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# Implementation of Digital TERRESTRIAL TELEVISION BROADCASTING: CASE STUDY — A U S T R A L I A

Report

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## Implementation of digital terrestrial television broadcasting: Case study – Australia



This case study has been developed by Mr Andrew King, with revision from Mr Roger Bunch, vice-chairman of ITU-R Study Group 6. ITU would like to thank the Department of Communications, Government of Australia, and the Australian Communications and Media Authority (ACMA) for their support.



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## **Executive summary**

#### Introduction

Australia's transition from analogue to Digital Terrestrial Television Broadcasting (DTTB) has been a project that spans a period since 1993. That may be thought of as a very slow transition, however that time span commences before DTTB was a reality and includes the involvement of Australian experts contributing to the development work in the ITU-R for a period of approximately four to five years, benefitting many Administrations that were to follow on the same transitional path. In the 1990s, the concept of a "digital dividend" had not been born. This concept developed during the period of simulcast of analogue and digital services, which resulted in an additional stage to the project to restack the DTTB services and release spectrum in the UHF band for other services. In Australia's case, this heightened the resources needed at the time of analogue switch off and added one year to the overall project.

The actual simulcast on-air duration of analogue and digital services during the transition varied by licence area. The shortest transition time was achieved in the rural area of Mildura which had a period of six year simulcasting, whereas the major metropolitan licence areas of Sydney and Melbourne had the longest simulcast times of 13 years.

#### **Broadcast networks**

Australia's population of 23.6 million people live mainly around the coastal areas and are able to watch free-to-air terrestrial broadcast television mostly provided by five broadcast networks. There are two national broadcasters, owned by the government whose licences cover the whole country, but their services tend to be organised to cover a state or even a state capital city. Commercial broadcasters are licenced to broadcast to a specific licence area, with only three licences available in any one area, except for some overlap areas between the cities and regional areas where six licences have been issued. Media ownership laws limit the population coverage for the owner of a commercial television network, so the commercial broadcast companies have formed into three capital city broadcast networks and six regional broadcast networks with programme affiliation agreements which results in most programming being available Australia-wide on a network of licenced stations but with different ownership as shown in the map below. The capital city broadcasters typically broadcast in Brisbane, Sydney, Melbourne, Adelaide and Perth (which comprise 66.71 per cent of the population of Australia). In the capital cities there is one community television service.

During the transition, each network had one 7 MHz channel for their analogue service and has one 7 MHz channel for their digital service. Each licence area is primarily served from a main transmitter which is fed via microwave or fibre links from the broadcast station. In areas where terrain would degrade reception from this transmitter, a broadcast site is established to receive the signal from the main transmitter and re-broadcast it on another channel. These sites are called translator sites, translating the main channel into the local in-fill channel.

The digital services are operated independently by each broadcaster, there is no common multiplex provider for digital broadcast services in Australia.



## A phased approach

The transition from analogue to DTTB is considered in five stages:

- Stage 1 Preparation and Planning
- Stage 2 Implementation
- Stage 3 Digital Enhancement
- Stage 4 Analogue Switch Off, and
- Stage 5 Digital Restack.

#### Stage 1 – Preparation and planning

This stage involved Australian experts contributing to the development work in the ITU-R Study Group 11 and in particular, Task Group 11/3 where Australia was instrumental in establishing the objective of preparing a common set of digital terrestrial television broadcasting (DTTB) standards.

Domestically, investigations were undertaken by a Specialist Group drawn from government and industry and led by the broadcasting regulator at the time, the Australian Broadcasting Authority. These investigations culminated in 1997 in broadcaster led testing of the two viable transmission systems available at the time, the North American ATSC system based on 8VSB modulation and the European DVB-T system with COFDM modulation. Exhaustive testing and evaluation led to the decision to recommend the DVB-T system for Australia.

Having the technical foundations in place, government policy was announced supporting legislation passed in 1998. This formed the basis for the regulator to commence planning the simulcast of analogue and digital services and undertake appropriate licencing. At the same time government and industry met to develop technical standards for the system.

#### Stage 2 – Implementation

This stage commenced approximately a year prior to the first DTTB transmissions as broadcasters sourced digital video encoders, multiplexers and other headend equipment and purchased and installed digital transmitters. The first on-air tests were undertaken in August 2000, followed in September 2000 by a mobile tests co-incident with the staging of the Sydney 2000 Olympic Games. DTTB formally commenced in Sydney, Melbourne, Brisbane, Adelaide and Perth on 1 January, 2001. Initially services were planned to have an eight year simulcast with digital, regional areas were scheduled three years later.

At commencement, limitations were placed on what broadcasters could do in their digital transmissions, limiting the flexibility and innovation available in a digital system. At the time, digital set-top receivers were considered expensive and widescreen displays were still based on analogue technologies, but there was considerable product development undertaken in display technologies commencing with cathode ray tubes (CRT) whose size was ultimately limited by the strength of glass in the screen, rear projection systems which enabled larger displays but suffered from optical alignment issues to plasma displays which were digital in nature and of high quality and finally to liquid crystal displays (LCD) which have ultimately been embraced by consumers and accelerated digital take up in homes.

This was a period of approximately six years which allowed broadcasters to test various aspects of the digital system and for engineers to focus on refinement of the transmission network. Digital take up by consumers provided a better statistical base for viewer complaints so reception issues could be investigated. These generally fell into two categories; complaints related to reception of single frequency networks (SFNs) and issues regarding variable reception which allowed better understanding of the "cliff effect" of digital signals related to terrain and foliage clutter in varying weather conditions.

Refinements were made to the service information inherent in digital broadcasts and the development of electronic programme guide information. Whereas many aspects of free-to-air television are highly regulated by government, Australia has a free unregulated market for supply of television receivers. Many manufacturers saw opportunities in Australia so a wide variety of receivers were available. The software design of each receiver had its own idiosyncrasies which often led to viewer complaints that were resolved by attention to fine detail in service information or close collaboration with manufacturer's design teams.

After the initial rollout of transmitters at existing broadcasting sites, there was a period of stability in the broadcast networks.

#### Stage 3 – Digital enhancement

In 2006, despite the take up actually accelerating due to the changes in display technology and lowering consumer prices, public debate over the take up of digital, pressure from telecommunication interests to secure spectrum from the "digital dividend" and the election of a new government triggered a review of the system with the aim of forcing the switch off of analogue broadcasts and release of broadcasting spectrum for other services.

Reliable, quality digital coverage is vital to broadcasters as that is their only means of accessing viewers. With the pending closure of the analogue service in sight, broadcasters commenced an intensive review of digital coverage. In Stage 2, "same coverage" was essentially achieved by installing digital transmitters at the existing analogue broadcasting sites and operating at powers 6 dB lower than analogue. However, garnering the experience gained in Stage 2 from investigating viewer reception complaints and undertaking extensive field surveys, each licence area was reviewed to investigate methods of cost-effectively enhancing coverage in areas where the digital service was proving to not be completely reliable.

This review necessitated the establishment of 34 new digital sites in the major metropolitan areas of Sydney, Melbourne, Brisbane, Adelaide and Perth and 85 new digital sites in regional licence areas. As part of this review, many smaller sites in metropolitan and regional areas that were outside of the broadcaster's control were taken over by broadcasters.

The government was also concerned that there would be some viewers that may not receive adequate digital services and to address this the government worked with the national broadcasters and remote area commercial broadcasters to provide a digital satellite service which would provide services to remote viewers and also provide a safety net for viewers in metropolitan and regional areas where viewers were not able to access terrestrial digital services.

The investigation and planning stage for these sites took approximately three years to complete and installation the following three to four years. This stage had to be completed prior to analogue switch off so that viewers did not lose services during the changeover.

When these additional gap filling sites were established, the main digital and analogue services were still in operation, so special attention was given to planning spectrum for these sites as the broadcasting spectrum was already heavily congested. Some smaller analogue only transmitter sites had to be turned off and turned on in digital mode on the same day as spectrum would not otherwise have been available. Other sites were integrated into single frequency networks with existing digital sites to make better use of available spectrum.

#### Stage 4 – Analogue switch off

Switching off a service is a relatively simple task. However, planning to ensure that the viewing public will not be impacted by the switch off is complex. The government established a Task Force to plan the switch off of analogue services. This group had to liaise widely with broadcasters and other industry segments to ensure that all facilities were in place in preparation for the switch off. Government and broadcasters had a shared outcome, broadcasters wanted to know that they would not suffer a loss of audience on switch off, for government this audience represents the voting public so they wanted to ensure they were not affected by the switch.

Hence a programme of household surveys was established to gauge the number of homes that had converted to digital and identify issues on acceptability of the digital service or reasons impeding the public from converting. Lower socio-economic groups in the community were identified for assistance in converting to digital, generally by being eligible for a free set-top box and installation.

As not all self-help translator sites were taken over and converted to digital by commercial broadcasters, the government also ran a programme to subsidise the installation of satellite reception equipment (dish and set-top-box), for viewers in areas where their local translator was not being converted to digital.

Switch off was planned to occur by licence area as this followed dependant signal paths where often switching off the main transmitter would mute the following translators and re-transmitters. Public information campaigns were devised to inform the public of the switchover date and assistance campaigns. Actual switch off dates and times were agreed between broadcasters and government to be a mutually acceptable time when no high rating or especially important programming was scheduled for broadcast.

The campaigns and plans were tested by first switching off the smaller regional licence area of Mildura. Post switch off surveys were conducted to provide feedback and modify the campaigns and plans. The remainder of the licence areas were switched off sequentially in a plan that allowed for timely mobilisation of resources for the assistance campaigns.

#### Stage 5 – Digital restack

Government had made a policy decision to auction the 694-820 MHz spectrum band in 2012 as a "Digital Dividend" before the switch off was completed. This required the planning of the restack of digital services co-incident with planning the switch off. Planning this stage involved examination by broadcasters of the practicality of re-tuning their digital transmitters. Digital / digital simulcasts were undertaken in areas of high populations of multi dwelling units (MDUs) where it was considered likely there were channelised headends which needed modification by antenna installers, hence viewers were not able to return their receivers at a nominated time.

Resourcing an intensive restack was a key issue. The programme for restacking was tendered by the government to a Program Implementation Manager who liaised with broadcasters and transmitter facility operators and arranged resources. The restack programme meant nearly every transmit site needed a modification to the filter / combiner which combines the transmitters into one feed for the antenna. This is a specialised area where overseas resources were needed to augment Australian manufacturing capacity. Technical restack teams were created from broadcaster, transmitter manufacturer and installation staff. The relatively short timeframe for restack and the number of sites involved meant local and overseas personnel were needed for the program.

In a similar manner to switch off, public information campaigns were undertaken. Actual restack days were placed into "windows" agreed by broadcasters to avoid high rating programming. Considerable spectrum planning was undertaken to ensure that a restack of services in a licence area did not cause interference into an adjacent licence area.

Australia has auctioned the "digital dividend" spectrum in lots based on the APT 700 MHz plan. However, to protect broadcasting services, the out-of-band emissions from the planned mobile services above 700 MHz, Australia has stipulated 6 dB tighter limits than the APT, but will relax this limit to the APT specification of –34 dBm/MHz only in areas where the three highest television channels 49, 50 & 51 are not used.

#### **Key learnings**

The key success factors of the conversion of Australian broadcasting to digital have been:

- maintenance of a close working relationship between government and broadcasters;
- open communication with the public, to seek feedback on reception conditions and communicate changes;
- development of standards to modify a 'toolkit' of international standards to incorporate local requirements;
- planning each stage is key, every detail must be examined.

The key lessons learned:

- set regular reviews to examine if policy and technical goals are being achieved;
- survey households from an earlier stage to judge the success of the conversion;
- setting target dates provides a firm goal for all parties to work towards;
- effort is needed to educate the public from 'analogue' to 'digital' thinking; influencing perceptions of degraded reception ('digital cliff'), channels to services and new features;
- every householder's reception conditions are different, a variety of causes and solutions to reception issues need to be developed;
- with respect to analogue switch off and the digital restack:
  - review digital coverage before considering the size of a digital dividend;
  - use the restack to remove legacy broadcast planning issues;
  - a single retune day can be successful only after considerable planning.

#### Conclusions

What started out as an engineering-led concept to deliver to the viewing public higher quality broadcast pictures and sound has opened up challenges and opportunities that are inherent with any disruptive technological change. The project has touched in some way every Australian; whether it be their need to purchase a new television receiver to continue to watch the shows they like or change the time they watch those shows as digital recorders have made "time shifting" a reality, businesses that have been rejuvenated implementing the changes, competitive media outlets who have had to change their business models or even to minority groups such as the hearing impaired who now enjoy a wider variety of captioned programmes. The impact has been greatest on two groups; broadcasters and government. The issues for government have been immense to chart a course through the political, social, economic and technological issues.

For broadcasters, every part of their business operations have changed. Changes have been required from camera to transmitter and every piece of equipment along the system chain. Delivering better pictures and sound to the viewer only highlighted the limitations in equipment used for contributing programmes to the broadcaster. More services have been added by each broadcaster, the presentation facilities for each service have changed from a local operation to aggregated national operations. The digitisation of studios has led to new workflows allowing more rapid response to breaking news stories, shortened production times and added flexibility as to what to put to air.

