digital Radio: Klara Continuo playing classical music; 927Live; nieuws+ which delivers the latest news bulletins on the hour and Donna Hitbits, which plays non-stop music. The RTBF ensemble carries five audio stations, all being simulcasts of existing analogue stations, among them is BRF in German. The RTBF multiplex retains several slots for commercial radio, but these have not yet been allocated. Data services are expected to be trialled over the coming year.

Available DAB Services

Regions: Flanders, French-Speaking Area

Region	Service Name	Service Description	Public/Commercial	Launch Date
Flanders	nieuws+	Specific DAB programme - news bulletins on the hourl	Public	14/11/03
	Donna Hitbits	Specific DAB programme - continuous hit music	Public	14/11/03

	927Live	Sports	Public	30/05/02
	Radio Vlaanderen International	The international station brings news and current events from Flanders, Belgium and Europe, in Dutch, English, French and German	Public	01/01/99
	Radio 1	Informative programme - "A window on the world"	Public	11/09/97
	Radio 2	Entertainment and local news	Public	11/09/97
	Klara	Classical music, cultural, political and scientific information	Public	11/09/97
	Studio Brussels	Interactive youth pop and news programme	Public	11/09/97
	Radio Donna	Programme aimed at young people with hitmusic and an eye for lifestyle and entertainment	Public	11/09/97
	DAB-Klassiek	Specific DAB programme - non-stop classical music	Public	11/09/97
French Speaking Area	BRF Belgischer Rundfunk	German speaking	Public	01/01/00
	Radio 21		Public	01/01/00
	FM 21		Public	01/01/00
	Musique 3	Culture, classical music	Public	01/01/00
	La Première	Radio dramas, literature	Public	01/01/00

Switzerland

DAB Coverage

Status of DAB

(03/02/2005) In Switzerland, regular digital radio broadcasts began on 15th October 1999 in the Berne/Biel/Interlaken/Solothurn area. In November 1999, a second network was launched in the Zurich region. Additional networks were switched on in

Basle and in the Geneva/Lausanne area in the Q1 of 2000. Switzerland currently has approximately 4 million potential listeners (60% of Swiss population).

Public broadcaster SRG-SSR received the first Swiss digital radio licence in February 1999 from the Federal regulator BAKOM/OFCOM. The SRG licence includes the operation of a DAB multiplex and transmission network in VHF as well as the right to launch a new youth service.

SRG-SSR did in January 2004 an expansion of programmes. There are 11 services (3 mono) in the German speaking part and 10 (3 mono) in the French speaking part of Switzerland. The data capacity per channel is 128 kbps (64 kbps for mono).

The first multiplex includes the services DRS 1 and DRS 3 (also on FM), the cultural service DRS 2 which has poor FM coverage, the new youth channel Virus, and the services Musigwälle, SwissJazz, SwissPop, SwissClassic and the services from the other language areas La Première, Rete Uno and radio Rumantsch which currently can only be received via cable or satellite.

The second multiplex includes all the French programmes of SRG SSR, SwissJazz, SwissPop, SwissClassic and the services from the other language areas DRS 1, Rete Uno ansd Radio Rumantsch as well. This multiplex covers the whole region between Geneva, Lausanne and Yverdon. With a car receiver the French multiplex could be heard as far as Neuchâtel.

SRG SSR plans to expand the networks have been postponed due to the insufficient receiver roll-out throughout Europe. The improvement of the receiver penetration (more than the earlier adopters) in neighbouring countries and in Switzerland will be decisive to reactivate the investment from SRG in DAB. The positive decision to restart the expansion was taken at the end of 2004. The coverage will be enlarged by the end of 2005 in the eastern and southern part of Switzerland (20 new DAB sites).

The commercial broadcasters now show an interest but they aim to operate DAB in Band III and not in L-Band. For this purpose in 2002 SRG SSR relocated television services from channel 11 to UHF Band to free additional spectrum for its own and commercial DAB multiplexes. The start of combined ensembles on a second coverage is forseen locally in 2006.

Available DAB Services

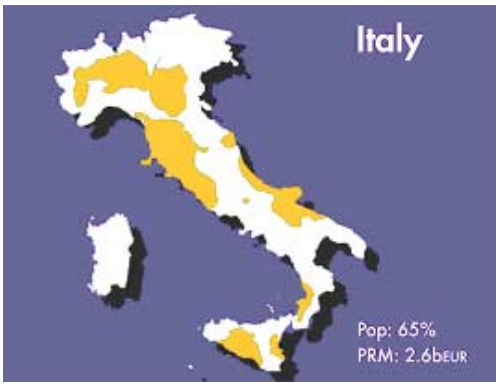
Regions: French Speaking Area, German Speaking Area, Graubünden, Italian Speaking Area

Region	Service Name	Service Description	Public/Commercial	Launch Date
French speaking area	La Première	French language, news, services, music MOR	public	01/03/00
	Espace 2	French language, classical music, culture	public	01/03/00
	Couleur 3	French language, rock, pop, special programmes for young	public	01/03/00

		people		
	Option Musique	News and information for older people	public	01/03/00
	DRS 1	German language, news, services, music for people aged 30+	public	01/03/00
	Rete 1	Italian language, news, services, music MOR	public	01/03/00
	Radio Rumantsch	programme in the 4th Swiss language, Romansch	public	01/03/00
	Swiss Jazz	German and English language, jazz and information about jazz	public	01/03/00
	Swiss Pop	German and English language, pop music and services (traffic/tourism)	public	01/03/00
German speaking area	DRS 1	German language, news, services, music for people aged 30+	public	14/10/99
	DRS 2	German language, classical music and culture	public	14/10/99
	DRS 3	German language, pop/rock/specials for younger people (25-50)	public	14/10/99
	Virus	Youth channel, rock/specials for young people aged 10-25	public	14/10/99
	Musigwälle 531	German language, Swiss folk music, information for older people	public	17/04/02
	Radio Rumantsch	Programme in the 4th Swiss language, Romansch	public	14/10/99
	Swiss Jazz	German and English language, jazz and information about jazz	public	14/10/99
	Swiss Pop	German and English language, pop music and services (traffic/tourism)	public	14/10/99
Graubünden	Radio Rumantsch	programme in the 4th Swiss language, Romansch	public	01/06/00
	DRS 1	German language, news, services, music	public	01/06/00

		for people aged 30+		
	Rete 1	Italian language, news, services, music MOR	public	01/06/00
	DRS 2	German language, classical music and culture	public	01/06/00
	Virus	Youth channel, rock/specials for young people aged 10-25	public	01/01/01
	La Première	French language, news, services, music MOR	public	01/01/01
	Musigwälle 531	German language, music, information for older people	public	01/01/01
	Swiss Pop	German and English language, pop music and services (traffic/tourism)	public	01/01/01
Italian speaking area	Rete 1	Italian language, news, services, music MOR	public	01/03/00
	Rete 2	Italian language, classical music and culture	public	01/03/00
	Rete 3	Italian language, pop/rock music	public	01/03/00
	DRS 1	German language, news, services, music for people aged 30+	public	01/03/00
	La Première	French language, news, services, music MOR	public	01/06/00
	Radio Rumantsch	Programme in the 4th Swiss language, Romansch	public	01/06/00
	Swiss Jazz	German and English language, jazz and information about jazz	public	01/06/00
	Swiss Pop	German and English language, pop music and services (traffic/tourism)	public	01/06/00

Italy



DAB Coverage

Status of DAB

(23/02/2005) Italy has been broadcasting DAB Digital Radio since 1995 when RAI began simulcasting its existing stations. In 1998 eight commercial analogue operators with national licences formed the Club DAB Italia consortium in order to simulcast their stations on their own digital mux.

