

## The Digital Dividend

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### Introduction

The term digital dividend has been around for a number of years in relation to the introduction of digital TV in other countries such as the UK. But what is it? And what could it be used for?

In this presentation I hope to provide an introduction to this topic and outline some initial thinking. I'll do this by looking at some overseas examples; doing a rough calculation to get a feel for how big it could be; we'll look the shape of it; and then take a look at each of the television bands to see if we can identify where some of this dividend might come from.

Before I go any further, I would like to stress that this presentation provides some initial thoughts only. This is an area of work that has been included as part of the recently announced Digital Action Plan, which tasks ACMA to commence work on issues associated with the return of analog spectrum at the end of the simulcast period[1]. The Digital Action Plan recognises that in order to ensure optimum use is made of that spectrum for delivery of services, there must be a detailed understanding of the impact of different uses and options.

To give you a flavour of some of the issues and options that may be involved in the planning for any 'digital dividend,' I am going to describe some possible options that are based on plausible scenarios. I have to emphasise that these do not represent either ACMA or Government policy and have been chosen merely to show you the kinds of tradeoffs entailed in digital dividend planning.

## The Digital Dividend – what is it?

The digital dividend is a term used to describe the benefits that arise from the conversion to digital television. But the term is not really about the benefits of digital television, such as clearer pictures, high definition, electronic program guides (EPGs), etc. The term is used more in the sense that the switching off of analog television services will free up significant amounts of spectrum in the VHF and UHF bands, and that will open up opportunities to provide new services.

### The Digital Dividend – potential uses

The size and nature of the digital dividend will depend on how Australia decides to use this spectrum. As we are not alone in considering the digital dividend, we can stand on the shoulders of others to get a better view...

The UK's regulator, Ofcom in its announcement on its digital dividend review [2], saw potential uses as including:

- New mobile services, with high quality video and interactive media delivered to handheld devices.
- Wireless broadband services, with high-speed data and voice services.
- Wider coverage for advanced services in remote and rural areas. This spectrum is particularly suitable for low cost, wider-area coverage.
- Advanced business and broadcasting services, such as those used to support major sporting events.
- Additional television channels including possible High Definition (HD) channels carried on Freeview.

An editorial in the European Broadcasting Union's EBU Technical Review [3] publication suggested a similar list:

- increasing the number of digital TV services (e.g. designed for reception on roof-top antennas or set-top antennas);
- improving the coverage of digital TV transmissions (e.g. increasing the population coverage and/or providing higher field strengths so as to deliver more reliable services to mobile receivers or set-top antennas);
- digital TV services designed for reception on hand-held receivers (e.g. DVB-H);
- high-definition TV (as in the USA, Japan, Korea, Australia)
- non-broadcasting services, such as 3G mobile phones, WiMax, etc.
- other services yet to be defined . . .

I won't go into discussing these uses but its important to note that many of these uses have markedly different spectrum requirements. Some uses, such as more fixed reception digital television services, could potentially operate directly in vacated analog channels. (Note: It's not quite that straight forward but close). Some other uses work best with large blocks of contiguous spectrum or paired blocks of spectrum.

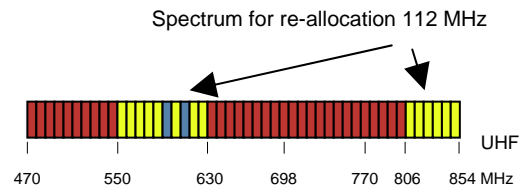
## Overseas experiences

Let's look at some overseas experiences. Countries with advanced thinking on digital dividend approaches include; the UK, the USA, Japan and Sweden.

Looking first at the UK...

## The UK

The UK has identified the channels to be released by digital switch-over. As shown in *Figure 1*, fourteen channels, each 8 MHz wide have been identified. That's a total of 112 MHz. These channels are all in the UHF bands, as the UK, unlike Australia, does not use VHF for television broadcasting.



*Figure 1: UK spectrum proposed for reallocation (yellow)*

Ofcom is currently conducting a review into the digital dividend. This work commenced late 2005 and is due to conclude shortly. The aim of this work is to assess how the cleared spectrum should best be made available for use. Ofcom will analyse the most efficient use of these frequencies and how best they should be packaged for potential users. It will also begin work on auction design, with a view to ensuring that the spectrum is acquired by users who are likely to make best use of it.