Has the transition been a success? Undoubtedly the answer is in the affirmative. Analogue has been switched off, very few, if any viewers were lost in the conversion to digital television. Whilst the timeframe might be considered long by some commentators, it must be remembered that Australia was one of the "early adopters" of digital television and conversion rates only increased when consumer technology features and price points matched the public's expectations of the new system. Others have benefitted from the process as well though the work undertaken jointly by broadcaster's and the regulator's engineering work refining the platform and offering that as contributory work to the ITU-R for other Administrations to build their systems on the work done in Australia.

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## Part 1 – Country profile

#### 1.1 Population and geographic overview

Australia is an island continent and the world's sixth largest country (7 682 300 km<sup>2</sup>). Lying between the Indian and Pacific oceans, the country is approximately 4 000 km from east to west and 3 200 km from north to south, with a coastline 36 735 km long.

It is on the whole exceedingly flat (the lowest point on the mainland, Lake Eyre, is 15 m and the highest, Mount Kosciuszko, is 2 228 m) and dry (less than 51 cm of precipitation falls annually over 70 per cent per cent of the land area). The coastal regions where most of the population resides comprise many river and creek valleys requiring additional transmitter sites to provide good terrestrial television coverage.

Canberra is Australia's capital city. With a population of approximately 320 000 people and situated in the Australian Capital Territory, Canberra is roughly half way between the two largest cities Melbourne and Sydney. Australia's population is concentrated along the coastal region of Australia from Adelaide to Cairns, with a small concentration around Perth, Western Australia. The centre of Australia is sparsely populated. As of October 2014, Australia's population is roughly 23.6 million people<sup>1</sup>. The most populous states are New South Wales and Victoria, with their respective capitals, Sydney and Melbourne, the largest cities in Australia.

## **1.2** System of government

The Commonwealth of Australia was formed in 1901 when six independent British colonies agreed to join together and become states of a new nation. The rules of government for this new nation were enshrined in the Australian Constitution, which defined how the Australia Government was to operate and what issues it could pass laws on, generally these are limited to areas that affect the whole country.

The Constitution created a 'federal' system of government. Under a federal system, powers are divided between a central government and individual states. In Australia, power was divided between the Australia Government and the six state governments. Laws relating to broadcasting and communications are passed by the Federal Government.

Although the six states joined together to form the Commonwealth of Australia and the Australia Government, they still each retain the power to make their own laws over matters not controlled by the Commonwealth under Section 51 of the Constitution. State governments also have their own constitutions, as well as a structure of legislature, executive and judiciary. Matters before a state judiciary may result in suppression orders by the courts for that state. Although not a law relating to broadcasting, such court orders over the years have influenced the design of broadcaster's studio and presentation facilities to provide programming within state boundaries to comply with such court orders.

## 1.3 Australian broadcast market

#### **1.3.1** Introduction

Australians have access to a range of television services, available on both free-to-air and pay television platforms.

 The Australian Broadcasting Corporation (ABC) and the Special Broadcasting Service (SBS) provide national (government-funded) television broadcasting services. The ABC is fully funded from government, supplemented only by content, services and branding sales whereas SBS is allowed to raise additional revenue by broadcasting limited advertisements and sponsorship announcements.

<sup>&</sup>lt;sup>1</sup> Australian Population Clock available at <u>www.abs.gov.au/</u>

- Commercial free-to-air television broadcasters provide television services within a specified licence area. As of 1<sup>st</sup> August 2013 there are 64 licensed commercial TV broadcasting services operating throughout Australia. Commercial free-to-air broadcaster's principal revenue is derived from broadcasting advertisements within breaks in programming.
- Community television services provide community based programming. Their revenue is derived from sponsorships, government grants and donations.
- Narrowcasting television services have reception limited in some way. There are open narrowcasting services available without cost to consumers, and subscription narrowcasting services available only on the payment of a subscription fee.
- Subscription television services (pay TV) are funded by subscriptions and limited advertising revenue.

## **1.3.2** Terrestrial broadcasting

National, commercial and community broadcasters provide free-to-air via terrestrial broadcasts. The national broadcasters licences cover the whole country, but their services tend to be organised to cover a state or even a state capital city.

Commercial broadcasters are licensed to broadcast to a specific licence area, with only three licences available in any one area, except for some overlap areas between the cities and regional areas where six licences have been issued. Media ownership laws stipulate that a person must not control television broadcasting licences whose combined licence area exceeds 75 per cent of the population or more than one licence within a licence area<sup>2</sup>, so the commercial broadcast companies have formed into three capital city broadcast networks and six regional broadcast networks with programme affiliation agreements which results in most programming being available Australia-wide on a network of licenced stations but with different ownership as shown in Figure 1. The capital city broadcasters typically broadcast in Brisbane, Sydney, Melbourne, Adelaide and Perth (which comprise 66.71 per cent of the population of Australia)<sup>3</sup>.

Australia's population mainly lives in cities and on the coastal fringe. 40.6 per cent of the country live within the TV licence areas of Sydney and Melbourne, yet these areas only account for 0.33 per cent of the country's land area, yielding a population density of 319 people / km<sup>2</sup> for broadcasters to cover. Brisbane, Adelaide and Perth have a further 26.1 per cent of the population living in 0.89 per cent of the country at a density of 78 people / km<sup>2</sup> for broadcasters to cover. Due to historical factors determining licence areas, approximately 4.3 per cent of the population live in an area where city and regional licence areas overlap. The regional broadcast licence areas serve 35.7 per cent of the country's population who live in 15.4 per cent of the country (including the overlap areas). In these areas 6 people live per km<sup>2</sup>. In the remaining remote areas of the country, 2.5 per cent of the population live in 87 per cent of the land mass at an average density of 0.075 people / km<sup>2</sup>.

Full statistics are provided in Table 1 and are shown in Figure 1 where the state capital city licence areas are indicated in pink and the regional licence areas are shown in shades of blue.

<sup>&</sup>lt;sup>2</sup> Section 53 of the Broadcasting Services Act 1992

<sup>&</sup>lt;sup>3</sup> Licence area populations in the ACMA BSA Section 30 Schedule <u>www.acma.gov.au/webwr/aba/</u> <u>licplan/planning/licareas/documents/bsa 92 s30 schedule.pdf</u>



Licence Area	Overlap Market	Population	Pop %	Area	Area %	Pop / km²
Australia		19 813 080		7 682 300		
Sydney		4 118 936	20.79%	12 145	0.16%	339.147
Melbourne		3 919 966	19.78%	13 086	0.17%	299.554
Sub Total		8 038 902	40.57%	25 231	0.33%	318.612
Adelaide		1 275 291	6.44%	30 642	0.40%	41.619
Brisbane		2 371 478	11.97%	17 987	0.23%	131.844
Perth		1 529 047	7.72%	17 927	0.23%	85.293
Sub Total		5 175 816	26.12%	66 556	0.87%	77.766
Broadcast Networks Total		13 214 718	66.70%	91 787	1.19%	143.972
Regional Queensland		1 480 612	7.47%	226 640	2.95%	6.533
Northern NSW		1 943 893	9.81%	133 109	1.73%	14.604
Southern NSW		1 273 215	6.43%	176 316	2.30%	7.221
Griffith and MIA		64 164	0.32%	39 690	0.52%	1.617
Regional Victoria		1 052 581	5.31%	190 212	2.48%	5.534
Mildura / Sunraysia		59 861	0.30%	21 343	0.28%	2.805
Riverland		35 201	0.18%	15 878	0.21%	2.217
Spencer Gulf		110 596	0.56%	55 933	0.73%	1.977
Mt Gambier / South East		68 590	0.35%	28 462	0.37%	2.410
Broken Hill		19 561	0.10%	18 669	0.24%	1.048
South West and Great		287 786	1.45%	88 920	1.16%	3.236
Southern						
Kalgoorlie		51 770	0.26%	81 237	1.06%	0.637
Geraldton		43 875	0.22%	41 899	0.55%	1.047
Darwin		107 312	0.54%	9 469	0.12%	11.333
		473 820	2.39%	51 971	0.68%	9.117
Regional Networks Total		7 072 837	35.70%	1 179 748	15.36%	5.995
	Duichean	71 424	0.26%			
Regional Queensiand	Brisbane	71 424	0.36%			
Northern NSW	Brisbane	395 885	2.00%			
Regional Vistoria	Syuney	298 018	1.50%			
South West and Creat	Dorth	10 040	0.06%			
Southorn	Pertit	08 908	0.55%			
Sub Total		850 281	4.29%			
Regional Networks Exclusive I	Market Totals	6 222 556	31.41%			
		0 111 000	01111/0			
Remote and regional WA		492 922	2.49%	2 519 716	32.80%	
less overlaps	Various	383 431	-1.94%	-212 056	-2.76%	0.047
	regional		2			
	licence areas					
Remote Central & Eastern Au	stralia	393 658	1.99%	4 377 945	56.99%	0.090
Remote Broadcasters Total		503 149	2.54%	6 685 605	87.03%	0.075

#### Table 1: Australian TV licence area statistics<sup>4</sup>

<sup>&</sup>lt;sup>4</sup> <u>www.acma.gov.au/Industry/Broadcast/Spectrum-for-broadcasting/Spectrum-digital-television/broadcasting-licence-areas-television-acma</u>

Hence, from a commercial perspective, the state capital city broadcast networks serve two thirds of the population and enjoy a more accessible market. By contrast, the regional networks cover just over a third of the country's population, but face a greater challenge accessing and serving their geographically-large market. The remote areas provide a further challenge. These characteristics have had a major influence on the design of each broadcasting network and the different technologies they employ.

## 1.3.3 Technical broadcast overview

Before digital television, free-to-air broadcasts were transmitted using the phase alternating line (PAL) colour system with stereo sound as described in ITU-R Recommendations BT.1700, BT.1701 and BS.707 in a 7 MHz channel raster in VHF Bands I (45-52, 56-70 MHz), II (85-92, 94-108 MHz) and III (137-144, 174-230 MHz) and in UHF Bands IV and V (520-820 MHz).

Each market or licence area is primarily served from a main transmitter which is fed via microwave or fibre links from the broadcast station. In areas where terrain would degrade reception from this transmitter, a broadcast site is established to receive the signal from the main transmitter and re-broadcast it on another channel. These sites are called translator sites, translating the main channel into the local in-fill channel. Main transmitter and translator sites are under control of the broadcaster, or use a third party transmission service provider company.

Over the years, government funds have been allocated to a television "black spots" programme to fund the establishment of a further level of in-fill translators, generally at very low power and operated and maintained by community organisations or the "third tier" of Australian government, local municipal councils. Section 212 of the Broadcasting Services Act allows any organisation to retransmit programmes within the licence area of the broadcaster and Section 212A specifically relates to re-transmission for the sole or principal purpose of obtaining or improving reception in a small community by self-help providers.



Technically, broadcaster responsibility in delivering a service ends effectively as delivery of a specified field strength at a level 10m above the ground. The level to be delivered varies according to the type of area served:

- in the cities in areas of concentrated high rise or dense dwelling structures, an "urban" field strength is specified;
- in the cities and regional towns and communities with a lower density of households, which may be single dwelling units, a "suburban" field strength is specified; and
- in other more rural and remote areas where dwellings are sparsely populated and there may be agricultural land a "rural" field strength is specified.

These levels take account for typical installation parameters and allow for the normally anticipated levels of signal degradation factors such as locally induced electrical noise.

The services are provided free-to-air, it is then the viewer's responsibility to organise reception and display of the television service.

Prior to consideration of conversion to digital transmission in 1993, Australia still had a television manufacturing facility. Many manufacturers have supply arrangements into the retail stores so Australian consumers have enjoyed a competitive retail marketplace for television equipment.

The final piece of the transmission chain from broadcaster facility to the viewer's television is through the viewer's antenna and cable distribution structure. The responsibility for this lies with the viewer / consumer who may contact local antenna installers to perform this work. For viewer's in high rise or multi-dwelling unit apartments, the distribution infrastructure may be owned and maintained by the building "body corporate" who are responsible for shared services into such buildings.

This broadcast structure is supported by a structure of technical standards and government regulatory authority technical specifications.

## 1.4 Key stakeholder groups

The broadcast market in Australia comprises key stakeholder groups involved in the transmission chain:

- Broadcasters as the originators, aggregators and distributors of programme content;
- Government who wish to see public policy objectives achieved;
- **Transmission service providers** an industry segment created out of the economy of scale when broadcasters have outsourced their transmission facilities;
- Manufacturers / suppliers who vie for sales in a vibrant television marketplace;
- Retailers as the conduit between the suppliers and the consumers;
- **Installers** a widely distributed small industry completing the broadcast chain between the field strength transmitted by the broadcasters and the antenna input of the television receiver.

In terms of viewing population, the free-to-air networks with affiliated stations are a dominant force, whilst the two government-funded national networks (ABC and SBS) also draw significant audiences. There has been little change over the period of digital conversion with free-to-air television being available in over 99 per cent of household in the country, with over 60 per cent of the population watching each day (and over 94 per cent watching in a month) for an average time of over 3 hours per day<sup>5</sup>.