Five national public services are simulcast on the public multiplex, reaching approximately 20% of the Italian population. Coverage on Ch 12, part of the public service charter, has been significantly reduced in order to allow the deployment of DVB-T along with the mandate of the new broadcasting law still to be approved by the Parliament. The commercial multiplex, which is operated by Club DAB Italia, and simulcasts six commercial and two non-profit FM services, is now on hold while it awaits a stable regulatory framework and is planning to start regular service. The private consortium EuroDAB has extended its trial coverage in some of the main populated areas reaching about 50% of the population. Their transmitters now provide coverage in Roma, Bergamo, Torino, Modena, Pisa, Grosseto and Genova. The multiplex, is composed of 5 FM simulcast services (3 national and 2 local) and 3 new digital only programs.

Among private operators Club DAB Italia has modified its membership and now includes a total of 9 stations licensed for national coverage. EuroDAB is now composed of 3 national and 2 local licensed operators. A new consortium has been set-up composed of one national station and a set of regional stations but has not started its trials yet.

Coverage layers in the South Tyrol province has been increased to 3 with two new multiplexes operated by the local public operator RAS, one in band VHF-III and one in band UHF-L.

Further development of Digital Radio poses the key issue of switch over from trials to regular service. Main trial coverage of the multiplexes is still limited to patches in the North-Western part of the country along the route from Turin to Milan, and in the South Tyrol province, in Rome, Neaples, and Palermo.

In mid-2002, the Italian Communication Authority released a frequency assignment plan for DAB that anticipated:

- in band VHF-III, two layers with national coverage (SFN) to be used by national services and one regional coverage (2-SFN) to be used for services that need a differentiation that approximately match the Italian administrative regions.
- in band UHF-L, four layers with local coverage (4-SFN) designed upon the needs of local operators.

The plan is based on allowing a minimum of seven services for each multiplex, but it does not take into account the situation at the borders nor the international frequency co-ordination aspects. In VHF-III it is based on Ch 12 only. Its publication has encouraged a new interest in DAB Digital Radio from local private broadcasters. However, the radio sector is now on hold awaiting clarification on the spectrum management issues and the new broadcasting law, as both aspects are linked to investment opportunities. Regarding spectrum the main drawback is linked to the pressure from public service DVB-T plans upon VHF band III that allows marginal resources to Digital Radio.

National public and commercial stations share the majority of the audience, but local stations remain important to the communities they serve. As digital broadcasting legislation is proposed, care will need to be taken for Digital Radio to maintain the balance currently enjoyed by analogue stations.

Available DAB Services

Regions: National, Local

Region	Service Name	Service Description	Public/Commercial	Launch Date
National	Radio 24 - Il sole 24 ore	News	commercial	01/08/01
	RDS - Radio Dimensione Suono	Music and Entertainment	commercial	08/10/98
	Radio DeeJay	Youth Music, Music News	commercial	08/10/98
	Radio Maria	Community Religious	non-commercial	08/10/98
	Radio Radicale	News, Parliament Works	non-commercial	08/10/98
	Radio 101 Centouno	Music, Entertainment	commercial	08/10/98
	RAI Radio 1	News	public	01/05/98
	RAI Radio 2	Music and Entertainment	public	01/05/98
	RAI Radio 3	Classical Music & Culture	public	01/05/98
	RAI IsoRadio	Traffic Information	public	01/05/98

	GR Parlamento	Parliament News	public	01/05/98
	RAI FD4	Classic Music	public	01/05/98
	RAI FD5	Pop Music	public	01/05/98
	Rete 105	Music and Entertainment	commercial	08/10/98
	RTL 102,5 Hit Music	Music, News, Entertainment	commercial	08/10/98
	Radio MonteCarlo	Music, News, Entertainment	commercial	01/08/03
	Top Digital Dance	Music (Digital Only)	commercial	01/08/03
	Top Digital Gold	Music (Digital Only)	commercial	01/08/03
	Top Digital Italy	Music (Digital Only)	commercial	01/08/03
Local	Radio Radio	Local News, Entertainment	commercial	01/03/01
	Hit Channel SAT	Music, News and Entertainment	commercial	01/08/03
	RAS-RAI Sender Bozen	Local News - German	public	01/04/03
	RAS Bayern Mobil	Traffic Info - German	public	01/07/97
	RAS Bayern 1		public	01/04/03
	RAS Bayern 2		public	01/04/03
	RAS Bayern 3	Classic Music - German	public	01/04/03
	RAS Bayern 4	Pop Music - German	public	01/07/97
	RAS Bayern 5	News - German	public	01/07/97
	RAS Bayern Data	Data	public	01/07/97
	RAS Data	Data	public	01/04/03
	RAS O1	Classical Music	public	
	RAS O 2		public	
	RAS O 3	Pop Music	public	
	RAS FM4		public	
	RAS Radio Rumantsch		public	
	RAS Swiss Jazz	Jazz Music	public	

Commercial analogue services expected to be launched in simulcast end '04

National	Radio Capital	Music, News, Entertainment	commercial

Radio m2o	Youth Music	commercial
Radio Italia Network	Youth Music	commercial
Radio Italia SMI	Italian Pop Music	commercial

Netherlands

DAB Coverage

Status of DAB

(22/02/2005) On February 27th 2004, NOS started broadcasting the public services Radio 1, 2 and 3FM via Digital Audio Broadcasting (DAB). On that date, Nozema inaugurated the first DAB transmitter in Lopik and started regular broadcasting in frequency block 12C.

On 2nd April 2004, radio stations Radio 4, 747AM and 'De Concertzender' were added, and can be listened to in the western part of The Netherlands. In February 2005 a news station called '24Nieuws' was added, and by April 2005 an 8th station will follow.

At the moment the Netherlands has a network that covers approximately 70% of the population. After commercial stations join in, coverage will rise in two stages from 90% to 100%.

The Dutch Government will issue DAB licences around summer 2005. After which commercial stations will fill two more national multiplexes and one multiplex for Randstad, the main urbanized area around Amsterdam, Rotterdam and the Hague. In total there will be about 48 radio stations in band III, later L-band will follow for local and regional radio.