Ofcom also notes that there will also be some unused spectrum where a frequency used by a transmitter in one part of the country is effectively unoccupied outside the range of that transmitter in another part of the country. Ofcom refers to this as 'interleaved spectrum' and it could be used for a variety of local or regional services. Ofcom estimates that around 208 MHz of interleaved spectrum may become available. The future use of this spectrum will also form part of their Digital Dividend Review.

A comment from me on this interleaved use is that the 208 MHz figure represents virtually all of the remaining broadcasting spectrum, and if this proposal comes about it leaves just six channels where 'interleaved' use would not be permitted.

## The USA

The US took a different approach in that they identified early on the spectrum they intended for release by the digital switch-over and have already sold some of this spectrum. While, switch-off is not until 17 February 2009, new spectrum owners can commence operation provided they limit the amount of interference to broadcasters.

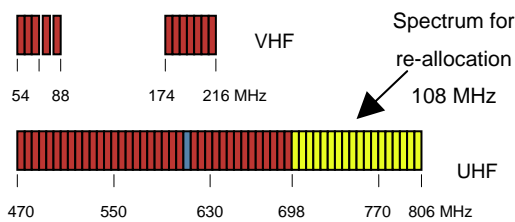


Figure 2: US spectrum proposed for reallocation (yellow)

As shown in Figure 2, the identified spectrum is a contiguous block of eighteen channels, each 6 MHz wide. That's a total of 108 MHz.

I'm not aware of any plans to recoup a digital dividend in VHF bands in the US.

## Japan

At UHF, Japan's digital dividend shown in Figure 3, looks a little like that of the US, except that their UHF broadcasting band has 6 fewer channels. They are looking to re-allocate up to 10 UHF channels (60 MHz). It also appears that VHF channels are not used for digital television, so switch-over may also release a further 70 MHz.

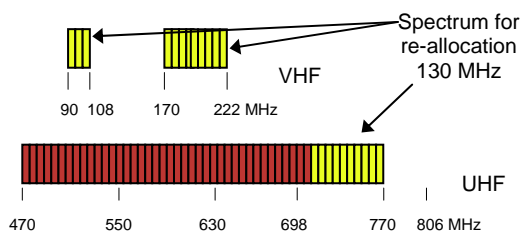


Figure 3: Japanese spectrum proposed for reallocation (yellow)

## Sweden

While Sweden hasn't yet decided on the size of its dividend there is an interesting consultant's report examining the issue. The report [4] calculates the number of channels that could be re-allocated for different types of services. For example it was calculated that if the dividend were to be used for new fixed reception digital television services the size of the dividend ranges from 5 to 19 channels (40 to 152 MHz). For mobile television it was zero to 27 channels (216 MHz); For Broadband wireless (eg WiMax) between 5 and 17 channels (40 to 136 MHz) and mobile telephony (3G/UMTS) it was 13 to 27 channels (104 to 216 MHz). The variability in the quantum of the dividend is typically due to different locations having different outcomes as spectrum use is not uniform and also due to testing different network topologies, with denser networks using lower power transmitters giving greater dividends.

## How big is it?

As we've just seen the amount of spectrum being re-allocated for other services could be anywhere up to 216 MHz. The US and UK examples gave a figure in the order of 110 MHz. But, lesser numbers are also possible, particularly in smaller countries with many close neighbours. Such factors don't affect Australia so we probably should be thinking of a similar or even larger amount to the UK and US.

To help calibrate our thinking lets do a 'back of the envelope' calculation.

In VHF Band III and the UHF bands, Australia has 50 channels that are used for analog and digital television services.

In most areas, Australia has five analog services, five digital services and a further two planned but as yet unassigned, digital television channels. This makes a total of twelve networks.

However in many areas, one of the analog services operates in VHF Bands I or II so let's exclude this from the calculation for the moment. There are a few locations with

either two or nil VHF Band I or II services, however, the assumption of one, is a reasonably representative average for high power transmissions, which have the biggest bearing on spectrum efficiency.

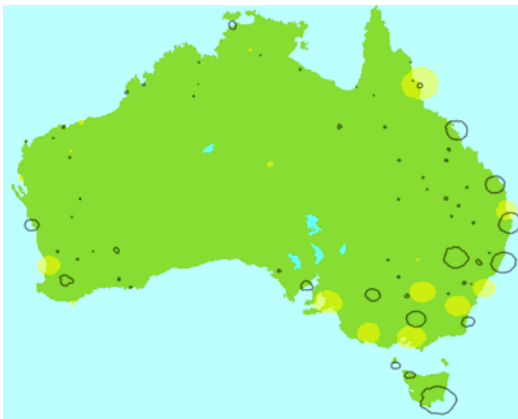
Therefore, 50 channels in VHF Band III and UHF support 11 networks at an average 4.5 channels per network.