Hence, touching the bulk of the population each day, free-to-air broadcast television plays a central role in Australian society and is therefore in a position of power and influence in society. Accordingly, any change to broadcast television attracts additional influencing stakeholders:

<sup>&</sup>lt;sup>5</sup> Free TV Stats & Graphs available from <u>www.freetv.com.au/content\_common/pg-free-tv-stats-and-graphs.seo</u>

- Special interest lobby groups seeking to impose on media policy an access right, for example
  advocacy groups for deaf people have influenced the number of programmes produced with
  open captions, groups representing actors have influenced the regulations on number of hours
  of locally produced drama, children's television groups have influenced the number of hours and
  timing of broadcasts of programming suitable for children;
- **Competitors** mainly other media interests such as print media who seek a competitive place in society for news; and
- **Other broadcast platforms** subscription television interests that would prefer to limit the freeto-air broadcast sector and hence lessen competition for their platforms.

At every stage of the digital conversion process for free-to-air terrestrial broadcasting, reviews by government have taken submissions and been influenced by this wide group of stakeholders, often with opposing views and desired outcomes. Australia, as an open democratic society has taken account of these influences sometimes to the detriment of the broadcast system.

The cost impact of public policy objectives on broadcasters is not uniform across Australia. As noted in Section 1.3.2 above, broadcast networks serving the main capital cities are seen to have a greater capacity to absorb the costs of additional policy requirements, for example digital rollouts were imposed sooner than for regional networks. Subsidies from government projects have flowed towards regional and to a greater extent to remote broadcasters to achieve the policy objective of universal television coverage. Whilst this does imply high subsidies on a per capita basis in rural and remote areas, for a very large part of the country, the population levels are relatively low but have significant economic importance to the country from agricultural and mining activities which are the main contributors to Australia's export income.

## 1.5 Policy, legal and regulatory frameworks

Television plays a central part in the life of many Australians, being their primary source of news, current affairs, live sport and quality Australian drama programmes. As an island continent that spans a wide range of geography from the tropical north to the temperate south plus vast desert areas in-between and spread over a number time zones (Australia is in the unique position of changing time zones east / west as well as north / south in summer-time to encompass five time zones), local content obligations in broadcasting are also paramount. Given this role, many aspects of free-to-air television are highly regulated by government to ensure their public policy outcomes are maintained which influence many parts of Australian life. This level of regulation ensures there is a constant dialogue between various arms of government, broadcasters and other key stakeholders.

## 1.5.1 Government and regulatory authorities

#### (i) Minister

Within the executive arm of government, responsibility for broadcasting lies within the communications portfolio of the Minister for Communications.

#### (ii) Department

The Minister has a Department of Communications reporting to him to provide good public policy advice to the government, so the Department must establish and maintain a deep and authoritative understanding of market developments and innovations, including international and domestic<sup>6</sup>. The Department also administers portfolio legislation and is tasked to deliver efficient and effective programmes to achieve the government policy outcomes.

<sup>&</sup>lt;sup>6</sup> From The Secretary's Introduction to the Corporate Plan 2014-17 <u>www.communications.gov.au/about\_us</u>

#### (iii) Regulator

The Australian Communications and Media Authority (ACMA) is the converged regulator for telecommunications, broadcasting, the Internet and also manages radio spectrum. Everything except for telecommunication competition regulation, which is handled by the economy wide competition regulator the Australia Competition and Consumer Commission (ACCC). Both regulators are independent. While the Minister has a number of important powers in a number of areas, he interacts with the regulators at arms length.

The ACMA plans the availability of segments of the broadcasting services bands for analogue and digital broadcasting<sup>7</sup>. It can allocate, renew, suspend and cancel broadcasting licences and collect any fees payable for those licences. It also allocates pay TV licences and administers the class licence regime for subscription radio broadcasting and open and subscription narrowcasting services.

In addition, the ACMA is required to inform itself and the Minister about advances and trends in broadcasting technology.

#### (iv) Department and regulatory authority changes

Over the 21 years since digital television was first investigated, the name of the Department has gone full circle, for reference throughout this document the following organisations were the responsible government department;

	1993-1994	Department of Communications
	1994-1998	Department of Communications and the Arts
	1998-2007	Department of Communications, Information Technology and the Arts (DCITA)
	2007-2013	Department of Broadband, Communications and the Digital Economy (DBCDE)
	2013-present	Department of Communications
Th	is period has also	seen the merger of the broadcasting and communications regulators into a single body.
	1992-2005	Australian Broadcasting Authority (ABA)
	1993-1997	Spectrum Management Authority (SMA)

1997-2005 Australian Communications Authority (ACA, a merger of SMA and AUSTEL)

2005-present Australian Communications and Media Authority (merger of ABA and ACA)

## **1.5.2** Industry co-regulation

Under communications and media legislation, self- and co-regulatory arrangements require industry participants to assume responsibility for regulatory detail within their own sectors, and this is underpinned by clear legislative obligations, with the regulator maintaining reserve powers. These arrangements provide flexibility for the ACMA, as the regulator, to exercise a variety of roles dependent on the nature of the concern, such as whether the issue is a policy matter or market issue. This includes the flexibility to not intervene to allow market-based solutions to develop, provide advice to government on policy issues, or encourage industry-developed solutions.

Co-regulation generally involves both industry and government (via the regulator) developing, administering and enforcing a solution, with arrangements accompanied by a legislative backstop. In relation to commercial television, Free TV Australia and its membership have developed the Commercial Television Code of Practice<sup>8</sup> which covers matters prescribed in Section 123 of the Broadcasting Services Act and other matters relating to programme content that are of concern to the community including:

<sup>&</sup>lt;sup>7</sup> Part 3 of the BSA

<sup>&</sup>lt;sup>8</sup> Available from <u>www.freetv.com.au/content\_common/pg-code-of-practice-.seo</u>

- programme classifications;
- accuracy, fairness and respect for privacy in news and current affairs;
- advertising time on television;
- placement of commercials and programmes promotions; and
- complaints handling.

The Commercial Television Code of Practice calls on broadcasters to resolve complaints with members of the public in the first instance, but these may be escalated to the ACMA for resolution of the complaint.

Similar arrangements are in place with the national broadcasters, for example the Australian Broadcasting Corporation (ABC) Board is required, under section 8(1)(e) of the ABC Act, to develop a code of practice relating to its television and radio programming, and to notify this code to the ACMA<sup>9</sup>.





<sup>&</sup>lt;sup>9</sup> Available from <u>http://about.abc.net.au/reports-publications/code-of-practice-2014/</u>

<sup>&</sup>lt;sup>10</sup> Adapted from information in presentations available on the ACMA website.

#### 1.5.3 Legislation

#### (i) Radiocommunications Act 1992

In line with the growing liberalisation of the radiocommunication sector in the early 1990s, the Commonwealth Government enacted the *Radiocommunications Act* 1992<sup>11</sup>(*RCA*), which provided the basic framework for the management of the radiofrequency spectrum based on the following objectives:

- (a) maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum;
- (b) make adequate provision of the spectrum for use by public or community services;
- (c) provide a responsive and flexible approach to meeting the needs of users of the spectrum;
- (d) encourage the use of efficient radiocommunication technologies so that a wide range of services of an adequate quality can be provided;
- (e) provide an efficient, equitable and transparent system of charging for the use of spectrum, taking account of the value of both commercial and non-commercial use of spectrum;
- (f) support the communications policy objectives of the Commonwealth Government;
- (g) provide a regulatory environment that maximises opportunities for the Australian communications industry in domestic and international markets;
- (h) promote Australia's interests concerning international agreements, treaties and conventions relating to radiocommunications or the radiofrequency spectrum.

The *RCA* established the Spectrum Management Agency (SMA), a statutory agency within the Transport and Communications portfolio, on a cost-recovery basis. The Minister retained responsibility for, and general policy control over, the agency. The SMA has subsequently become part of the Australian Communications Authority which has now been merged with the ABA to form the ACMA.

The market-based reforms which inspired the *RCA* included a new category of licence called "spectrum licensing" (together with the ongoing apparatus and class licensing systems) whereby licences assigning less prescriptive spectrum rights would allow to operate radiocommunication transmitters in a specified frequency band and geographical area, with the ability to trade or lease licences. Other reforms included the selective and progressive introduction of auctions for some licences in some frequency bands.

This more market-oriented licensing regime was seen as a necessary adjunct to the introduction of competition between telecommunication carriers with rival demands for radio frequency allocations. At the same time, a more flexible radio frequency regime was introduced for setting technical standards and managing conformity with standards.

Section 31 of the RCA provides for the Minister to:

- (a) designate a part of the spectrum as being primarily for broadcasting purposes or restricted datacasting services, or both; and
- (b) refer it to the ACMA for planning under Part 3 of the Broadcasting Services Act 1992.

At the time the Act was established, this mechanism handed over administration and planning of the Broadcasting Services Bands to the ABA (now part of the ACMA), whereas from a radio spectrum perspective, all other bands are administered under the RCA.

<sup>&</sup>lt;sup>11</sup> www.comlaw.gov.au/Details/C2013C00586

#### (ii) Broadcasting Services Act 1992

The "broadcasting services bands" so designated by the Minister in Section 31 of the RCA are managed through the Broadcasting Services Act<sup>12</sup> (BSA) 1992 as amended which is the main legislative instrument governing terrestrial broadcasting in Australia and defines the role of the regulatory authority (originally the Australian Broadcasting Authority and now the Australian Communications and Media Authority), gives the regulator a range of powers and functions, and sets out explicit policy objectives. The regulator is independent from, and has a separate legal identity to, the Australia government.

## **1.6** Planning and licencing

#### 1.6.1 Analogue planning

The BSA sets out three stages for the planning process for the broadcasting services bands:

- determination of priorities for the planning of services using the broadcasting services bands [s.24];
- preparation of a frequency allotment plan (FAP) [s.25]; and
- preparation of licence area plans (LAPs) [s.26].

The LAP is a legislative instrument determines the number and characteristics, including technical specifications, of broadcasting services that are to be available in particular areas of Australia with the use of the broadcasting services bands, and those plans must be consistent with the relevant frequency allotment plan<sup>13</sup>.

The LAPs specify all the technical characteristics of the analogue broadcast service for the broadcaster and define the licence area over which they have rights to broadcast. Before issuing a final LAP, the ACMA release a draft for comment and seek submissions. At this time a discussion paper is released offering background on the selection of various characteristics. This provides the broadcaster an opportunity to review and seek changes prior to the final plan being released. The benefits of this consultation for both parties are to bring together a national planning view via the regulator enhanced by the local knowledge of the broadcaster to avoid instances where local conditions may not conform to planning models.

## **1.6.2** Digital terrestrial television broadcasting (DTTB) planning

#### (i) Commercial and national television conversion schemes

Schedule 4 to the *BSA* sets out arrangements for the conversion, over time, of the transmission of television broadcasting services from analogue to digital mode. Under the arrangements, the ABA (now ACMA) was required to formulate two schemes for the conversion – a commercial television conversion scheme, and a national television conversion scheme:

- the Commercial Television Conversion (CTC) scheme was formulated in March 1999. The scheme commenced on 9 June 1999. The ABA varied the CTC scheme on 21 December 2000;
- the National Television Conversion (NTC) scheme was formulated in December 1999. It was approved by the Minister on 2 February 2000, and commenced on that date. The Minister approved a variation to this scheme on 20 December 2000.

<sup>&</sup>lt;sup>12</sup> www.comlaw.gov.au/Details/C2014C00649

<sup>&</sup>lt;sup>13</sup> Final LAPs are available from <u>www.acma.gov.au/Industry/Broadcast/Spectrum-for-broadcasting/Spectrum-radio-broadcasting/final-licence-area-plans-broadcast-planning-acma</u>

#### (ii) Digital channel plans (DCPs)

Under both schemes, the ABA (now ACMA) was required to make digital channel plans that allotted additional channels to broadcasters so as to enable them to transmit programmes in analogue and digital modes during a simulcast period (originally foreseen to last 8 years). Incumbent television broadcasters were provided additional spectrum to simulcast their analogue signal in digital form during the conversion period. At the end of the conversion period, the spectrum used for analogue transmission was returned to the regulator.

## (iii) Television licence area plans (TLAPs)

Television licence area plans are the long-term planning instruments for television broadcasting services, and are the primary instruments for managing the restack of television broadcasting services. Restack refers to the process of clearing digital television services from the digital dividend band (694-820 MHz). A TLAP identifies channel allotments for digital television services, details any necessary changes and a timeframe for those changes. Once TLAPs come into effect they replace the licence area plans (LAPs) and digital channel plans (DCPs) for those areas.

## (iv) Technical planning guidelines

Under section 33 of the Broadcasting Services Act 1992, the ACMA is required to prepare technical guidelines for planning radio and television services that use the broadcasting services bands. The Technical Planning Guidelines (TPGs) contain mandatory technical requirements for commercial, community (including temporary community) and datacasting licensees, when planning and operating new transmission facilities or proposing changes to existing facilities.

The guidelines cover both analogue and digital television as well as other broadcast services and specify the emission characteristics. For the analogue service this inherently specifies baseband characteristics as well, but for digital television the document relies on a reference to the modulation characteristics in the Australian Standard AS4599.1-2007, hence providing a link between the digital transmission standard and the *BSA*.



The linkages between the BSA and other technical documentation are shown in Figure 4.

#### (v) DTTB Planning Handbook

All technical and general assumptions considered by the ABA (now ACMA) to develop DCPs are set out in the *DTTB Planning Handbook* – *March 2005*<sup>14</sup>.

## 1.6.3 Licensing

There are two types of licences relevant to broadcasting; a broadcasting licence and apparatus licences.