Available DAB Services

Region	Service Name	Service Description	Public / Commercial	Launch Date
Rotterdam	Nozema		commercial	01/01/99
	Radio 1		public	27/02/04
	Radio 2		public	27/02/04
	Radio 4		public	01/02/02

	747 AM	public	01/02/02
	Radio 3 FM	public	27/02/04
	Concertradio	commercial	01/01/99
	Testkanaal 2	commercial	01/01/99
National	Amstel Radio	commercial	01/01/99
	I D & T	commercial	01/01/99
	City FM	commercial	01/01/99
	Salto Anderstalig	commercial	01/01/99
	Radio 1	public	27/02/04
	Radio 2	public	27/02/04
	Radio 3 FM	public	27/02/04
	Radio 4	public	02/04/04
	747 AM	public	02/04/04
	Concertzender	public	02/04/04

Portugal

DAB Coverage

Status of DAB

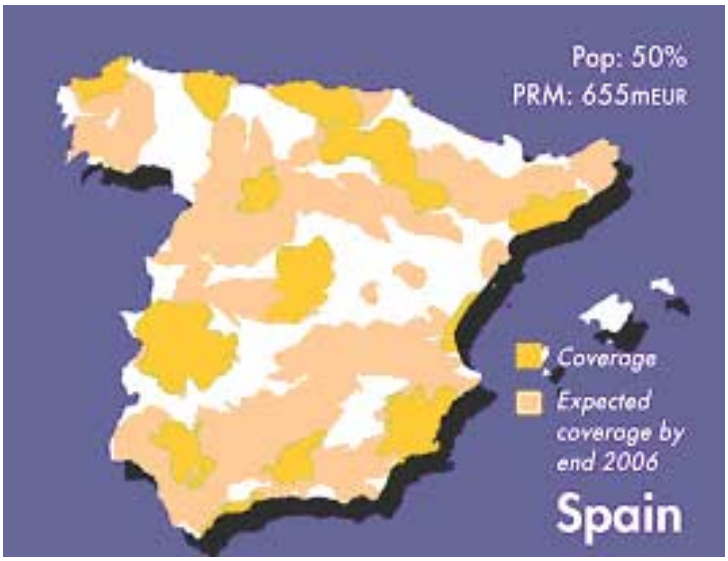
(02/02/2005) The public broadcaster RDP started DAB pilot broadcasts in January 1998. During Expo98, in Lisbon, several initiatives promoting DAB were developed. In March 1999 RDP won the licence for installing and operating the national multiplex (operated on channel 12B). RDP is also the programme provider for half of the DAB multiplex. A national network of some 74 transmitters will cover the whole country (Mainland and Atlantic Islands of Azores and Madeira) carrying 6 programmes – 3 of them from RDP (Antena 1, Antena 2 and Antena 3). Meanwhile, RDP is providing 5 programmes and is using the last available channel for a test transmission of the classical music programme, Antena 2, at reduced rate of 192 kbps.

There are 42 transmitters in use, 27 in the mainland, 9 in Azores and 6 in Madeira, covering more than 75% of the population. Portugal's 750km coastline is already fully served.

Available DAB Services

Region	Service Name	Service Description	Public/Commercial	Launch Date
National	Antena 1	Nationwide information and entertainment	public	22/05/98
	Antena 2	Classical Music and Culture	public	22/05/98
	Antena 3	Youth Music, Music News	public	22/05/98
	RDP Africa	Portuguese speaking countries	Public	*
	RDP Internacional	Worldwide Portuguese communities	Public	*
	Antena 2	Test transmission at 192 kbits/s		test
		* Temporary services, to be replaced by commercial services		

Spain



DAB Coverage

Status of DAB

(18/03/2005) DAB Digital Radio in Spain began with pilot stations in 1998 and today is a mix of public and commercial broadcasting, with 18 stations transmitting digitally. Most are simulcasts of analogue stations, and those unique digital stations, which do exist, are all run by commercial operators.

Stations unique to DAB Digital Radio include El Mundo, ABC and Recoletos, all of which are owned by newspaper groups. Other digital-only stations are Cope Digital, Ser Digital and Quiero Radio, which all follow a general music programming format.

There are plans for local DAB Digital Radio stations. In Catalonia 2 regional and 8 local commercial multiplexes were awarded at the end of 2003. Coverage stands at 52% of the population and this is set to rise to 80% by 2006.

Available DAB Services

Region	Service Name	Service Description	Public / Commercial	Launch Date
National	Radio 1	General programming	Public	2.2.01
	Radio Clásica	Classic Music	Public	2.2.01
	Radio 3	Pop Music	Public	2.2.01
	REE Europa	General programming for Europe	Public	2.2.01
	11B Prog. 5 (Grupo Correo)	Music	Commercial	2.2.01
	M-80 Digital	Music	Commercial	2.2.01
	SRDT Sólo Música	Music	Commercial	25.7.00
	Radio 1	General programming	Public	25.7.00
	Radio 5 Todo Noticias	All News	Public	25.7.00
	Punto Radio	Music	Commercial	25.7.00
	Quiero Radio	Music	Commercial	25.7.00
	Radio España	General programming	Commercial	25.7.00
	Cope Digital	General programming	Commercial	25.7.00
	El Mundo	General programming	Commercial	25.7.00
	Intereconomía	Financial News	Commercial	25.7.00
	Radio Marca	Sports	Commercial	25.7.00
	Ser Digital	General programming	Commercial	25.7.00
	Onda Cero Radio	General programming	Commercial	25.7.00

Finland

DAB Coverage

Status of DAB

(20/01/2005) In May 1999, the first part of the national DAB network was launched by the public broadcaster YLE with 10 transmitters (rising to 11 since 29th November

2001), covering 2 million people (approximately 40% of the Finnish population). One month later, a first regional multiplex was launched covering 1.2 million people.

YLE currently simulcasts its 5 existing analogue channels and has added 5 new 24h services (News/Talk service, Classical music channel, Young adult lifestyle channel, Multilingual foreign language news service, English news service) and 4 part-time services (YLE Parliament, Swedish language extra news, Swedish language extra sports, Educational radio).

On 14 November 2002 the Finnish Government granted Digita a network operating licence for the national multiplex and for the regional multiplex. Public broadcaster YLE has been assigned 4/6 of the capacity of the both multiplexes. Telemast Nordic Oy was issued with network operating licence for a digital local network in Greater Helsinki. Digital radio programme licences for private radio companies will become available in due course.

Available DAB Services

Region	Service Name	Service Description	Public/ Commercial	Simulcast/ DAB Only	Launch Date
National	YLEQ	Young adult lifestyle channel	public		01/11/99
	YLE Eduskunta	Direct transmissions from the parliament	public	DAB only	01/09/99
	YLE Radio 1	Cultural Channel	public	FM-Simulcast	01/05/99
	YLEX	Youth channel	public	FM-Simulcast	01/05/99
	Radio Extrem	Swedish Language youth channel	public	FM-Simulcast	01/05/99
	Ylen Klassinen	24 hours classical music channel	public	DAB only	01/05/99
	Radio Peili	News-talk; night time jazz	public	partly FM/AM	01/10/98
National/ Regional	YLE Radio Suomi	News, sports, information and regional channel	public	FM-Simulcast	01/06/99
	Radio Vega	Swedish language cultural channel	public	FM-Simulcast	01/05/99
Regional	Radio Vega+	Swedish language, news, Information, cultural channel	public		01/10/00
	Multiforum	Educational radio	public		01/01/01
	YLE World	English language news service	public		01/04/00
	YLE Mondo	Multilingual foreign language news service	public		01/04/00

Germany

DAB Coverage

Status of DAB

(01/02/2005) In Germany, approximately 80% of the population and area are covered and most of the 16 Federal States have now launched DAB services (audio programmes). There are approximately 80 different stations on the air.

In April 1999, the eastern German state of Saxony Anhalt was the first to launch Digital Radio services. More than 95% of the area, and virtually all of the 2.7 million inhabitants were covered from the start.