If we close 4 analog networks (plus 1 in VHF Band I or II), we should free up the equivalent of 18 (4 x 4.5) channels each 7 MHz wide. That's 126 MHz split across VHF Band III and UHF. Adding VHF Band I back in makes a total of 21 channels or 147 MHz.

An alternative calculation that includes Band I, gives a result of 22 channels or 154 MHz. ( $53/12 \times 5 = 22$  channels)

## What shape is it?

Is it Swiss Cheese or Cheddar? *Figure 4* illustrates the Swiss cheese style holes left in the spectrum at switch-over.



*Figure 4: Spectrum 'holes' left by closure of analog television (VHF channel 6). Grey circles show analog television and yellow digital television.*

While the Swiss cheese option is straight forward, it doesn't give a very big dividend... if you measure it in megahertz... as I'll now discuss.

If we maintain our assumption that one service is in VHF Band I or II, the number of channels freed up in any given area will be just four, not 18. We could consider plugging

the spectrum holes with four additional digital TV services. Please note, however, it's not that straight forward due to the somewhat different interference potential between digital and analog services versus the digital to digital situation. So you can't just assume an analog service can be switched off and replaced by an equivalent coverage digital service.

Now, four new digital services doesn't seem very much when our back of the envelope calculation came up with 18 channels. Effectively it implies that the freed up channels would be organised in the same way that current television services have been planned, with different sets of four channels in each area. This then raises the question of whether we can achieve greater spectrum efficiency than this?

If it were practical to re-plan all the remaining digital networks so that they were packed as closely together as possible (without interference of course) then the 18 channel number might be realised. Continuing the cheesy analogy, the cheddar cheese option would be to re-pack the remaining digital services to free up one or more contiguous blocks of spectrum.

But there are a few of issues that might limit the amount of re-packing that could be done such as:

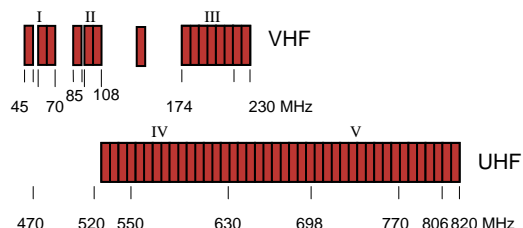
- The limited bandwidth of current viewer antennas in some areas;
- The installed base of community retransmission services;
- Costs to broadcasters...
- Disruption to viewers...
- etc

Ultimately, I think the size and shape of the dividend is likely to be determined by a balancing of these negative factors against the benefits:

- to Australia;
- to the Australian economy;
- to Australian consumers from the new services; and
- to potential providers of the new services.

## In which bands will Australia's digital dividend be?

Lets take a look at all the bands, as shown in *Figure 5*, one by one to see where this digital dividend is going to come from.

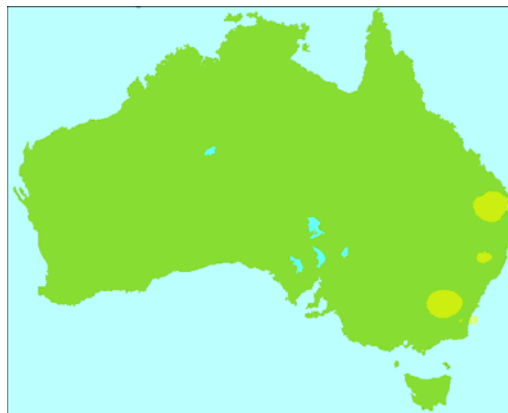


*Figure 5: Australian television broadcasting bands.*

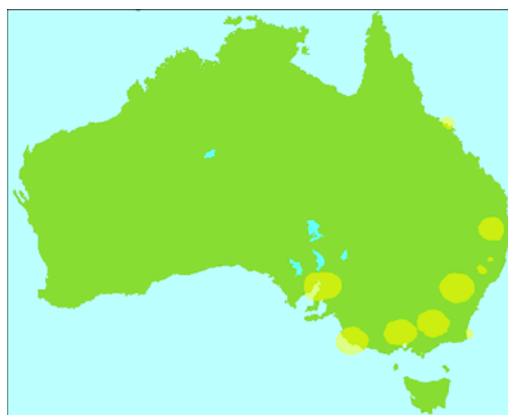
Firstly the simpler ones...