A broadcasting licence not only gives the broadcaster the right to broadcast the service, it also confers a right to use the broadcasting services bands to transmit the service. Therefore, in its statutory role for planning and licensing the broadcasting services bands, the ACMA issues most broadcasters with apparatus licences that grant them access to the spectrum when they receive their broadcasting licence.

Most of the broadcasting licences carry the entitlement to sufficient spectrum to maximise coverage in a market or licence area while minimising coverage outside it. These broadcasting licences may be transferred as a complete package, but it is not possible under the current regulations to transfer access to the spectrum separately from the licence to broadcast.

The transition to digital, requiring a second channel to simulcast analogue and digital services during the transition period, has seen considerable debate in Australia in recent years regarding the methods for allocation and charging of broadcasting spectrum. Much of the policy debate is around what broadcasters do under the banner of public interest to make culturally and socially valuable content accessible to large numbers of people, and how to place a value on that content.

#### 1.6.4 Television spectrum

Australia has a 7 MHz channel raster in VHF Bands I, II and III and in UHF Bands IV and V as shown in Table 2.

<sup>&</sup>lt;sup>14</sup> www.acma.gov.au/~/media/Licence%20Issue%20and%20Allocation/Publication/pdf/Digital%20Terrestrial%20 Television%20Broadcasting%20Planning%20Handbook%20including%20technical%20and%20general%20assumptions.pdf

	VHF	UHF				
	BAND I <sup>(1)</sup>		BAND IV	47	659-666 MHz	
0	45-52 MHz	27	520-526 MHz	48	666-673 MHz	
1	56-63 MHz	28	526-533 MHz	49	673-680 MHz	
2	63-70 MHz	29	533-540 MHz	50	680-687 MHz	
		30	540-547 MHz	51	687-694 MHz	
		31	547-554 MHz	52	694-701 MHz	
	BAND II <sup>(1)</sup>	32	554-561 MHz	53	701-708 MHz	
3	85-92 MHz	33	561-568 MHz	54	708-715 MHz	
4	94-101 MHz	34	568-575 MHz	55	715-722 MHz	
5	101-108 MHz	35	575-582 MHz	56	722-729 MHz	
				57	729-736 MHz	
			BAND V	58	736-743 MHz	
BAND III		36	582-589 MHz	59	743-750 MHz	
5A <sup>(2)</sup>	137-144 MHz	37	589-596 MHz	60	750-757 MHz	
6	174-181 MHz	38	596-603 MHz	61	757-764 MHz	
7	181-188 MHz	39	603-610 MHz	62	764-771 MHz	
8	188-195 MHz	40	610-617 MHz	63	771-778 MHz	
9	195-202 MHz	41	617-624 MHz	64	778-785 MHz	
9A <sup>(3)</sup>	202-209 MHz	42	624-631 MHz	65	785-792 MHz	
10(4)	208-215 MHz (superseded)	43	631-638 MHz	66	792-799 MHz	
	209-216 MHz (current)	44	638-645 MHz	67	799-806 MHz	
11(4)	215-222 MHz (superseded)	45	645-652 MHz	68	806-813 MHz	
	216-223 MHz (current)	46	652-659 MHz	69	813-820 MHz	
12 <sup>(3)</sup>	223-230 MHz					

Table 2. Chamiles for the Australian refeation relevator service	Table 2: Channels for	the Australian	Terrestrial	Television	Service <sup>15</sup>
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*Note* 1 – Television Band I (channels 0, 1 & 2) and Band II (channels 3, 4 & 5) are not being considered for new analogue television services or for the introduction or ongoing transmission of digital television services.

*Note 2* – VHF channel 5A is currently within the Broadcasting Services Bands (BSB) and has been recommended for clearance by ACMA to allow for the introduction of Low Earth Orbiting (LEO) satellites. Channel 5A is not being considered for new analogue television services or for the introduction or ongoing transmission of digital television services.

*Note 3* – Clearance of radiocommunication services from 202-208 MHz and from 222-230 MHz has allowed a revised channel arrangement to be implemented. The current channel arrangement has two new channels (channels 9A and 12). To accommodate channel 9A, channels 10 and 11 were shifted up in frequency 1 MHz.

*Note 4* – The majority of existing services on channels 10 and 11 were assigned using the superseded channel arrangement. Services on channels 10 and 11 may be required to shift in frequency to align with the current channel arrangement. Any such requirement will be considered on a case-by-case basis. New services on channels 10 and 11 will be assigned according to the current channel arrangement i.e. channel 10 (209-216 MHz) and channel 11 (216-223 MHz).

<sup>&</sup>lt;sup>15</sup> Appendix 5 of Broadcasting Services (Technical Planning) Guidelines 2007as amended <u>www.comlaw.gov.au/</u> <u>Details/F2009C01061</u>

## 1.6.5 Standards

Section 130A of the *BSA* provides that the ACMA may, by legislative instrument, determine technical standards that relate to digital terrestrial transmission. The ACMA have not made such an instrument, but have regulated the digital emission characteristics by reference to the Australian Standard AS4599.1-2007 in the Technical Planning Guidelines, which are a legislative instrument.

Similarly Section 130B of the *BSA* provides that the ACMA may, by legislative instrument, determine technical standards that determine technical standards that relate to domestic digital television reception equipment. Government policy in Australia maintains a free market for supply of television receivers so no regulations regarding the digital reception aspects of receivers have been made. Other aspects such as electrical safety and electromagnetic radiation have been regulated for consumer products and these regulations apply to digital television receivers.

## 1.7 Roadmap overview

The roadmap of the transition from analogue to DTTB has five stages as shown in Figure 5:

- Stage 1 Preparation and planning
- Stage 2 Implementation
- Stage 3 Digital enhancement
- Stage 4 Analogue switch off, and
- Stage 5 Digital restack.



#### **1.7.1** Stage 1 – Preparation and planning

This stage initially involved Australian experts contributing to the development work in the ITU-R Study Group 11 and in particular, Task Group 11/3.

Studies within Australia were brought together under a Specialist Group drawn from government and industry and led by the regulator at the time, the Australian Broadcasting Authority which recommended adoption of DTTB in 1997. Exhaustive testing and evaluation of ATSC and DVB-T by government and industry experts led to the decision to recommend the DVB-T system for Australia.

Having the technical foundations in place, government policy was announced supporting legislation passed in 1998. This formed the basis for the regulator to commence planning the simulcast of analogue and digital services and undertake appropriate licencing. At the same time government and industry met to develop technical standards for the system.

## **1.7.2** Stage 2 – Implementation

In 2000, a year prior to the first DTTB transmissions, broadcasters commenced installation of digital headend and transmission equipment. DTTB formally commenced in Sydney, Melbourne, Brisbane, Adelaide and Perth on 1<sup>st</sup> January 2001. Initially services were planned to have an eight year simulcast with digital, regional areas were scheduled three years later.

This was a period of approximately six years which allowed broadcasters to test various aspects of the digital system and for engineers to focus on refinement of the transmission network. Digital take up by consumers provided a better statistical base for viewer complaints so reception issues could be investigated. Refinements were made to the service information inherent in digital broadcasts and the development of electronic programme guide information. After the initial rollout of transmitters at existing broadcasting sites, there was a period of stability in the broadcast networks.

## 1.7.3 Stage 3 – Digital enhancement

With the pending closure of the analogue service in sight, broadcasters commenced an intensive review of digital coverage. Garnering the experience gained from the Implementation Stage, each licence area was reviewed to investigate methods of cost-effectively enhancing coverage in areas where the digital service was proving to not be completely reliable.

Special attention was given to planning spectrum for these additional sites as the television broadcasting spectrum was already heavily congested.

## 1.7.4 Stage 4 – Analogue switch off

Extensive planning was needed to ensure that the viewing public will not be impacted by the switch off of analogue service as it was a complex process. The government established a Task Force to plan the switch off of analogue services which had to liaise widely with broadcasters and other industry sectors to ensure that all facilities were in place in preparation for the switch off.

Actual conversion status needed to be quantified and assistance programmes developed. Switch-off was planned to occur in stages by licence area.

## 1.7.5 Stage 5 – Digital restack

Government made a policy decision to auction the 694-820 MHz spectrum band as a "Digital Dividend" in 2012 before the switch off was completed which required the planning of the restack of digital services co-incident with planning the switch off. Methods for restacking were examined, resourcing was a key issue and public information campaigns devised.

Considerable spectrum planning was undertaken to ensure that a restack of services in a licence area did not cause interference into an adjacent licence area.

## Part 2 – Preparation and planning

## 2.1 System selection

## 2.1.1 Origins for considering digital

Australian television broadcast engineers have been involved throughout the development of HDTV and digital television broadcasting, from the debates on HDTV standards from the mid 1980's. In particular, Australian delegations to the International Telecommunication Union (ITU-R) forums have consistently pressed for a common international standard for digital television. The ITU was seen to be the main forum in which to argue for convergence of globally harmonised television standards for the new technology choices, so as to avoid the need for continuing standards conversion within the exchange of programme content and consequent operational and quality difficulties.

From about 1990 it became apparent that work on development of analogue HDTV standards based on proposals from Europe, the USA and Japan was becoming deadlocked because of the unavoidable linkages between system standards and the respective regulatory, planning and operational environments of the countries of origin. In addition, none of the analogue HDTV proposals was particularly attractive for use in Australia. In the same time frame, work in the ISO/IEC JTC-1 MPEG group on compression systems and in other related fields indicated that digital technologies might offer viable new solutions for consumer services in television broadcasting.

From its monitoring of developing technologies, the then Federation of Australian Commercial Television Stations (FACTS – now Free TV Australia) Engineering Committee became confident that digital compression and transmission would evolve into practical technologies to carry terrestrial broadcasting into the new millennium. It established a specialist group to study the subject, particularly the early developments in the US. While European broadcasting technology was concentrating on the development of Multiplexed Analogue Component (MAC), FACTS saw little benefit in the MAC technology for terrestrial broadcasting. The commercial broadcasting structure of Australian television depends heavily on local programming and local advertising revenue. The European technology was fundamentally directed to satellite distribution, not suited to distribution to smaller locally-concentrated broadcasting markets.

Early work on the use of Orthogonal Frequency Division Multiplexing (OFDM) published by the IBA in the UK and in other European studies showed similar promise to parallel work on a system to develop HDTV terrestrial broadcasting in the USA. The Australian broadcasting experts identified a need for the ITU to provide a common forum where these disparate studies could be drawn together in an attempt to evolve, for the first time, a world- wide common system of television broadcasting. As a result of an Australian proposal to ITU-R Study Group 11, Task Group 11/3 was established with the objective of preparing a common set of digital terrestrial television broadcasting (DTTB) standards. Task Group 11/3 was very successful in fostering a high level of convergence between the North American and European DTTB systems, except for the modulation system. In the US, a single carrier 8VSB modulation system was formally adopted. European countries confirmed their adoption of a multiple carrier Coded Orthogonal Frequency Division Multiplex modulation system (COFDM). Towards the end of the studies of Task Group 11/3, Japan announced that it was working on a third modulation variant which would offer segmentation of the RF channel.

## 2.1.2 ABA Specialist Group on Digital Terrestrial Broadcasting

In 1993 a group of specialists was drawn together by the broadcasting regulator at the time the Australian Broadcasting Authority, Department of Transport and Communications, in addition to broadcasters and manufacturers. The ABA Specialist Group was intended to bring together studies taking place in a number of Australian forums and investigate potential options and policies relating to digital television.

In 1995 the group released a report, Digital Terrestrial Broadcasting in Australia, containing the preliminary conclusions of the group. It made the observation that picture quality was an early driver of digital:

For decades television engineers have striven to deliver the picture quality they have been able to generate in the studios to home viewers. Their efforts have been hampered by the inherent limitations of the analogue [sic] system. Now, with digital video technology it is possible to realise this ambition<sup>16</sup>.

However, It found that premature regulation of the new platform might stifle the market-driven development of the service, that it should be based upon existing standards, and should not restrict the ability of broadcasters to tailor local content. It was too early at the time to make decisions relating to what standard should be used, when transmissions should commence, and whether analogue television should be phased out.

The final report, was released in February 1997<sup>17</sup>, recommending to government that:

- Australia should adopt a single system standard for DTTB after completion of detailed technical evaluation trials in Australia of candidate systems;
- DTTB should be implemented in Australia with digital high definition television (HDTV) capabilities available from the outset;
- all existing licensed commercial and national television services should be given access to a full 7 MHz bandwidth DTTB channel and be given full control over the use of the delivery capacity of that channel;
- the year 2000 could be a useful target date for commencement of permanent DTTB broadcasting in Australia (and the commencement of the development phase). The period between now (1997) and the commencement in 2000 might be regarded as an experimental phase; and
- the eventual termination of PAL analogue services after the commencement of DTTB services in Australia should be driven by market factors and subject to regular review. The decision should be made in the light of findings and in consultation with both government and industry organisations.

In July 1997 the ABA responded to the Specialist Group's report with its Paper, Digital Terrestrial Television Broadcasting, which recommended to the government that it support the early introduction of DTTB into Australia. It considered that DTTB should be a free-to-air service rather than a form of pay TV and it endorsed the loan of a 7MHz channel to each of the ABC, SBS and each commercial network, as this would enable the introduction of HDTV from the outset<sup>18</sup>.

In April 1998, the Australia government announced its policy to introduce digital television throughout the country from January 2001.