In May 1999, Bavaria became the second Federal State in Germany to switch from pilot to regular services, with an initial coverage of over 40% of area and population. At the end of 2001 over 10.6 million inhabitants were reached. The networks have been extended to over 90% coverage.

Since then, DAB has been implemented in all states (Länder) although the northern part, which comprise Schleswig-Holstein and Mecklenburg-Vorpommern still has a substantial way to go towards a nearly total coverage as in all other states. Germany is currently preparing for additional coverages expected from the RRC ’06. The additional capacity will be the necessary basis for sufficient and new stations to boost the industry. L-Band is perceived as necessary and beneficial technology for the specific needs of metropolitan areas.

In Germany, separate licences are required for network and multiplex operation and actual programme services. Network operators include Deutsche Telekom AG T-Systems International, Media & Broadcast, public broadcasters and new joint venture companies.

As well as a DAB commission within ZVEI, the German consumer electronics manufacturers’ association, which is trying to improve receiver penetration through co-operation with broadcasters and the automobile industry, the Initiative Marketing Digital Radio (IMDR) was launched on 9th May 2001. Members of the initiative are all network operators in Germany, some of the major receiver manufacturers (Blaupunkt, Delphi Grundig, Kenwood, Pioneer, Panasonic, TerraTec, Harris, Perstel Limited, Rohde & Schwarz. Texas Instruments, Visteon) and broadcasters (Bayerischer Rundfunk, NOVA RADIO). The German Car Manufacturers’ Association

(VDA) has in between also launched activities on behalf of DAB, in particular as a bearer for (traffic) data services.

Germany is a key country for the success of DAB because of the size of its potential market of more than 80 million people, 38 million households and 42 million cars.

Available DAB Services

Regions:
Augsburg | Baden-Wurttemberg | Bavaria | Berlin | Berlin-Brandenburg |Berlin Brandenburg West | Darmstadt/Wiesbaden | Frankfurt/Main | Freiburg | Halle | Hamburg | Hessen |Ingolstadt | Karlsruhe | Lower Saxony |Ludwigshafen | Magdeburg | Mainz | Mannheim | Meckl.-Vorp/Schwerin | Munich | North-Rhine/Westphalia | Nuremberg | Rhineland-Palatinate | Saarland | Saxony | Saxony Anhalt | Lower Saxony | Stuttgart | Thuringia | Ulm

Region	Service Name	Service Description	Public / Commercial	Launch Date
Augsburg	Radio Augsburg	Information and Culture	commercial	01/05/99
	Deutschlandfunk	Nationwide information and culture	public	01/05/99
	DeutschlandRadio Berlin	Nationwide information and culture	public	01/05/99
	Fantasy Aktuell	Information and News	commercial	01/05/99
	Fantasy Bayern	Contemporary Hit Radio	commercial	01/05/99
	Oldie Radio RT2	Oldies	commercial	01/05/99
	Smart Radio	Jazz	commercial	01/06/01
Baden-Württemberg	SWR1	Music and information channel	public	01/11/99
	SWR2	Culture	public	01/11/99
	SWR3	Rock and Pop music	public	01/11/99
	DASDING	Youth channel	public	01/11/99
	Hitradio Antenne 1	Music and Information channel	commercial	01/11/99
	Antenne 1 info digital	Information	commercial	01/11/99
	BIG FM	Music channel	commercial	
	ContRa	Information channel	public	01/08/02

Bavaria	BR-DAS Modul	Youth channel	public	27/01/03
	BR-Business	Business channel	public	27/01/03
	BR-Verkehr	News and information	public	27/01/03
	BR Wetter	Weather channel	public	27/01/03
	Bayern 4 Klassik	Classical Music	public	01/05/99
	Bayern 5 Aktuell	News and information	public	01/05/99
	Bayern Mobil	Traffic information	public	01/05/99
	Radio Galaxy	Youth channel	commercial	01/05/99
	Rock Antenne	Rock Music	commercial	01/05/99
	MobilData	Data Services	commercial	15/09/99
Berlin	BB Radio Regional			
	Deutsche Welle - Fremdsprachenkette			
	Hit-Radio			
	Hundert,6		commercial	26/08/95
	MCC Datendienst			
	ORB-SFB-radio kultur			
	RockIT Radio			
	SFB-ORB InfoRadio			
	SFB-88 Acht!			
	SFB Multi-Kulti			
	VoA - 87,9 Rock FM			
	WDR2			
Berlin-Brandenburg	BB Radio Landeswelle			
	Deutschland Radio Berlin		public	
	Deutschlandfunk		public	
	ORB-Antenne Brandenburg			
	94.3 r.s.2		commercial	26/08/95
	Hit Radio			
	VoA - 87,9			

	RockIT			
Berlin/Brandenburg West	Energy 103.4			
	Radio Starlet			
	104.6 RTL		commercial	26/08/95
Darmstadt/Wiesbaden	RTL Oldie Radio		commercial	01/01/99
	Frankfurt Business Radio		commercial	01/04/97
	Harmony FM			
	Sky Radio			
	DAB Antenne Magic			
Frankfurt/Main	Harmony FM	Oldies	commercial	01/08/02
	News Aktuell			
	Frankfurt Business Radio			
	Sky Radio			
	DAB Antenne Magic			
Freiburg	Radio Energy	Pop music	commercial	01/11/99
	Radio Regenbogen	Adult contemporary	commercial	01/11/99
	Radio L-Fun	Literature and classical music	commercial	01/11/99
	SWR4	'Volksmusic'	public	01/11/99
	Deutschlandfunk	News and culture	public	01/05/99
	DeutschlandRadio	News and culture	public	01/11/00
	Antenne Sudbaden			
Hamburg	DeutschlandRadio	Nationwide Information and Culture	public	06/01/03
	Deutschlandfunk	Nationwide Information and Culture	public	06/01/03
Halle	ARVID			
	Project 98,0 DIGITAL			
	Radio SAW			
	Rockland Sachen-Anhalt			
Hessen	DeutschlandRadio	Nationwide	public	01/01/01

		Information and Culture		
	Deutschlandfunk	Nationwide Information and Culture	public	01/01/01
	Hit Radio FFH	Pop music	commercial	01/08/02
	n-tv	Video streaming of n-tv TV news	commercial	01/01/98
	InfoLine		commercial	01/04/97
	Train Information	Train information (timetables etc)	commercial	01/01/98
Ingolstadt	Cool Radio		commercial	
	Radio Riverside	Country Music	commercial	01/02/01
	Radio Melodie	Folk Music	commercial	
	MobilData	Data Services	commercial	02/06/99
	Deutschlandfunk	Nationwide information and culture channel	public	01/05/99
	DeutschlandRadio Berlin	Nationwide information and culture channel	public	01/05/99
	Fantasy Bayern	Contemporary Hit Radio	commercial	01/05/99
	Radio IN	Pop Music	commercial	01/05/99
Karlsruhe	Radio Energy	Pop music	commercial	01/11/99
	Radio Regenbogen	Adult contemporary	commercial	01/11/99
	Radio L-Fun	Literature and classical music	commercial	01/11/99
	SWR4	'Volksmusic'	public	01/11/99
	Deutschlandfunk	News and culture	public	01/11/99
	DeutschlandRadio	News and culture	public	01/11/00
Ludwigshafen	Deutschlandfunk	Culture and information	public	01/07/02
	Domradio	Diocese radio	commercial	02/02/03
	Project 89.0 digital	Youth channel	commercial	tba