**VHF Band I:** We don't use this band for digital television, so at switch-over, 3 channels or 21 MHz becomes virtually clear, although there is some Defence usage on a secondary basis for fixed and mobile services. In the upper 2 MHz of channel 0 there is also some secondary amateur use. One potential application of at least some of this spectrum is the introduction of digital radio services using the DRM+ technology that is currently under development. It is expected that this technology will complement the DAB digital radio services that are to be rolled out in state capital cities by 2009. DRM+, might provide a good solution for digitalisation of local community radio services in city areas as well as providing wide coverage in regional areas for national, commercial and community broadcasting sectors.

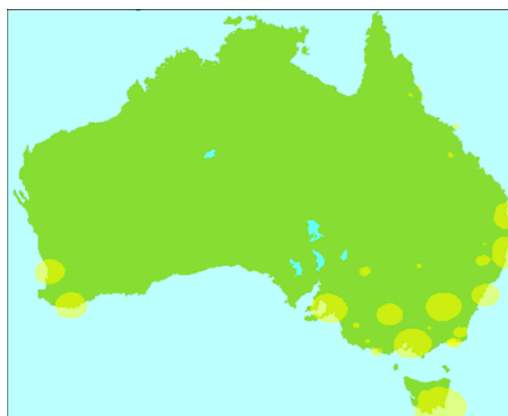
*Figures 6, 7 and 8* show the current channel usage for channel 0, channel 1 and channel 2. Switch-over will yield some cheddar in this band as all the yellow circles shown go away.



*Figure 6: Channel 0 usage by analog television.*



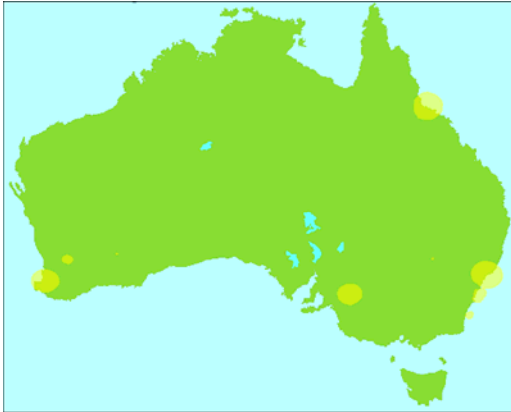
*Figure 7: Channel 1 usage by analog television.*



*Figure 8: Channel 2 usage by analog television.*

**VHF Band II:** As mentioned earlier, switch-over will mainly benefit FM radio broadcasting in a limited number of areas, such as the Newcastle/Hunter Valley region, Townsville, Bunbury and south-west WA and parts of

regional South Australia. Access to the 85-87.5 MHz band for land mobile services<sup>1</sup> will also improve for the areas of channel 3 usage as illustrated in *Figure 9*. Also benefiting in these areas will be low power open narrowcasting services using 87.6-88.0 MHz.

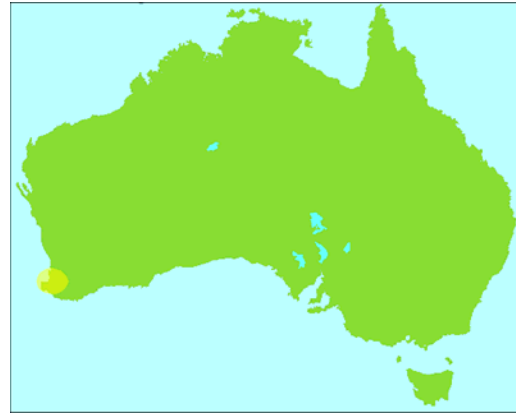


*Figure 9: Channel 3 usage by analog television*

*Figures 10 and 11* show the current channel 4 and channel 5 usage, where FM radio will benefit.