## 2.1.3 Broadcaster-led specialist group

As the Specialist Group on DTTB work concluded, the FACTS Engineering Committee resumed its direct involvement in DTTB by re-establishing the Specialist Group DTTB. The Specialist Group was instrumental in organising the first experimental broadcasting of DTTB in Australia. This broadcast from the Nine Network in Sydney occurred during the final meeting of Task Group 11/3 in Sydney, Australia, in November 1996.

<sup>&</sup>lt;sup>16</sup> Australian Broadcasting Authority (ABA), Specialist Group on Digital Terrestrial Broadcasting, *Digital terrestrial television broadcasting in Australia*, First report, ABA, 1995, p. 13.

<sup>&</sup>lt;sup>17</sup> Australian Broadcasting Authority. Specialist Group on Digital Terrestrial Broadcasting, "Digital terrestrial television broadcasting in Australia: final report of the Australian Broadcasting Authority Digital Terrestrial Television Specialist Group." Available in hard copy only refer to <a href="http://trove.nla.gov.au/work/9829292?q=+&versionld=45821709">http://trove.nla.gov.au/work/9829292?q=+&versionld=45821709</a> for locations.

<sup>&</sup>lt;sup>18</sup> Bills Digest No. 178 1997-98 Television Broadcasting Services (Digital Conversion) Bill 1998 <u>www.aph.gov.au/</u> Parliamentary Business/Bills Legislation/bd/BD9798/98BD178

A programme of tests to evaluate both DVB-T and the ATSC systems was drawn up and progressed over the following year, focussing on operation in a 7 MHz channel and adjacent to the existing analogue transmissions to test the viability of a "simulcast" between analogue and digital. It should be noted that the ISDB system in development in Japan was not tested or considered, as it was not expected to be sufficiently advanced to meet the scheduled Australian commencement date of 2001. These tests which remain today as the only directly comparative tests conducted in the world, provided a solid technical basis for the selection of the DTTB system to be used in Australia and involved extensive laboratory and field testing of the two systems during 1997. The laboratory evaluations were conducted in the government Communications Laboratory facilities in Canberra by Laboratory staff assisted by experts from the industry. The field tests were supervised by experts from FACTS members, assisted by the Communications Laboratory staff, the Australian Broadcasting Authority and a consultant employed by FACTS.

From the outset it was recognised that the ATSC system parameters are mainly fixed and deliver a total useable data rate of 19.39 Mbps whilst the DVB system offered a range of operating modes, ranging from low data payloads with rugged coverage ability to higher payloads with less rugged coverage capability, so a DVB-T mode that provides a payload of 19.35 Mbps was chosen to be similar to ATSC. The payload was based on the findings of the ABA Specialist Group which indicated that a payload in the order of 20 Mbps is desirable in order to meet the HDTV objectives of the 7 MHz service.

In the assessment of the test results, the DTTB Selection Panel felt that there was insufficient information for technical assessment of some relevant criteria. In particular, this applied to translator performance, indoor antenna performance and carriage through Master Antenna Television systems. It was considered that each of these matters would require further testing and evaluation.

## 2.1.4 Selection panel

The Selection Panel was given the responsibility of analysing the comparative tests and other available information, establishing the relevance of the performance differences to Australian broadcasting, and recommending the system to be used.

The Panel was unanimous in its view that all free-to-air television broadcasters should use a common standard to ensure commonality of equipment and minimum cost to viewers. The evaluation process which was used assisted in clarifying the merits of each system in the context of the Australian broadcasting environment, and the process of planning for the transition to digital television.

Starting from an initial list of some 50 possible criteria, the Panel researched, analysed and refined the list to those criteria that were considered to have relevance for the selection. Individual elements were grouped into five sets of related criteria:

- Group 1 Coverage; population served based on transmitting from the existing analogue transmission sites, consideration of reception capability using rooftop vs set-top antennas and the possibility of mobile reception, performance when broadcast within channels with the existing analogue system and the impacts of degradations e.g. co-channel and adjacent channel performance, multi-path performance, immunity to electrical noise and the any effects of using cabled or MATV systems.
- Group 2 System Design Elements; combining to use common transmit antenna systems, implementation of translators, common channel translator capability, the potential to re-purpose existing transmitters.
- Group 3 Operational Modes Supported, ability to transmit HDTV, closed captions, multilanguage audio and multi-channel audio.
- Group 4 Overall System; accepted rather than unique HDTV system, operation and payload capability in 7 MHz channels, overall encode/decode delay, system upgrade capability.
- Group 5 Receiver Elements; availability and features, MP@HL capability, availability of receivers with both PAL and DTTB capability, consideration of design for unique Australian conditions, software upgrades, lock-up time and ability to provide automatic channel selection for Australian channelling.

Based on these assessment of all criteria, related to the agreed weighting factors, the DTTB Selection Panel found a clear indication in favour of DVB-T. It further noted that even if the further testing of indoor reception indicated preference for ATSC, the overall assessment would still lead to DVB, based on the assessments and the weighting factors applied to the respective criteria.

In June, 1998, the Selection Panel unanimously agreed to recommend that the DVB-T system of modulation be used for DTTB in Australia<sup>19</sup>.

## 2.1.5 Planning implications

From the result of laboratory and field tests undertaken by the Specialist Group DTTB, the concept of mixing analogue and digital channels in the broadcast band with acceptable levels of degradation to the analogue service was proven. The test results were a critical input to a group the ABA established to consult regarding the digital channel plans, the Digital Television Channel Planning Consultative Group (DTCPCG). The important work of a subgroup of the DTCPCG is recorded in Appendix A of the ABA's DTTB Planning Handbook regarding how to implement digital services with the same level of coverage as analogue services and potential reception quality.

The conclusion was to transmit digital signals at an effective radiated power 6 dB below the analogue service.

Two approaches to deriving planning values for defining field strength were studied; a 'ratio approach' and a 'first principles approach'. provides the derivation for the 'first principles approach' which the figures were rounded to the nearest dB to set the planning levels<sup>20</sup>.

			Band III			Band IV			Band V	
Parameter	Unit	Rural	Sub- urban	Urban	Rural	Sub- urban	Urban	Rural	Sub- urban	Urban
Frequency	MHz	230	230	230	582	582	582	820	820	820
Equivalent Noise Bandwidth	MHz	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Receiver Noise Figure	dB	6	6	6	7	7	7	8	8	8
Receiver Noise Input Voltage	dBuV	9.0	9.0	9.0	10.0	10.0	10.0	11.0	11.0	11.0
Required Threshold C/N	dB	20	20	20	20	20	20	20	20	20
Minimum Receiver Input Voltage	dBuV	29.0	29.0	29.0	30.0	30.0	30.0	31.0	31.0	31.0
Antenna Gain	dBd	8	5	5	11	8	8	12	9	9
Feeder loss	dB	3	2	2	4	2.7	2.7	5	3.4	3.4
Antenna Factor	dB	8.5	10.5	10.5	14.6	16.3	16.3	17.6	19.0	19.0

#### Table 3: Derivation of field strength for DTTB in Australia<sup>21</sup>

<sup>19</sup> Digital Terrestrial Television Report of the DTTB Selection Panel, FACTS, June, 1998

<sup>&</sup>lt;sup>20</sup> Australian television planning sets three different planning levels to cater for the variation in the Australian environment: rural, suburban and urban levels. Although not strictly defined, they are intended to plan for the inner urban areas of cities, the surrounding outer suburban areas and regional and remote rural areas. The planning model is calculated on a nominal receiver configuration and allowances for the variations in expected interference, noise and antenna location availability. Only the rural field strength is used as the absolute definition of whether a broadcaster is serving their licence area.

<sup>&</sup>lt;sup>21</sup> Digital television planning based on DVB-T mode 64-QAM with 2/3 FEC and a 1/8 guard interval

			Band III			Band IV			Band V	
Parameter	Unit	Rural	Sub- urban	Urban	Rural	Sub- urban	Urban	Rural	Sub- urban	Urban
Minimum Field Strength	dBuV/m	37.6	39.6	39.6	44.6	46.3	46.3	48.6	49.9	49.9
Location Availability Margin	dB	4.0	6.5	8.5	4.5	7.0	9.0	4.5	7.0	9.0
Time Availability Margin	dB	0	0	0	0	0	0	0	0	0
Multipath Margin	dB	0	2	4	0	2	4	0	2	4
Height Gain Allowance	dB	0	5	6	0	6	8	0	6	8
Environmental Noise Allowance	dB	1	3	7	0	1	3	0	1	2
Interference Margin	dB	1	1	1	1	1	1	1	1	1
Resultant Operating F.S.	dBuV/m	43.6	57.1	66.1	50.1	63.3	71.3	54.1	66.9	73.9

These values are reasonably close to values derived from ITU-R Recommendation BT.1368, as is noted in ITU-R Report BT.2140-7, Appendix 1 to Part 2, Section 1.6.1:

Australian digital television planning is based on provision of minimum median field strength levels in rural environments of 44, 50 and 54 dB( $\mu$ V/m) in Bands III, IV and V respectively. These values are reasonably close to the values that can be derived from the sample calculation value provided in Table 53 (§ 6) of Annex 2 to Recommendation ITU-R BT.1368-10, once a location correction factor<sup>22</sup>, bandwidth adjustment <sup>23</sup> and interference margin <sup>24</sup> are applied. The Australian values for rural environments are, respectively, 0.3 and 0.1 dB lower, and 1.8 dB higher than values that would be derived from the Recommendation, for Bands III, IV and V, respectively.

The differences are due to: inclusion of a 1 dB higher receiver noise figure allowance in Bands III and V; inclusion of a 1 dB allowance for man-made noise in VHF Band III; different combinations of antenna gain/feeder loss in Bands III and IV; and, use of frequencies at the top rather than the middle of each band as the reference frequency for the calculation.

<sup>&</sup>lt;sup>22</sup> Australian planning is based on provision of a service at 80% of locations within 200 m by 200 m areas for rural environments. A 4.5 dB correction factor is applied to convert from a 50% of locations to an 80% locations field strength value.

<sup>&</sup>lt;sup>23</sup> A 0.5 dB lower noise power applies due to the receiver bandwidth being 6.7 rather than 7.6 MHz.

<sup>&</sup>lt;sup>24</sup> The minimum field strength calculations also include a 1 dB "interference margin" for the support of co-channel frequency reuse planning.

## 2.2 Government decisions

On the 24 March 1998 the Minister for Communications, the Information Economy and the Arts, announced the government decisions on the introduction of digital television. The key elements were as follows<sup>25</sup>:

- the commercial and national free-to-air television broadcasters (FTAs) will be loaned 7 MHz of spectrum free of upfront charge. In return they will be required to simulcast their existing service in analogue and digital format for eight years, after which they will have to return the equivalent of their loaned spectrum to the Commonwealth;
- the FTAs will be required to commence DTTB in metropolitan areas by 1 January 2001 and in regional areas from that date onwards so that all areas have DTTB by 1 January 2004;
- Following the start-up of DTTB, the FTAs will be required to broadcast minimum levels of HDTV, with these levels increasing over time. If the FTAs do not comply with these requirements they will forfeit their loaned digital spectrum.

As well as decisions relating to FTAs providing competition to other industry sectors (not being able to datacast in the loaned spectrum without paying additional fees, not allowed to multi-channel or provide subscription television services) and in return a prohibition on new commercial FTA entrants will be extended until December 2008. The current Australian local programme content requirements will continue to apply in the digital environment and closed captioning provisions were included for news and current affairs programmes as well as the establishment of committees to advise on regulatory and technical matters relating to the conversion. The government was still considering the funding requirements for the ABC and SBS for digital conversion, as well as whether the national broadcasters would be permitted to broadcast non-commercial multi-channel programming in line with their charter obligations.

Passage of this legislation was an attempt to appease competing stakeholders, but the actual situation is summarised by Jock Given (Director of the Communications Law Centre at the University of NSW) in an article published in one of Sydney's morning newspapers:

...the commercial networks which get frequencies can't use them to provide multi-channel TV services, because that would be competition for the Pay-TV business. And the new players which get frequencies for datacasting can't use them for TV services, because that would be competition for the free-to-air TV business. Policy is made by keeping the warring commercial interests equally unhappy, rather than encouraging the creative exploration of the capabilities of a new and cost efficient technology to provide a flexible and interesting service mix<sup>26</sup>.

The 1998 legislation specified that a number of reviews on future directions for digital television and datacasting take place before 2000. The review process allowed competing stakeholders to lobby for boundaries to be set on the digital system. The main changes of these reviews resulted in:

- broadcasters were able to offer digital enhancements to their main simulcast programmes if these were directly linked to main channel programmes and broadcast as separate multi-channel programmes ("multicasting" or "multiviewing"); and
- "triplecasting"; the telecast of the broadcaster's analogue signal had to be broadcasting as a standard definition digital signal at all times in addition to being broadcast in high definition for at least 1040 hours per annum (of "native" content, not up-converted).

It has been argued by many commentators that these initial policy-driven technical limitations on the DTTB system were an impediment to consumer uptake of digital television, but the initial availability of standard definition receivers allowed the public its first experience of digital television.