	Radio Trier 22	Adult contemporary	commercial	23/12/02
	Magaradio	Youth channel	commercial	tba
	SWR4	Volksmusik	public	01/07/02
Magdeburg	ARVID		non-commercial	
	Project 98,0 DIGITAL			
	Radio SAW			
	Rockland Sachsen-Anhalt			
Mainz	Deutschlandfunk	Culture and information	public	01/07/02
	Domradio	Diocese radio	commercial	02/02/03
	Project 89.0 digital	Youth channel	commercial	tba
	Radio Trier 22	Adult contemporary	commercial	23/12/02
	Magaradio	Youth channel	commercial	tba
	SWR4	Volksmusik	public	01/07/02
Mannheim	Radio Regenbogen	Adult contemporary	commercial	01/11/99
	Radio TON_Regional	Adult contemporary	commercial	01/11/99
	Radio Sunshine live	Youth channel	commercial	01/11/99
	Radio L-Fun	Literature and classical music	commercial	01/11/99
	SWR4	'Volksmusic'	public	01/11/99
	Deutschlandfunk	News and culture	public	01/11/99
	DeutschlandRadio	News and culture	public	01/11/00
Meckl.-Vorp. / Schwerin	DeutschlandRadio	Nationwide Information & Culture	public	06/01/03
	Deutschlandfunk	Nationwide Information & Culture	public	06/01/03
Munich	Radio Deluxe	Smooth Jazz	commercial	
	MobilData	Data Services	commercial	17/10/99

	Deutschlandfunk	Nationwide information and culture channel	public	01/05/99
	DeutschlandRadio Berlin	Nationwide information and culture channel	public	01/05/99
	Digital Classix	Classic Hit Radio	commercial	01/05/99
	Fantasy Bayern	Contemporary Hit Radio	commercial	01/05/99
	Gong Mobil	Traffic information	commercial	01/05/99
	Nova Radio			
North-Rhine Westphalia	Power Radio		commercial	30/01/97
	WDR Eins Live	Rock & Pop music	public	30/01/97
	WDR 2 Klassik	WDR 2 content plus classical music	public	30/01/97
	WDR 3	Classical music	public	30/01/97
	Deutschlandfunk	Nationwide information and culture channel	public	30/01/97
	DeutschlandRadio Berlin	Nationwide information and culture channel	public	30/01/97
	WDR-InfoKanal		public	30/01/97
	WDR Verkehrskanal	Traffic announcement channel	public	30/01/97
Nuremberg	Deutschlandfunk	Nationwide information and culture channel	public	01/05/99
	DeutschlandRadio Berlin	Nationwide information and culture channel	public	01/05/99
	Energy Nürnberg	Pop Music	commercial	01/05/99
	Fantasy Bayern	Contemporary	commercial	01/05/99

		Hit Radio		
	Pirate Radio	Techno and House	commercial	01/05/99
	Vil Radio	Jazz and modern music	commercial	01/05/99
Rhineland - Palatinate	SWR1 Rheinland-Pfalz	News and music	public	01/12/01
	SWR2	Culture and classical music	public	01/12/01
	DASDING	Youth channel	public	01/12/01
	Radio RPR Eins	Schlager	commercial	01/12/01
	DeutschlandRadio	Culture and information	commercial	01/12/01
Saarland	SR 1 Europawelle		public	17/12/96
	SR 2 KulturRadio		public	17/12/96
	Radio Salü		commercial	17/12/96
	Radio Salü Gold		commercial	06/01/03
Saxony	DR Klassik	Classical music		03/04/02
	Hit Radio Antenne Sachsen			03/12/01
	Project 89,0 Digital			03/12/01
	Deutschlandfunk	Nationwide information and culture channel	public	30/11/99
	DeutschlandRadio Berlin	Nationwide information and culture channel	public	30/11/99
Saxony Anhalt	MDR Klassik			06/05/02
	Project 89,0 digital			04/04/01
	Radio SAW			01/04/99
	Rockland Sachsen-Anhalt	Rock music, news, traffic	commercial	01/04/99
	Deutschlandfunk	Nationwide information and culture channel	public	01/04/99

	DeutschlandRadio Berlin	Nationwide information and culture channel	public	01/04/99
	ARVID		non-commercial	01/04/99
Lower Saxony	NDR Info	News and information	public	01/07/02
	DeutschlandRadio	Nationwide information & culture channel	public	01/07/02
	Deutschlandfunk	Nationwide information & culture channel	public	01/06/00
	NDR1 Niedersachsen	Local channel for Lower Saxony	public	01/06/00
	NDR 2	Pop music & information	public	01/06/00
	NDR 90,3			
Stuttgart	Die Neue 107,7	Oldies & hits for people 25 & over	commercial	01/11/99
	Radio NRJ//Energy	Hits and oldies	commercial	01/11/99
	Radio BB	Smooth Jazz	commercial	01/11/99
	Neckar Alb Radio	Adult contemporary	commercial	01/11/99
	SWR4	'Volksmusic'	public	01/11/99
	Deutschlandfunk	News and culture	public	01/11/99
	DeutschlandRadio	News and culture	public	01/11/00
Thuringia	MDR Klassik			06/05/02
	Antenne Thüringen		commercial	01/02/00
	Radio Top 40		commercial	01/02/00
	Deutschlandfunk	Nationwide information and culture channel	public	01/02/00
	DeutschlandRadio Berlin	Nationwide information and culture channel	public	01/02/00

Ulm	Neckar Alb Radio	Adult contemporary	commercial	01/11/99
	Antenne Filstal	For listeners aged 20 to 50	commercial	01/11/99
	Radio Free FM	"open radio", targeting youth	public	01/11/99
	Deutschlandfunk	News and culture	public	01/11/99
	DeutschlandRadio	News and culture	public	01/11/00

Appendix 2 Network Planning

The network design and planning requirement for DRB is set against the backdrop of a recent Government statement:

> "The Government is committed to ensuring that all Australians, regardless of where they live, have access to the best radio services possible. In choosing suitable digital radio technology, the ability to serve metropolitan, regional and rural areas in a viable fashion is an important factor to be considered".

(i) Propagation characteristics of VHF and L-Band spectrum

The propagation characteristics of VHF Band III (174 – 230MHz) are very well suited to use in broadcast applications such as DRB. The non-line of sight propagation enhances the achieved coverage of this spectrum whilst impulse noise is less of an issue than, say, at VHF Band I.

The use of VHF Band III spectrum for DRB in Australia is largely restricted by the current use of this spectrum for analogue and digital television services. To maximise the radiated power of the DRB services in this band, it is necessary to "co-site" the DRB services with the adjacent television services. By "co-site", in the same way as this is used for DTV, this means that the transmissions need to originate from materially the same location. For example, in Brisbane, transmissions from any of the towers at Mt Coot-tha could be considered "co-sited". Similarly, transmissions from the three broadcast towers in the Artarmon triangle would be considered to be "co-sited".

L-Band spectrum (1452 – 1492MHz) is very good for line-of-sight propagation and provides a good compromise for a mixed satellite/terrestrial solution.

International experience is that building penetration loss at VHF Band III is approximately 2dB less than that experienced at L-Band.