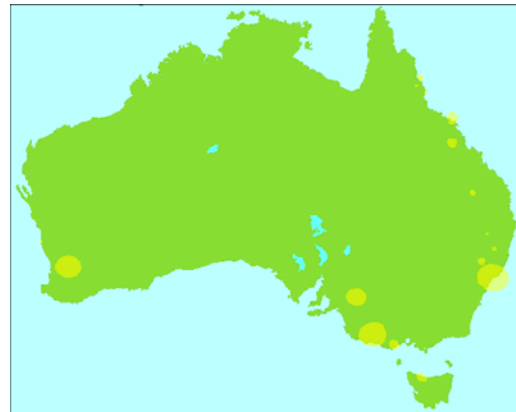


*Figure 10: Channel 4 usage by analog television*



*Figure 11: Channel 5 usage by analog television*

**VHF Channel 5A:** Although channel 5A usually is usually considered to be in VHF Band III, I'll mention it now, because the benefit is similar to the other Band II channels, in that the spectrum use is already well established but perhaps restricted in a number of locations by 5A transmissions.



*Figure 12: Channel 5A usage by analog television*

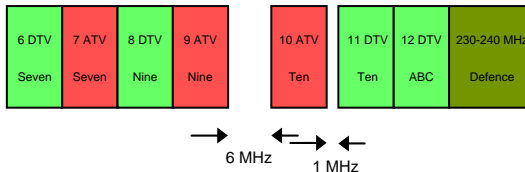
Possible uses for channel 5A spectrum as per the Australian Radiofrequency Spectrum Plan include:

- Space Operations (s-E<sup>2</sup>)
- Meteorological Satellite (s-E)
- Mobile Satellite (s-E)
- Space Research (s-E)
- Fixed and Mobile

<sup>1</sup> Refer to the VHF Mid Band Frequency Band Plan [5].

<sup>2</sup> Space to Earth (s-E)

**VHF Band III:** This is where things get more interesting and it should be noted that the spectrum usage of this band is quite uneven across the country. The most intensive usage is in the five largest capital cities. So let's look at these areas which are illustrated in *Figure 13*.



*Figure 13: VHF Band III spectrum use in the five largest capital cities*

Currently in all five cities there are three analog television services (shown in red) and four digital television services (shown in green) making use of the eight channels in the band. The available spectrum is a 6 MHz chunk in channel 9A and a one 1 MHz chunk at the top of channel 10.

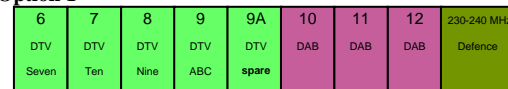
It is commonly assumed that a major use of the VHF Band III 'dividend' will be for Eureka DAB digital radio, although there could be other options. It is currently planned to use the vacant 6 MHz of 'channel 9A' in metro areas for DAB digital radio services, although there is some thought being given to temporarily placing these in parts of the 10 MHz immediately above channel 12, which is used for a range of purposes by Defence.

Assuming DAB ends up being a major user of digital dividend spectrum in this band, there's a few possible options that arise out of analog switch-over; I'll show two such options in a moment. But first it important to understand that its not desirable to mix services with different network topologies on adjacent spectrum. The digital TV services are based on a high power network model delivering relatively low field strengths to fixed roof top antennas. In contrast, digital radio is generally targeted at mobile, portable or hand held receivers. Because these receivers will have poor antenna gain and be closer to the ground, much higher signal levels are required. While high power main transmitters can be used, a number of repeaters will also be required. However, placing a digital radio repeater near houses trying to watch digital TV signals in the order of 40 something dB

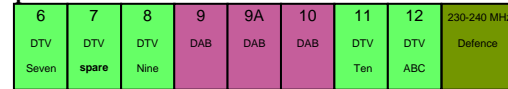
microvolts per metre is asking for trouble. This is a bit like your neighbours having a noisy party. The ideal is to live a long way from noisy neighbours which is like implementing a guard band but its not very efficient. An alternative would be to ask the neighbours to have their party in a different city. This is like using the immediately adjacent channel say in Newcastle instead of Sydney. But if you can't move far enough away you have to limit how noisy they are or buy ear plugs, the equivalent of power limits or filters...

To limit the number of neighbourhood disputes, it's preferable to segment the bands in a way that minimises the number of band edges.

**Option 1**



**Option 2**



*Figure 14: Some options for post switch-over use of VHF Band III spectrum in the five largest capital cities*

The two options are shown in *Figure 14*. The first option minimises the band edges but increases the disruption by requiring the ABC and Network Ten to change channels, although this may have advantages if some viewers haven't upgraded their old antennas which roll-off in gain above channel 10. The second option minimises disruption but leaves us with two digital TV – digital radio band edges to manage. Both options show 21 MHz for digital radio with a channel spare for possibly a new digital television service. I have to emphasise that the figure of 21 MHz is simply an assumption I have made and does not represent either ACMA or a government policy about the future of radio digitalisation. When you look at the Government's October 2005 announcement of the introduction of DAB, it is clear that the government envisages a staged roll-out, starting in metropolitan areas, with no decision yet on whether DAB is ultimately even a replacement technology at all.