<sup>&</sup>lt;sup>25</sup> Bills Digest No. 178 1997-98 Television Broadcasting Services (Digital Conversion) Bill 1998 <u>www.aph.gov.au/</u> <u>Parliamentary\_Business/Bills\_Legislation/bd/BD9798/98BD178</u>

<sup>&</sup>lt;sup>26</sup> J Given, 'Taking a punt with TV', *The Sydney Morning Herald*, 26 March 1998, p. 19
## 2.3 Standards development

### 2.3.1 Transmission

In 1998 the Australian regulatory body for broadcasting, the Australian Broadcasting Authority, in conjunction with the Australian national standards body, Standards Australia, and terrestrial televisions broadcasters commenced development of a standard which specified the terrestrial television transmission characteristics for Australia.

The BSA allows<sup>27</sup> the regulator, the ACMA, by legislative instrument, to determine technical standards that relate to digital television transmissions. Rather than legislate a technical standard, the regulator has used its powers under s.33 of the BSA to make reference in the Technical Planning Guidelines to the transmission standard developed in Standards Australia, *Digital television – Terrestrial broadcasting Part 1: Characteristics of digital terrestrial television transmissions AS4599.1-2007*. The links between the BSA and the standard is shown in Figure 4.

As indicated graphically in Figure 6, this standard builds on and references a suite of DVB standards published as European Technical Standards Institute (ETSI) documents, but importantly makes special note of variations required to suit the Australian legislated and technical environment. The standard was structured in this manner to convey to manufacturers, who are mainly overseas companies, to highlight how a standard DVB-T transmitter (and by inference a DVB-T receiver) could be readily adapted for Australia. The standard also references a suite of Free TV Operational Practices. These are documents developed by the broadcasters<sup>28</sup> to provide common information or technical inputs into their broadcast streams, for example parental guidance codes which meet the Code of Practice and are displayed in an electronic programme guide, and are a further example of the co-regulatory nature of the Australian broadcast system.

When published in 2000, AS4599 specified that while the DVB specifications and ETSI standards provide a range of possible operations, the standard highlighted variations specific to Australian regulatory and legislative requirements of most importance were:

- 7 MHz channels were to be used both at VHF and UHF.
- Both 2K and 8K COFDM carrier operations could be expected.
- Transmissions could include video MPEG encoded at 25 frames, 50 fields and 50 frames per second. The video could be scanned up to 1920 pixels by 1080 lines.
- Transmissions may include, at a minimum MPEG-1 Layer II sound, and potentially AC-3 sound streams in either mono, stereo or stereo with surround, or an AC-3 sound stream with 5.1 channel sound.
- Transmissions could include closed caption subtitles based on either or both ETSI standards EN 300 473 and ETS 300 742.
- Transmissions may include data broadcasting as specified in EN 301 192.
- Transmission filter masks for Australia's 7 MHz channel spacing would take into account the relative proximity of lower adjacent channel dual analogue sound carriers compared with a less stringent 8 MHz channel spacing.

<sup>&</sup>lt;sup>27</sup> s.130A of the BSA

<sup>&</sup>lt;sup>28</sup> Available at <u>www.freetv.com.au/content\_common/pg-engineering-guides.seo</u>



# 2.3.2 Development of a DTTB reference transport stream

Australian terrestrial television broadcasters realised they were one of the first 'horizontal' implementations of DVB-T with no "cross carry" of service information between broadcaster multiplexes. Within the 'vertical' implementations of the DVB standards to date individual organisations and multiplex operators had developed specifications for receivers and had a common source of service information. In Australia there was the possibility in some licence areas services could be provided by at least 12 broadcasters, each with their own multiplex and a viewing audience supplied with receivers from a larger number of sources.

Broadcasters developed a DTTB Reference Transport Stream for the testing of television receivers in a broadcast environment simulating Australian conditions. The Streams were representative of the broadcast signals to be provided at launch by Australian DTTB transmissions and specifications within the Australian Standard AS4599. The video was presented in a variety of bit rates. The Service Information elements were representative of a single location at a fixed point in time.

Two stream recordings were provided:

- File 1 Australian DTTB Reference Transport Stream Ver 2-0 (19 Mbit/s) is a recording of 188 byte packets at 19.352941 Mbit/s suitable for DVB-T 64-QAM with 2/3 FEC and a 1/8 guard interval.
- File 2 Australian DTTB Reference Transport Stream Ver 2-0 (23 Mbit/s) is a recording of 188 byte packets at 23.052768 Mbit/s suitable for DVB-T 64-QAM with 3/4 FEC and a 1/16 guard interval.

The features of the streams included:

- Source material of the highest video/audio quality prior to coding. SD material is 720 x 576i and HD is 1920 x 1080i (50Hz). All aspect ratios are 16:9.
- Several services, up to two standard definition (SD) services and a high definition (HD) service. The standard definition services comprise video, teletext closed captioning, Dolby AC-3 audio and MPEG-1 Layer II audio components. The high definition service comprises video, Dolby AC-3 audio and MPEG-1 Layer II audio components. The encode rates of each component are provided in the mode table.

The streams incorporate extensive service information to test receivers for typical Australian DTTB transmissions, including:

- The Network Information Table uses network identification codes assigned to Free TV and included a complete channel list for the Australian state capital city markets. Each stream incorporated a logical channel number (LCN) assignment as described in Free TV Operational Practice OP-42 including multiple LCN assignments of a service.
- The Time Offset Table incorporated a typical summer to winter time change transition for Australia as occurred in March 2001. It is important to note that Australia changes from three time zones during winter months to five time zones in the summer.
- An extensive Event Information Table (EIT) was included for each service. There are three events, with the first event repeated for the "next" information for the third event. The EIT exercises all fields in the short\_event\_descriptor and the extended\_event\_descriptor. In addition, content\_descriptors and parental\_rating\_descriptors contained data as described in Free TV Operational Practice OP-41 and in AS4599.

## 2.3.3 Reception

Broadcasters, receiver manufacturers, suppliers and the regulator have also worked together within Standards Australia to develop other standards related to the digital broadcast system. These include *Digital television – Requirements for receivers Part 1: VHF/UHF DVB-T television AS4933.1.* There was no regulated basis for this standard, it provided guidance to overseas manufacturers as to what is required to receive and decode DTTB in Australia.

Whilst the planning for DTTB is for fixed reception with rooftop antennas, many Australians live in home units or apartments known as multi dwelling units (MDUs). In MDUs, the home owner may not own or have direct access to the rooftop aerial, but signals are fed via a common distribution system, the system characteristic of which may affect reception of free-to-air broadcast television. Broadcasters and industry have also authored a standard *Coaxial cable and optical fibre systems for the distribution of analogue and digital television and sound signals in single and multiple dwelling installations AS/NZS 1367:2000* to specify the requirements of these systems to pass DTTB signals in an acceptable manner.

#### Australian digital TV key initial factors

- DVB-T system selected.
- Broadcasters have own 7 MHz digital channel no "cross carry" of service information to make a digital platform.
- Digital transmitters located at the same sites to that of the analogue transmitters to provide same coverage.
- Transmit Power 6 dB below analogue service.
- DTTB Service level defined by Field Strength values in rural, suburban and urban environments.
- "Triplecast" of programming simultaneously in analogue, SD and HD.
- 1 January 2001 commencement in metropolitan areas, regional areas up to 3 years later, originally anticipated to have an 8 year analogue / digital simulcast.
- Initial consumer proposition better pictures (HD) and sound (up to 5.1 surround sound).
- Quota on HD TV broadcasts (1040 hours per annum).
- Local content and captioning requirements.
- Limits on multi-channels in return for prohibition on new commercial FTA entrants.

# Part 3 – Implementation

### 3.1 Introduction

Implementation was a stage of the project that was led by broadcasters. Commencing a year prior to the first DTTB transmissions, broadcasters sourced digital video encoders, multiplexers and other headend equipment and purchased and installed digital transmitters. The first on-air tests were undertaken in August 2000, followed in September 2000 with transmissions in a very robust mode (with FEC R1/2) to try mobile reception in demonstration tests co-incident with the staging of the Sydney 2000 Olympic Games.

### 3.2 Digital services

Initially multiplexes were launched with at least one SD video service and one HD video service. Some services were accompanied by multiple audio services to provide MPEG-1 Layer 2 and Dolby AC-3 encoded formats of the same content. Broadcasters who experimented with multiview services (multiple SD channels) would undertake a mode change in their multiplex to remove the HD service to free up capacity for the additional SD services. Table 4 summarises typical component bitrates in the multiplex when services were launched.

Component	Parameters	Bitrate		
Service Information (PSI/SI)		~250 kbit/s		
HD Video	MPEG-2 1440x1080i	~15 Mbit/s		
SD Video	MPEG-2 720x576i	5-6 Mbit/s		
Teletext	Lines 21 334	73 kbit/s		
Stereo Audio	MPEG-1 Layer II	256 kbit/s		
Stereo Audio	AC-3 Mode 2/0	256 kbit/s		
Multi Channel Audio	AC-3 Mode 5/1	448 kbit/s		

#### Table 4: Initial multiplex component bit rates

In later years as government policy had changed to allow extra services and broadcasters had upgraded their encoding and multiplexing equipment, subsequent technological developments allowed bitrates to be reduced without sacrificing quality. Also, an effective capacity increase was created through the use of statistical multiplexing, allowing higher peak encoding bitrates as the demands of each video service would peak at different times due to different picture content. SD video rates typically now vary between 0.5 to 2 Mbit/s in a statistical multiplex for services with low movement video whereas premium channels are set to operate between 2 to 6 Mbit/s. HD has been reduced to operate between 7 to 13 Mbit/s in a statistical multiplex. In 2014, all video services still use MPEG-2 encoding. Audio components were rationalised and reduced as receivers were able to adequately change between MPEG and AC-3 coded audio without annoying audio spikes. A greater capacity of approximately 300 kbit/s (in addition to SI/PSI) is now dedicated to the broadcast of electronic programme guide (EPG) data as there has been considerable development over the years in EPG systems to provide better programme information to viewers.

# 3.3 Transmitter rollout

DVB-T formally commenced in Sydney, Melbourne, Brisbane, Adelaide and Perth on 1 January, 2001. Initially services were planned to have an eight year simulcast with digital, regional areas were scheduled three years later.

Commencement of a digital service involved a number of new workflows for a broadcaster:

- in Australia's case, the vision aspect ratio changed from 4:3 to 16:9 which required the addition of many aspect ratio converters to the broadcaster facility;
- the number of audio channels increased from stereo up to six channels of surround sound which also required additional facilities;
- digital headends needed to be established to encode video and audio services and multiplex them together with data in the form of service information and other ancillary data;
- establishing digital links between the broadcaster studios and transmitter site(s);
- installing transmitters;
- establishing translator facilities, often in a single frequency network.

The network structure is shown below in Figure 7. This figure should be compared to Figure 2 to highlight the differences compared to the analogue network.



# 3.3.1 Interference management scheme

Commencing a new radio frequency transmission carries the risk of creating interference to existing services. This was particularly the case with the broadcasting services bands used for television as the implementation of DTTB was to fill in between the analogue services. Although the tests and planning had indicated that this was possible to do, the statistical nature of field strength as it varies in response to natural phenomena, can create unexpected results.

For broadcasters, in particular commercial broadcasters, any loss of audience possibly translates into a loss of revenue, so they are particularly careful to avoid or readily quantify and correct any interference.

Broadcasters and the regulator devised a scheme to manage the process of commencing a new DTTB service and managing any interference complaints that arose. This process was legislated as Part 7 of the Technical Planning Guidelines *Interference Management Scheme for digital television*.

#### (i) Interference management process

Broadcasters, through their industry body, the Federation of Australian Commercial Television Stations (FACTS – now Free TV Australia) coordinated all aspects related to the administration of the process. The key elements of the process were:

- development of a brochure delivered to residents. The brochures outlined types of interference and re-tuning information;
- the establishment of an interference hotline (the hotline) for all Australian States. This toll-free number provided advice to viewers on re-tuning arrangements, and provided access to technicians where required; and
- a media campaign, which included advertisements in local and national newspapers and on local television stations.

#### (ii) Bringing a new transmitter into service

To commence a new transmission:

- at least seven days before commencing, the broadcaster had to notify nominated organisations including other broadcasters in the same and adjacent licence areas, the regulator and make public notices in an area up to 200 km from the transmitter site (the distance depended on the transmitted power);
- transmissions generally commenced 10dB below their nominated power and were brought up to nominated levels over a few days, during this period;
- broadcaster obligations regarding receiving and handling complaints were handled by the industry interference management scheme hotline (see below). These obligations lasted for 12 months after the service commenced.

The telephone hotline was for the public to make complaints. Broadcasters jointly funded this operation and contracted a commercial call centre to undertake the work. Based information from the caller, either standard advice was provided by the call centre to resolve the complaint or for more difficult cases an installation company was contracted to visit the complainant's home and undertake corrective work.

An escalation procedure was included to allow for cases where the complaint levels were above a predetermined threshold, obliging the broadcaster to promptly resolve the complaints by various means including as a last resort, lowering transmitter power. This accommodated the political objective of resolving what would otherwise be complaints to a local member of the federal parliament.

### (iii) Technical resolution of complaints

Investigation of the problems reported by the public revealed the following common problems:

- VHF antenna bandwidth; in the major metropolitan cities, VHF Band III analogue channels were 7, 9 and 10. DTTB were established on channels 6, 8, 11 and 12. Reports of no reception of mainly channels 12, 11 and 6 (in that order) revealed that some antennas had been designed with a narrower bandwidth to increase the gain and so had a lower gain and bad gain scope across the outer channels. Replacement with a new antenna designed for all services resolved these complaints.
- Antenna maintenance; roof mounted antennas are open to the elements and deteriorate over time, but a householder's priority to maintain their antenna is very low. Whereas the viewer would suffer a grade 3 analogue signal, the "cliff effect" of digital made viewing unwatchable and highlighted the need for maintenance or a new antenna.