One of the requirements of the future DRB system is that it can provide the same level of coverage as the existing AM and FM services.

Replication of wide-area transmissions, for example 3WV in Western Victoria, would be extremely expensive to achieve using the Eureka 147 standard in VHF and L-Band spectrum, given the number of transmission sites that would be required. In cases such as these, we believe that serious consideration should be given to the adoption of DRM technology.

With the Eureka system, one of the key decisions required is the determination of the target receiver. The options include a "kitchen-type" portable receiver with telescopic antenna, a handheld device with integrated receiver or a car mounted receiver with powered externally mounted receive antenna. (In all cases, the actual height of the receive antenna for these receivers is typically 1.5m.) Once the target receiver type has been selected, the minimum field strength requirement to achieve "same coverage" can be determined. The tables below show indicative minimum field strength requirements for the three types discussed above.

VHF Band III Minimum Field Strength Requirements for Rural areas

	Portable	**Hand-Held**	**Car**
Minimum FS dBuV/m	40	44	35
Antenna Height Correction from 1.5m to 10m	10	10	10
Location Correction for 95% locations	9	9	9
Building penetration loss for a single storey building	6	6	0
Effective minimum medium field strength at 10m (dBuV/m)	66	70	54

L-Band Minimum Field Strength Requirements for Rural areas

	Portable	**Hand-Held**	**Car**
Minimum FS dBuV/m	52	58	46
Antenna Height Correction from 1.5m to 10m	10	10	10
Location Correction for 95% locations	9	9	9
Building penetration loss for a single storey building	8	8	0
Effective minimum medium field strength at 10m (dBuV/m)	79	85	65

As can be seen from the above tables, the selection of target receiver has a significant impact on the required minimum field strength. This has a corresponding impact on the number of sites required to achieve same coverage.

To ensure that DRB is a success, we believe that its coverage must be near ubiquitous, and satisfy the 'same coverage' requirements as analogue radio services. Therefore, planning should allow for all existing listeners to have the choice of receiver and hence, planning should be on the basis of hand-held receivers.

On the basis of a hand-held receiver as the target receiver for DRB, an equivalent 70dBuV/m minimum field strength is required for same coverage. In the case of Sydney, where the National and Commercial FM services operate at 150kW ERP, this would imply an ERP of 6MW for the DRB service (replicating the same a single transmission facility) – clearly impractical! The solution is to provide coverage through a distributed network of transmission sites.

The minimum field strength requirements for suburban and urban coverage based on the use of the hand-held reference receiver, are shown in the tables below for VHF and L-Band respectively.

VHF Band III Minimum Field Strength Requirements for Suburban and Urban areas

Parameter	Hand-held	
	Suburban	**Urban**
Minimum FS (dBμV/m)	44	44
Antenna Height Correction from 1.5m to 10m	10	10
Target Location availability	95%	99%
Location Correction for 95% locations	9	13
Building type assumption	2 to 4 storey buildings	Over 6 storey buildings
Building penetration loss (dB)	12	15
Effective minimum medium field strength at 10m (dBμV/m)	75	82

L-Band Minimum Field Strength Requirements for Suburban and Urban areas

Parameter	Hand-held	
	Suburban	**Urban**
Minimum FS (dBμV/m)	58	58
Antenna Height Correction from 1.5m to 10m	10	10
Target Location availability	95%	99%
Location Correction for 95% locations	9	13
Building type assumption	2 to 4 storey buildings	Over 6 storey buildings
Building penetration loss (dB)	14	17
Effective minimum medium field strength at 10m (dBμV/m)	91	98

(ii) Availability of spectrum

Significant work was done in 1998 and 1999 by an industry working group formed by DCITA, ABA and ACA to consider the availability of L-Band spectrum to meet the current and proposed future needs. Given the uncertainty surrounding availability of VHF Band III spectrum at that time, only an L-Band channel plan was developed.

Whilst, from Appendix 2, it can be seen that this previously assumed minimum field strength expectation is low, in comparison to current expectations (this being primarily driven by the change in target receiver and the higher location availability required), the L-Band channel plan developed at that time provides a good indication of the potential channel availability at L-Band.

Given the significant advantage of VHF spectrum over L-Band, it is likely that, wherever practical, it will be the first choice for use for DRB.

In the five metropolitan markets, there is currently a 6MHz block available which can accommodate ensembles 9A, 9B and 9C. It would be possible to make available a fourth ensemble, (9D) however, this would require the existing channel 10 analogue transmissions to be moved upwards by 1MHz; such change would require careful planning, and would more likely be considered for implementation at a time when the major audience had transferred to DTV.

In all cases, the use of VHF spectrum in the Metropolitan markets will be limited because of the adjacent channel analogue television services. Whilst the ERP limitation is not consistent across the ensembles, it is thought likely that all ensembles will operate at the same power to provide equity of coverage. This is made more likely by the fact that all ensembles would require additional L-Band repeaters.

Given that adequate spectrum was previously identified in the 1998/9 study for an all L-band solution, we see no reason for there to be adequate spectrum to provide an L-band repeater channel for the VHF Band III ensembles, as well as providing an all L-Band solution in markets where no Band III spectrum can be made available.

(iii) Applicability of SFN's

SFNs <u>will</u> be required for DRB when using L-Band due to spectrum scarcity.

It would be beneficial to have VHF SFNs, however, this will not generally be practical in areas where the VHF spectrum used for DRB is adjacent to existing analogue television services. It may be possible to plan some VHF SFNs from existing television repeater sites provided careful attention is paid to the viewing habits of the local residents.

The use of well planned SFNs provides the following advantages over a single site transmission:

1. Spectrum efficiency
    a. one frequency used from multiple transmitters; and
    b. reduced frequency re-use distance because of lower powered sites

2. Higher service availability
    a. Advantage of network gain whereby multiple received signals have a cumulative affect making the received signal more robust
    b. Loss of one transmission site does not equate to total loss of service; and
    c. Diversity of transmission path to receivers – particularly valuable in densely built-up areas such as the CBD

The disadvantages of SFNs may include:

1. More complex planning required
2. More complex network of transmission sites to operate
3. Higher cost – particularly distribution costs to the transmission sites

The use of SFN's is fairly widespread within the Australian DTV environment, and although more complex in design and planning than a Multi-Frequency Network (MFN), there is significant Australian expertise.

The use of a VHF Band III main site with L-band off-air repeaters opens up the opportunity for the operators to reduce distribution costs relative to a L-band only SFN. Whilst this approach does reduce costs, it also introduces a potential single point of failure for the service – the VHF transmission from the 'parent' source.

The selection of Mode II or Mode IV for L-Band SFNs is a compromise between transmitter spacing and the maximum speed a vehicle can travel at in a straight line to or from a transmitter site. As such, Mode IV may find favour in metropolitan areas, however, it is unlikely to be viable in markets with significant amounts of highway.

Appendix 3 Scenario testing

Aggregation versus existing markets - particularly in rural areas

The use of the Eureka system provides an efficient means of transmission where there are sufficient services in a market to fill or nearly fill the ensemble. However, in areas where there are two or three services, it can be an expensive system to implement.

Scenario 1: Aggregation of adjacent markets: to ensure that there is an appropriate number of services in a market.