For present purposes, I have chosen a figure (21 MHz) that accommodates the current initiative as well as VHF capacity in surrounding regional radio markets and a limited amount of capacity to cater for some new services in both Metro and regional areas should this be required in the future. Note that these charts are simplistic in that they assume the digital radio services won't impact on digital television services in regional areas. Based on currently available information, the interference potential from digital radio into digital TV is slightly greater than digital TV to digital TV, but further study of this and regional digital TV use is required before any decisions are made.

**UHF Bands IV & V:** Now this is where it gets more complex. There are no really clear cut options if we were minded to clear a contiguous block of spectrum.

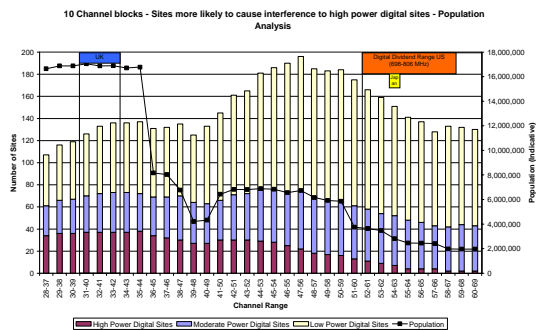


Figure 15: Affect of clearing a 10 channel block of spectrum in UHF television bands

Looking at Figure 15, the top end of the UHF Band V looks attractive in that it affects very few high power services (shown in Purple) and the population affected by any disruption is lower (black line). However, the number of sites and allotments affected is significant as there are many low power services here (pale yellow). Conversely, the lower parts of UHF Bands IV and V affect fewer channel allotments overall but significantly more population.

It would be useful to do some analysis on the costs of infrastructure changes and potential costs to consumers. Some of the \$5.6 million for ACMA announced by the Minister in the Digital Action Plan will be used for such analysis. One way of identifying the issues associated with clearing a contiguous block of

spectrum would be to perhaps do a number of hypothetical replanning studies looking to clear different sized blocks of spectrum in a limited number of representative areas. This however is resource intensive, noting that the planning of digital channels for all metropolitan and regional areas has taken around eight years.

To quickly sum up... we get a dividend of 21 MHz from VHF Band I, very little from VHF Band II except in a limited number of areas, and in capital cities we get 21 MHz from VHF Band III. That's 42 MHz. As we noted earlier a number of at least 110 MHz appears achievable if the UK and US are a guide, but it could be up to 147 MHz or more based on our back of the envelope calculation. Using the lower figure of 110 MHz and subtracting the 42 MHz we obtain from VHF means the UHF dividend could be around 68 MHz or roughly 10 channels; while the higher figure implies 106 MHz or 15 channels from UHF. Our future studies could show it's even greater.

## Conclusion

That's where I'll leave this topic now. We're really only at the start of this process, so you'll be hearing more about this in the future as our work progresses.

Before I finish, its worth noting that the Honourable Senator Helen Coonan, commented in her address to the ACMA ICE conference [6] last month "I will not lose sight of the digital dividend". What makes this even more interesting is that it was not in the published version of the speech. So those, presumably, are her own words – she must mean it.

Keep those words in mind as we work together to take this issue forward. I'd urge you all to take a cooperative approach so that all sectors of industry and all Australians can benefit from the digital dividend. Thank you.

## References:

[1] Ready, Set, Go to Digital – A Digital Action Plan for Australia. Media Release, 23 November 2006.

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[2] Ofcom Digital Dividend Review Overview. January 2006

<http://www.ofcom.org.uk/radiocomms/ddr/documents/ddoverview/>

[3] EBU Technical Review Editorial Issue 308. October 2006

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[4] Technical investigation of the usage of the frequency spectrum released by the switchover to digital terrestrial TV. HiQ Data AB/Progira Radio Communication AB.

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[5] VHF Mid Band Frequency Band Plan (70 to 87.5 MHz) 1991.

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[6] Ready, Get Set, Go Digital – A Digital Action Plan for Australia. A speech by Minister Helen Coonan at the Australian Communications Media Authority Conference, 23 November 2006.

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