- Masthead overload; adding the digital signals, although at lower powers than analogue (but the crest factor of digital signals must be considered) increase the loading on installations with an amplifier in the ceiling to amplify the signal before splitting and distribution in a household. Reducing the gain of the amplifier (many are adjustable) resolved the problem.
- Similarly, some viewers near the transmitter sites had signal levels into their receivers that were too high. A commonly misunderstood concept is that higher signal levels are worse, not better for digital. Generally an in-line attenuator solved the issue.
- In some cases differing signal levels between services caused problems and were generally solved by installing filters. However, these needed to be removed when digital services were later restacked.

# 3.3.2 Development of DVB service information

In an analogue television broadcasting system, channel selection is based on tuning to a new frequency and then demodulating the signals in that channel.

A digital television system operates in a completely different manner. The concept of channel selection does not exist, replaced by a service selection concept which is organised by data in the digital multiplex called Service Information. This information is organised into a number of tables of key parameters to identify a service; the original\_network\_id (ONID), transport stream\_id (TSID) and service\_id (SID) (often referred to as the "DVB triple"). A DVB digital television receiver generally scans all available channels to discover digital carriers, demodulates them and discovers this service information then stores the result in memory to later "tune" the television to the desired service by the viewer.

As indicated in Section 1.6.5, this level of information in the broadcast transport streams is managed by the industry operational practices. Free TV Operational Practice OP-40 assigns ranges of values of ONIDs, TSIDs and SIDs for each broadcaster in each licence area. To make the discovery of services more viewer-friendly, Free TV Operational Practice OP-41 lists values of a logical\_channel\_descriptor (LCN) so that a reasonable service number is presented to the viewer while the receiver actually works on the DVB triple in the background.

# (i) The concept of service information (SI) interference

In an analogue system, interference occurs in the radio frequency domain; e.g. a distant transmitter on the same channel being received at a low level compare to the desired local channel and the result is a degraded picture and sound quality.

In a digital system, clashes in the service information allows one operator to "capture" the intended viewer selection of another service. Depending on the order in which a receiver scans each channel and stores the "DVB triple" information, a competitor could add some data into their digital stream to mimick the competitor's service, but point to their own video and audio components, so the viewer would never actually see their intended service, but have two instances of the competitor's service! This is the concept of service information interference.

In Australia's digital system each broadcaster has their own 7 MHz channel and they organise their own service information in their digital streams. Historically this is a result of the fiercely competitive nature of Australian commercial broadcasters who dislike having any part of their business influenced by their competitors. A practical reason emerged as the impacts of digital grew – broadcasters were able to aggregate their presentation systems to gain an operational cost reduction. Not all broadcasters aggregated their presentation facilities in the same location. For example, digital television services for Cairns in North Queensland are generated in Sydney (2 broadcasters), Canberra, Wollongong and Melbourne. The nearest headend is 2 000 km from the licence area and the headends are over 700 km apart, which would require considerable very expensive linking to aggregate services in one location. Hence with separate multiplex locations and separate generation of SI, clashes are avoided by following the allocations of the broadcast industry operational practices.

Other Administrations have DTTB systems where there is a single country multiplex operator, broadcaster content is delivered to the multiplex operator for encoding, multiplexing and transmission. The multiplex operator ensures the same SI is in each digital stream, referred to a 'cross carry' of SI. In this instance the multiplex operator is the sole controller of service information in the stream so they ensure there are no clashes in allocation of SI.

## (ii) Adapting to local requirements

Other operational practices have been developed to cater for local requirements:

- Without any 'cross carry' of SI, the Australian system has had to develop methods of building electronic service guides.
- An operational practice regarding time zones and daylight saving changes was created to cater for the different manner in which Australian states change to daylight saving. It is worth noting that as the DVB system is European-based, Australia had to make submissions to change their system to cater for time zones on the other side of the world! The important lesson here is each Administration needs to examine the specifications and standard in fine detail to ensure they cater for local circumstances.
- For example an operational practice was developed to assist viewers move from HD content when it was broadcast back to the SD service at the conclusion. However, this was not a success as receivers reacted differently to the SI standard.

# 3.4 Consumer take-up

At commencement, limitations were placed on what broadcasters could do in their digital transmissions, limiting the flexibility and innovation available in a digital system. At the time, digital set-top receivers were considered expensive and widescreen displays were still based on analogue technologies, but there was considerable product development undertaken in display technologies commencing with cathode ray tubes (CRT) whose size was ultimately limited by the strength of glass in the screen, rear projection systems which enabled larger displays but suffered from optical alignment issues to plasma displays which were digital in nature and of high quality and finally to liquid crystal displays (LCD) which have ultimately been embraced by consumers and accelerated digital take up in homes.

Reasonably priced quality integrated LCD and plasma televisions appeared in the market circa 2006 and this was a major driver of take up of HD capable receivers. Figure 8: Consumer conversion to digital television is an aggregation of different data sources to show the growth in digital television into Australian households. The early data is sourced from Digital Broadcasting Australia (DBA) an industry organisation formed in the early years of digital broadcasting in Australia. At the time, no organisation was surveying households to assess take up of digital television, DBA initiated action by seeking sales figures from DBA members. In 2005 this task was undertaken on a more formal basis by others and continued through until 2009 when the government Digital Switchover Taskforce (DSTF) commissioned the Digital Tracker surveys of households<sup>29</sup>. It must be noted that the figures prior to June, 2009 are based on sales of televisions, whereas the Digital Tracker is based on households so the two sets of data are not measuring the same entity. The sales figures have been scaled by assumptions related to estimates of second and other sets in a household and replacement sales for failed units or consumer upgrades, in an attempt to convert sales into households. The only reference point between the two sets of data is the ACMA surveys of DTTB household penetration undertaken on an irregular basis between 2005 and 2007, which provides reasonable correlation to the total estimated households. The BuddeComm estimates<sup>30</sup> are based on the same industry data, but are shown as estimates for 2008 and 2009.

<sup>&</sup>lt;sup>29</sup> Data extracted from reports available at <u>www.communications.gov.au/television/digital tv in australia/</u> <u>digital switchover reports</u>

<sup>&</sup>lt;sup>30</sup> Box 7 Dr Rhonda Jolly, Going digital: tracing the transition to digital terrestrial television in Australia, RESEARCH PAPER No. 7, 2010-11, 19 November 2010, Parliament of Australia Parliamentary Library

However, the sales-based data provided a key indicator in the earlier years – that of the split between SD and HD capable receivers, showing the tipping point occurring in early 2008 when sales of HD receivers exceeded SD receivers and the trend can be seen from about a year earlier. Within a few months, household penetration reached 50 per cent, this was the point at which Australia changed from being a nation with an analogue broadcast system and sampling digital services, to a nation with a digital broadcast system needing the remaining households to convert.

Although the Digital Tracker surveys peak at approximately 95 per cent conversion, the final numbers are much closer to 100 per cent when considering the effect of last minute conversions by the government assistance programmes and 'laggard' viewers converting. Post switchover surveys in each switchover region indicated between 98 and 99 per cent of households could watch digital television.



# 3.5 Viewer complaints

For a period of approximately six years there were no dramatic changes in television broadcasting policy, so from a technical perspective it was a stable period which allowed broadcasters to test various aspects of the digital system and for engineers to focus on refinement of the transmission network. Digital take up by consumers provided a better statistical base for viewer complaints so reception issues could be investigated.

Unexpected problems were highlighted by analysis of reports from the Interference Management Scheme. As resources permitted, broadcast engineers would visit areas and make detailed field strength surveys to observe actual conditions and then analyse those results against the predictive models used in planning. This allowed broadcast engineers a better understanding of the "cliff effect" of digital signals related to terrain and foliage clutter in varying weather conditions.

### (i) The "Cliff Effect" of digital reception

Figure 9 shows the digital quality scale as a graphical representation of the second line of Table 1 in ITU-R Recommendation BT.1735-2. Although shown as a wide range, in practice, the width of the Q2 scale is approximately 1 to 1.5 dB of variation in field strength which is the point where a DVB-T demodulator changes from Quasi Error Free (QEF) reception (providing near imperceptible video and audio) to the Signal Failure Point (SFP). Overlaid on this graph is an example of the slower degradation with reducing field strength reception of analogue signals, coloured in accordance with the ITU-R quality and impairment scales of Table 3 of ITU-R Recommendation BT.500-13. *It is important to note that the analogue and digital quality scales are not directly related to each other, they are two scales aiming to provide an assessment of the different methods of transmission.* 

During the simulcast period, anecdotal evidence was provided by viewers that when the digital service began to suffer break up, they would change back to the analogue service to continue their viewing and suffer the worse picture quality, but they could follow the story as the sound was still intelligible. Conversely, viewers who had good, reliable digital reception are represented by the shaded area in Figure 9 and enjoy better pictures and sound than they would have with analogue reception. The future of a reliable widespread digital service is for the planning and broadcast engineers to ensure that as many people as possible have reception equating to the blue shaded area.



In many cases, viewers complained they normally had reliable digital reception, but only at times (which seemed to correspond to broadcast times for their favourite programmes!) the reception would suddenly degrade. Generally issues identified were:

- The viewer's reception or antenna system was marginal so their normal conditions provided excellent digital reception, but any change such as weather conditions reduced the signal to the "cliff effect" region and so reception suddenly became unwatchable.
- The effect of local clutter such as vegetation draws on the margins in the reception system. This was demonstrated often by viewers complaining that their reception degraded when the receiving antenna was pointed towards trees nearby and although not quantified, the water vapour in the leaves, or during or immediately after wet weather, would degrade reception. Often these cases were corrected by removing the offending vegetation, or if this was not possible,

relocating the antenna. This problem was investigated in depth by one of the national broadcasters following up on complaints in Darwin which is in the tropical north of Australia. In summary, the conclusion was wet palm fronds were affecting reception. Darwin is a very flat environment so there was not a great clearance above the ground to most households in the licence area.

Investigations at Brooklyn north of Sydney demonstrated the combined effect of varying knife edge diffraction of signals and the different effective pattern of a transmit antenna over a wide frequency range. Brooklyn is located in a deep valley of the Hawkesbury River so they cannot receive transmissions from the main Sydney transmitters. A translator site at Bouddi is located on the coastline near where the Hawkesbury River meets the ocean. Even in the direction to Bouddi the radio propagation path is blocked by other hills, but there is much less blockage than to Sydney, so over the years installed antennas pointed to Bouddi. The analogue channels assigned were low UHF Band IV for national broadcasters and high UHF Band V for commercial broadcasters. Digital allocations were opposite - low UHF Band IV for commercial broadcasters and high UHF Band V for national broadcasters. Investigations in the local area soon revealed that viewers were watching national services in analogue and commercial services in digital. The extra knife edge diffraction and slight change in radiation pattern across the band resulted in the high UHF Band V services being 7dB lower than the low UHF Band IV services. In an area which had marginal reception, the 7 dB made the services unusable. It was, however an interesting consideration into the future restack of digital services to remove these factors by placing all services on adjacent channels and reducing the frequency spread.

## (ii) Single Frequency Networks (SFNs)

The other category of reception problems related to the implementation of SFNs. Transmitters operating in an SFN have to be locked so that the same information is broadcast on the same frequency at precisely the same time. If any one of these three factors changes, the transmitters fail to offer continuous coverage and become interferers with each other. Failure of a transmitter or its GPS timing reference has to be readily identified and corrected as the level of interference goes far beyond the coverage area of the transmitter. The co-channel protection ratio varies depending on the modulation parameters, but in Australia's case, if the carrier-to-noise ratio is less than 20 dB reception problems will be experienced. Hence if all transmitters in an SFN are producing the same field strength, the interference boundary would exist a further 20 dB away which could be several kilometres, so reception over a very wide area is affected.

The relative timing of transmitters in an SFN has to be planned to avoid "mush zones" where the signals arrive at the receive antenna at the same time and are about the same level. Australian experience is that many receivers encountering these conditions are not able to decide which impulse to lock onto as the reference in the SFN network, so as they change (effectively between locking to different transmitters in the SFN) they have a corrupted data output which manifests as momentary blocking or picture breakup. It is best for the network planner to try and delay the launching of signals from one transmitter so the areas where same receive level / same time does not coincide with populated areas. For example two translators at North Head and Kings Cross in Sydney operate in an SFN and the timing was adjusted such that the signals arrive at the same time in Sydney Harbour, where a "mush zone" is created rather than across the harbourside suburbs.

The "mush zone" issue may be partially resolved by careful location of receive antennas to employ the front-to-back ratio of the antenna as a discriminator between the transmitters in the SFN. This technique has also been used when additional sites were required but no additional frequencies were available, resulting in the design of an SFN which transmit outside of the guard interval timing as the distance between transmit sites was too large. In this case a large zone was created where the signals arrived outside of the guard interval, so the transmitters would interfere. However, by using the front-to-back ratio of the receiving antenna to expand the differences in effective receive level from the wanted and unwanted transmitters, the receivers "saw" sufficient co-channel protection ratio and had a decodable carrier to noise ratio.