It is anticipated that many of the broadcasters using MF spectrum (AM) will wish to convert to the Eureka standard using VHF and/or L-Band spectrum. Given the very different propagation characteristics of MF/VHF/L-Band spectrum, in many cases, the MF transmission site will be geographically distant from the site most suited to the delivery of VHF and L-Band transmissions. It will not therefore be practical to attempt to precisely match to DRB services with the AM service; this will generally be less of an issue for FM services, as these operate at VHF and in most cases will be expected to be co-located with the future DRB services, particularly for the prime transmitter. In some cases, deliberate coverage matching will prove unnecessarily costly. The best suited terrain for MF broadcasting is that with good conductivity, which tends to be swampy, or adjacent to river/water systems, and is therefore low lying – unlike the high ground required for optimum line-of-site launch of VHF/UHF/L-Band transmissions

Scenario 2: Aggregation of adjacent markets which incorporates a practical level of overlap between markets in digital mode.

This may result in a cost effective and practicle solutions and be particularly applicable in situations where the main transmission site for television covers both of the existing radio markets. In these circumstances, existing infrastructure will be available for the primary site.

Unlike television, where de-facto orientation of directional antennae can be used to in part define the market/coverage boundary, radio reception generally operates from omni-directional antennae – usually built-in to the receiver. It is important that in planning the introduction of DRB services, that the planning constraints do not entirely rely on a straightjacket of pure analogue replication – coverage planning regulation needs to be sensibly applied, taking account of the current market definition, natural social and geographic boundaries, the availability and suitability of spectrum for digital transmissions, and the availability and suitability of existing infrastructure.

Appendix 4 Audio Coding Technologies and Standards

(i) MPEG Coding

Since 1988 ISO/MPEG has been undertaking the standardisation of compression techniques for video and audio. The original main topic of MPEG was video coding together with audio coding for digital storage media. The audio coding standard developed by this group has found its way into many different applications, including:

- Digital Audio Broadcasting (Eureka, DAB, WorldSpace, ARIB, DRM)
- ISDN transmission for broadcast contribution and distribution purposes
- Archival storage for broadcasting
- Accompanying audio for digital TV (DVB, Video CD, ARIB)
- Internet streaming
- Portable audio (mplayer3 and others)
- Storage and exchange of music files on computers

MPEG-1 is the name for the first phase of MPEG work, started in 1988 and was finalised with the adoption of ISO/IEC IS 11172 in late 1992. The audio coding part of MPEG-1 describes a generic coding system, designed to fit the demands of many applications. MPEG-1 audio consists of three operating modes called layers with increasing complexity and performance from Layer-1 to Layer-3.

The most widely used audio compression formats are MPEG-1/MPEG-2 audio layers 2 and 3.

Since the development of MPEG-1 technology, research on perceptual audio coding has progressed and codecs with better compression efficiency have become available. Of these, Advanced Audio Coding (AAC) was developed as the successor for MPEG-1 audio. AAC is a second generation audio coding scheme for generic coding of stereo and multi-channel signals.

MPEG-4, finished in late 1998 is the next major standard for multimedia with focus on functionalities such as interactive, mobile etc.. This standard facilitates the growing interaction between computing, broadcasting and telecommunications. MPEG-4 audio consists of a family of audio coding over large bitrates and uses AAC for generic audio coding.

In MPEG-1 codecs are hardware based whereas AAC codecs are software based which lends itself for easier upgrades.

(ii) Advanced Audio Coding (AAC)

The basic or original coding scheme is referred to as AAC and written as ‘AAC’. This basic system was later improved with the addition of Spectral Band Replication (SBR)[5] leading to the aacPlus v1 coding scheme. This is often written as ‘AAC+’, ‘AAC+ v1’ or ‘aacPlus v1’ or ‘HE-AAC’ (‘HE’ standing for high efficiency AAC) as it has been standardised as the high-efficiency profile in MPEG-4 part 10.

[5] Spectral Band Replication became part of the MPEG-4 standard (2003) as the High Efficiency AAC profile and also part of the MPEG-2 standard (2003)

The improved system was later further improved with the addition of Parametric Stereo (PS) leading to the aacPlus v2 coding scheme. This is often written as 'AAC+ v2', 'enhanced AAC+'.

In other words,

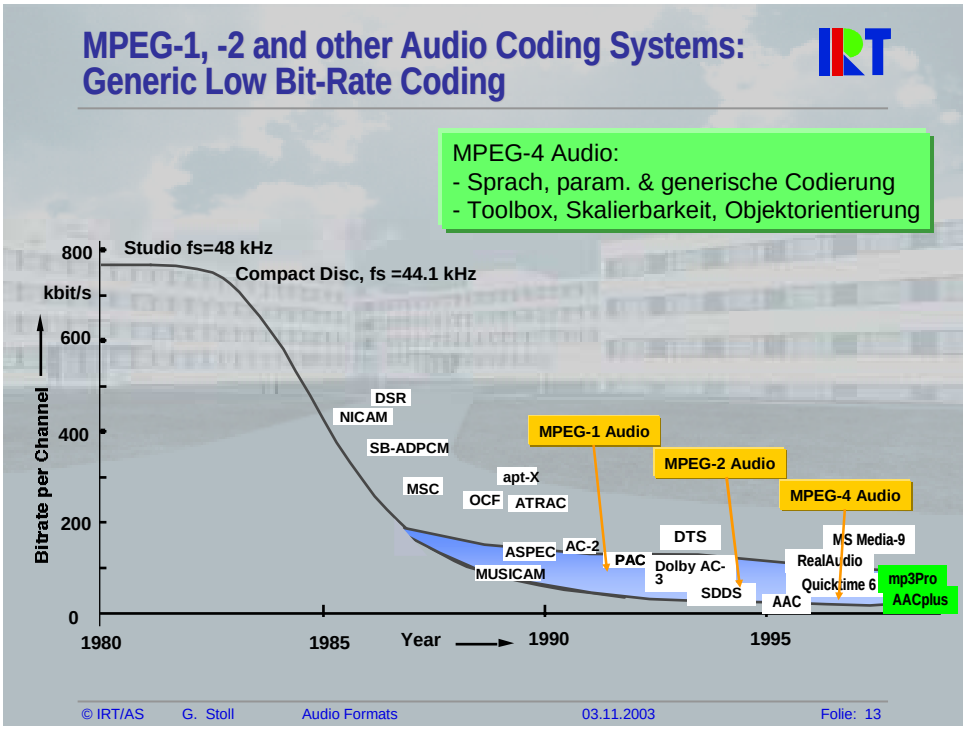
'AAC' and SBR = 'aacPlus v1' (or 'AAC+' or 'HE-AAC')
'aacPlus v1' and PS = 'aacPlus v2' (or 'AAC+ v2' or 'enhanced AAC+').

As an integral part of MPEG-4 audio, AAC+ is ideal for deployment with the new H.264/AVC video codec standardised in MPEG-4 part 10.

AAC (and its variants) is increasingly being based on software encoders and decoders; it therefore provides a much better future-proofing path for equipment than the traditional MPEG hardware/firmware approach and implementations.

(iii) Bit-rate and Quality: improvements over time

The following chart (*extract from paper by Gerhard Stoll from Institut fur Rundfunktechnik, Munchen, Germany)* illustrates the reduction in bit-rate requirements over time against an acceptable level of subjective audio quality; it clearly highlights mp3PRO and AAC+ as leading coding schemes and shows the time legacy of earlier coding systems, such as MPEG 1, Layer II.



To this date, controlled listening tests are still the only method available to compare the performance of different coding algorithms and different encoders. The ITU-R has developed a very elaborate set of rules for listening tests. The aim of these tests is to stress the encoders under worst case conditions.

MPEG 1 Layer II is mature technology; encoder efficiency performance has virtually reached a plateau, and from the evidence of controlled listening testing, is now only showing incremental improvement over earlier generation coders. No material step-change improvement is anticipated going forward.

New coding techniques provide major improvements. Many of these alternative encoding standards are targeted at specific applications eg internet streaming and not necessarily suitable for digital radio applications

AAC+ is being widely adopted across multiple platforms. AAC+ offers mono, stereo and multi-channel capabilities.

"EBU technical report 3296 of June 2003 carried out subjective listening tests on low-bitrate audio codecs. This document contains results of recent evaluations carried out on several commercial audio codecs by the EBU Project Group B/AIM (audio in multimedia). The evaluations were carried out on the newer generation of codecs, such as Windows Media 8, CTaacPlus, mp3PRO, RealAudio 8 and others.

The report shows that at 48kbps to 64kbps, a new technology – spectral band replication (SBR) – has contributed to some significant improvements. This technology has been built into several existing codecs and has helped AAC and mp3 to become virtually transparent at 64kbps. These are extremely encouraging developments."

The EBU 3296 report had not considered developments with Parametric Stereo (PS) at the time of testing.

Refer also to EBU Tech report 3296 on 'Low-bitrate audio codecs' which reports that AAC and mp3 are virtually transparent at 64kbps.

Some new research (from the Fraunhoffer institute for example) is showing how newer generation codecs can now adapt to differing incoming audio content genres (ie not fixed tweaked to any specific genre).

There are several ITU-R recommendations which show improvements over time: for example, BS.1115 'Low bit-rate audio coding' (1994) recommended 256kbps for a stereo signal but BS.1548-1 'User requirements for audio coding systems for digital broadcasting' (2001-2002) for example shows that AAC at 144kbps fulfils the same requirement as the old recommendation – this does not even take into account HE-AAC V2 (enhanced) which provides significant further enhancement. More recent ITU-R study group tests 'Coding of moving pictures and associated audio information' (25 January 2005) recommends that some of the older ITU-R standards such as 1115 and 1548-1 be updated by July 2005 to reflect the significant improvements that HE-AAC V2 provide. A detailed report WG 11 N 6009 provides the formal verification.

(iv) Widespread deployment of AAC as the coding standard

The proliferation of the AAC+ is becoming increasingly adopted in a wide range of digital broadcasting standards as listed below:

DVB: DVB has specified AAC+ and AAC+ V2 (enhanced) for broadcasting using MPEG-2 transport stream (ETSI TS 101 154) and for IP based services (ETSI TS 102 005).

DVB-H: This is an IP-based DVB service, and uses AAC+ and AAC+ V2.

DRM: AAC is used on this platform.

The DRM system can use three different types of audio coding, depending on broadcasters' preferences. MPEG4 AAC+ audio coding is used as a general-purpose audio coder and provides the highest quality. Alternatively, MPEG4 CELP speech coding is used for high quality speech coding where there is no musical content and HVXC speech coding can be used to provide a very low bit-rate speech coder.

DMB: This can be divided into three categories:

(i) Korean market with T-DMB: This will use BSAC
(ii) Korean market with S-DMB: This will use AAC+
(iii) European market with T-DMB: Most likely to use AAC+ V2

WorldDAB: As part of their DVB project, WorldDAB are actively looking for alignment of technologies over several platforms including DMB/3G/UMPTS and DVB-H *(WorldDAB Technical Committee report 18 March)*

XM Satellite: AAC is used on this platform

ISDB: AAC is optional on this platform

MBCo: AAC is used on this platform in Japan

3GPP: AAC has been tested on this mobile phone platform (3rd Generation Partnership Program) down to 18kbps.

The range and number of chip sets is continuing to rapidly evolve and is being deployed in CE devices, the ability to adopt AAC within Eureka 147 devices is not a barrier at the technical and production level.

Although AAC (and its variants) have yet to be formally adopted into the Eureka standards, the industry perspective (from a number of leading industry and regulatory representatives across Europe) is that this is only a matter of time – and probably soon.

Radioscape are already developing a Eureka receiver module with an AAC+ decode capability for a Canadian client and have stated that this is a straightforward configuration of their product, albeit non-standard because of the current Eureka specification, and which could be made available to others if required.

(iv) Emission vs Contribution/Distribution requirements

In considering the specification and standard for audio encoding in the DRB system, it is important to separate the requirements for contribution and distribution and that required for emission (i.e. transmission)

Emission requirements are those for linking content providers with their audiences whereas contribution/distribution requirements are those for linking the internal production process.

Contribution/distribution requirements are typically far more stringent in relation to the ability to cascade compressed audio over a number of iterations. In contrast, the emission requirement is the last link in the chain which connects the content provider with the audience and thus there is no further cascading requirement.

It does not automatically follow that the optimal solution for emission requirements is also optimal for contribution/distribution requirements and vice versa.

The following table is an extract from report[6] showing relative impact of cascading effects:

Pros and Cons of audio coding systems

MPEG Audio	**Suitability**	**Standard**
High Quality	++	MPEG-1, -2, -4
Scalable Quality	+	MPEG-1, -2, -4
Reduction of transmission or storage costs	+ ++	MPEG-1 MPEG-2, -4
Cascadability	+ - --	MPEG-1, -2, L1 & L2 MPEG-1, -2, L3 MPEG-2, -4, AAC
Coding Delay	- --	MPEG-1, L1 & L2 MPEG-1 L3, MPEG-2, -4

(v) Enhanced Packet Mode for DAB

The original implementation of DAB using MPEG-1 Layer II encoding operates satisfactorily with a bit-error-rate (BER) of up to 10^{-4}. However, this error rate performance is not adequate for more efficient video and audio coding schemes which require a BER performance of the order of up to 10^{-8}.

Consequently, in order for newer coding schemes to be accommodated on DAB a new system known as 'Enhanced Packet Mode' has been developed for DAB and is currently being submitted to ETSI for formal adoption (refer to WorldDAB EP-57 document for details).

[6] *Extract from paper by Gerhard Stoll from Institut fur Rundfunktechnik, Munchen, Germany.*

This system establishes a mechanism for taking DAB packets and adding a second set of packets, which contain the forward error protection information, which allows a receiver with the enhanced error protection for packet mode capability to receive the original packets in an errored channel. Any existing receivers without the enhanced packet mode capability will be able to decode the original set of packets and ignore the packets containing the error protection information.

The system performs the addition of outer Reed Solomon (RS) coding and outer interleaving (virtual interleaving).

Enhanced Packet Mode will provide a significant level of future-proofing for DAB so as to be able to accommodate different types of audio and video codecs. This will move DAB forward for other applications such as streaming, IP based services, carouselling etc., thus allowing DAB to be not only regarded as a radio standard in the future.

Implementation of this enhancement in DAB receivers has already commenced by way of example as is evident in the forthcoming launch of the UK Livetime project in September this year.