However, due to the constraints of channel planning within the simulcast period, some broadcasters had to use SFNs based on a different set of transmit sites to other broadcasters. When the viewer installs their antenna towards one of the sites in the SFN, this would often mean other wanted broadcaster signals were mainly coming in from an adjacent transmitter site, so the discriminatory nature of the antenna was non-optimal for the adjacent site and reception problems arose. This could be solved by installing a second antenna and extensive filtering, but the viewer tended to just go without the service or drop back to analogue. This was another consideration for the future restack of digital services to ensure all broadcaster SFNs were from the same sites.

# 3.6 Receivers

Whereas many aspects of free-to-air television are highly regulated by government, Australia has a free unregulated market for supply of television receivers. Many consumer electronics manufacturers saw business opportunities in Australia so a wide variety of receivers were available. The software design of each receiver had its own idiosyncrasies which often led to viewer complaints that were resolved by attention to fine detail in service information or close collaboration with manufacturer's design teams.

The different receiver reactions and consequent potential loss of audience if a broadcaster implemented some of the more esoteric service information features of DVB discouraged broadcasters to innovate and offer new services.

Later systems implemented by broadcasters such as the addition of a common MHEG-based electronic programme guide or the subsequent Hybrid Broadband Broadcast television (hbbTV) systems have insisted on accreditation and testing schemes to overcome these types of issues.

# 3.7 Government reviews

Between 2004 and early 2006, the Department of Communications, Information Technology and the Arts (DCITA) conducted a series of reviews on various aspects of digital television broadcasting including restrictions on additional programming, the moratorium on new broadcast licences, the allocation of spectrum, underserved television markets, high definition requirements and the duration of simulcast. The only notable outcome from these reviews was an acknowledgement that HDTV was becoming more popular with the public.

The lower house in the Australian Parliament, the House of Representatives, held an enquiry shortly afterwards in 2006 at which point multi-channelling became a prominent issue.

The Government followed these reviews with a Media Reform Package, including the following digital changes :

- removed genre restrictions previously imposed on the ABC and SBS multi channels;
- allowed commercial television licensees to provide a non-simulcast HD channel from 1 January 2007, a standard definition multi channel from 1 January 2009 and any number of multi channels at the conclusion of the simulcast period;
- removed the HDTV quota at the end of the simulcast period; and
- provided that content requirements on multi channels should not be 'overly onerous'.

To implement these policy changes, the *Broadcasting Legislation Amendment (Digital Television) Act 2006* was enacted which made changes to the *BSA* and *RCA*.

The effect of these changes was to allow broadcasters to offer more programming and so begin to allow the capabilities of a digital system to be enjoyed by the public, which provided further impetus to digital conversion of households.

### 3.8 Digital Australia

As part of the Media Reform Package, the government established Digital Australia – a dedicated digital switchover body within the Department of Communications, Information Technology and the Arts to coordinate and oversee Australia's transition to digital<sup>31</sup>.

The government stated aim in establishing Digital Australia was to provide a clear focal point for all Australians wanting to know more about digital switchover, when it is occurring and how it is being managed, with the following objectives:

- educate Australians on the benefits of digital television in order to accelerate take-up and inform consumers about the need to convert to digital transmission as switchover approaches;
- identify sections of the community which may have special needs and co-ordinate efforts to meet those needs;
- harness the expertise and co-ordinate the diverse interests of industry in the switchover process broadcasters, receiver importers, antenna installers and retailers will all be called upon to participate; and
- work closely with government and the regulator (ACMA) to ensure Australia is able to commence switchover in 2010-2012.

The government also established an Industry Advisory Group comprising broadcasters, manufacturers, retailers, antenna technicians and consumer representatives to advise and liaise with Digital Australia in implementing its Digital Action Plan.

In establishing Digital Australia and the Digital Action Plan, the government began the process of setting the timetable for the end of analogue broadcasting.

#### Australian digital TV implementation lessons

- Establishing detailed transmission and receiver standards for harmonisation of international standards with local conditions is a foundation to the success of the transition.
- Careful establishment of digital services is essential to avoid interruption to existing services.
- A well-managed and resourced Interference Management Scheme is essential.
- The need for viewers to upgrade or maintain their reception equipment should not be overlooked to achieve good digital reception.
- Available reasonably priced receiving equipment will drive market take up.
- Government should undertake regular surveys to quantify the success of the take up.
- Variability in reception should not be overlooked to avoid viewers operating near the digital cliff.
- Make sufficient allowances in the planning for local clutter.
- When planning channel assignments, avoid a wide spread of channels to serve a particular area.
- Single Frequency Networks are good for efficient use of spectrum, but care needs to be taken to the design of the network in the SFN.
- All services should have the same SFN characteristics.
- In a free consumer market, receiver testing must be encouraged in some manner to generate conformity and allow the digital system to be fully utilised.
- Policy settings should be carefully considered to assist in driving market take up.

<sup>&</sup>lt;sup>31</sup> Australia Government, DCITA, READY, SET, GO DIGITAL A Digital Action Plan for Australia, November 2006 Page 13

# Part 4 – Digital enhancement

### 4.1 Introduction

Despite the take up actually accelerating due to the changes in display technology and lowering consumer prices, public debate over the take up of digital, there was pressure from telecommunication interests to secure spectrum from the "digital dividend". The election of a new government in November 2007 then announced on 19 December 2007 that analogue would be switched off at the end of 2013 and a new Digital Switchover Taskforce established (see Section 5.2) within the newly named Department of Broadband, Communications and the Digital Economy, with the aim of hastening the switch off of analogue broadcasts and release of broadcasting spectrum for other services.

Reliable, quality digital coverage is vital to broadcasters as that is their only means of accessing viewers in the future. With the pending closure of the analogue service in sight, broadcasters commenced an intensive review of digital coverage. In Stage 2, "same coverage" was essentially achieved by installing digital transmitters at the existing analogue broadcasting sites and operating at powers 6 dB lower than analogue. However, garnering the experience gained in Stage 2 from investigating viewer reception complaints and undertaking extensive field surveys, each licence area was reviewed to investigate methods of cost-effectively enhancing coverage in areas where the digital service was proving to not be completely reliable.

The investigation and planning stage for these new sites took approximately three years to complete and installation the following three to four years. This stage had to be completed prior to analogue switch off so that viewers did not lose coverage during the changeover.

### 4.2 Review of underserved areas

Broadcasters commissioned an engineering review of underserved areas. The review included interviewing local staff from each network station to gather all the local information regarding poorly served areas. The study looked at over 300 locations across the country and performed an initial evaluation, categorising sites into:

- sites where new "gap filler" translators would be required;
- existing sites that might be modified to provide coverage;
- locations that needed further study;
- areas where a community information campaign would be appropriate (for example to use an existing digital service);
- areas that should be served by a new "gap filler" but would be commercially unviable;
- areas where upgrading an existing community self help facility;
- areas where no solution could be found;
- areas where no action is required.

The review also encompassed nearly 200 community self-help sites, which had been installed over many years as part of a government funded programme to assist underserved communities. These facilities were operated and maintained by local authorities and only provided analogue television transmissions.

In the review, broadcasters proposed to:

- convert nearly 50 per cent of the sites to digital transmission;
- not convert nearly 25 per cent of the sites as they would be covered by other digital transmission facilities, in particular there were a number of sites installed to solve local analogue ghosting issues so these were not needed in digital;

- not convert 25 per cent of the sites as they would be better served by the VAST system (see next section);
- not convert a few sites as commercial services were not broadcast from those sites.

### (i) Gap filler planning

What followed was probably the most intense period of broadcast planning undertaken in Australia. Every licence area was analysed and propagation predictions undertaken simultaneously by metropolitan and regional broadcast engineers and the results then discussed with the ACMA engineering staff and reanalysed using their propagation software. All three groups used software models from different companies and different ITU-R propagation models were used. Comparison of the results and comparison to measurement data undertaken by the ACMA increased the confidence level in the resulting predictions.

For broadcasters, this represented the last opportunity to establish sites to provide reliable network coverage into the future. Hence, the planning also needed to take into account predictions on future events such as geographic population growth, so special attention was paid to developing growth areas to make sure they were covered, or a plan devised to include coverage in the future. Consideration was given to the problems that had been reported by viewers.

- In the metropolitan licence areas new growth areas needed coverage and a major issue is the
  increasing density of development which often includes new high rise buildings or even large
  blocks of units which effectively shade their neighbours of television signals. The solution to these
  issues was to find new sites in each city to primarily cover the underserved or growth areas, but
  as a secondary consideration have their wider coverage as an alternative for households who may
  suffer "building clutter" in the direction of their primary site in the future. Of course, this still
  needed to be achieved in a spectrally efficient manner, so particular attention was given to
  antenna patterns and SFN design.
- In the regional licence areas, new towns had been established which needed coverage, also the main issue reported by viewers related to having sufficient field strength to pass through areas of vegetation, particularly along riverbanks where otherwise Australia may be considered as an arid area, but rural settlements mainly were established near the only water source and available transport routes, the rivers.

During discussions with the regulator, the ACMA, regarding the planned coverage of these gap filler sites, the ACMA requested that the target service areas for each gap filler be defined by the suburban grade contour even when the target environment was of a rural nature. As is noted in Section 02.1.5, only the rural field strength is used as the definition of whether a broadcaster is serving their licence area correctly, so this was a change of technical policy and no formal written explanation has been provided by the regulator. However, broadcasters were generally in agreement with this change as providing a higher field strength meant better coverage. What was later evident once restack planning had been completed was that the regulator was pre-empting the need to have higher field strengths as frequency re-use planning rules needed to be breached (and hence creating interference between transmitter service areas where the wanted transmitter signal strength is low) in order to provide services in constrained bands one the digital dividend had been removed from broadcasting use. Previously a concept of 'fortuitous coverage' prevailed where viewers were able to receive distant transmissions where the received signal carrier / noise was only limited by electrical noise, not licenced for their location. The restack changed the unwritten model in some areas from a "noise limited" model to an "interference limited" model.

The final outcome of this review necessitated the eventual establishment of 34 new digital sites in the major metropolitan areas of Sydney, Melbourne, Brisbane, Adelaide and Perth and 85 new digital sites in regional licence areas, including the conversion of many self-help community broadcast sites. In addition, a number of existing sites were upgraded by either having larger transmitters installed, or the transmit antenna patterns changed to serve new areas which had been developed since the site was first established.

When these additional gap filling sites were established, there were still in operation the main digital and analogue services, so special attention was given to planning spectrum for these sites as the broadcasting spectrum was already heavily congested. When these services commenced, the broadcasting services bands spectrum was at its highest utilisation. In fact there was no spectrum left for the conversion of the smaller self-help community sites, so they had to be turned off and turned on in digital mode on the same day. Other sites were integrated into single frequency networks with existing digital sites to make better use of existing spectrum.

Some of the planning and implementation of this stage was conducted in parallel with planning the analogue switch off and restack planning (see Part 5 and Part 6 below). In some remote areas, these Stages of the overall project merged to the point where sites were installed on their restacked channel assignments, rather than be installed and have to be subsequently retuned. When to planning commenced, the scale of the digital dividend was unknown.

## (ii) Public information campaign

Although broadcasters were driving the programme of installation and commissioning new gap filler transmission sites, no public information campaign was undertaken at the time these sites commenced operation. At the time, the public information campaigns conducted by government in relation to analogue switch off and restack were underway, it was thought that any other campaign might confuse the issues for the public. The necessary information was passed to the government who integrated key messages into their systems.

## (iii) Coverage working group

Co-incident with the work on gap fillers, the broadcasters established a forum with the regulator to jointly work on deeper investigation of digital coverage issues. The Technical Working Group on Coverage was a collection of experts from each broadcaster and the ACMA planning group and undertook review of reception reports and measurement techniques. Many Australian contributions to ITU-R Working Party 6A emanated from this group including the formative work that has led to Recommendations on field survey techniques, objective reception quality assessment of DVB-T and the effects of wind farms on reception of DVB-T.

# 4.3 Black spot and satellite solutions

Simultaneously with the broadcaster engineering review, the government was receiving complaints about 'black spots'<sup>32</sup> for digital television reception. The government was keen to release a switch off timetable, highlighting the need to devise solutions for these sites as well as the community self-help sites previously funded by the government, but operating as analogue transmission sites outside of the control of, or management by broadcasters.

Negotiations between commercial broadcasters and government saw the commercial broadcasters take on responsibility for converting and maintaining the self-help facilities, including funding translators for the national networks (national networks are normally funded by the government), while the government committed to delivering a free-to-air satellite service to provide digital television transmission to over a quarter of a million households which would be unable to access services from terrestrial transmitters<sup>33</sup>. Subsequently in April 2010, the government announced that an agreement had been reached to establish a joint venture company, Viewer Access Satellite Television (VAST), to deliver the satellite service.

<sup>&</sup>lt;sup>32</sup> In Australia, areas where reception of television is unsatisfactory are called television signal "black spots".

<sup>&</sup>lt;sup>33</sup> S Conroy (Minister for Broadband, Communications and the Digital Economy), *Digital television Australia-wide*, media release, 11 January 2010

In addition to its primary role of providing television to remote areas, the VAST service is the 'catch all' service to serve isolated areas in metropolitan and regional licence areas that do not have acceptable digital terrestrial broadcasting. The service within a licence area must be by agreement of the licenced broadcasters in that area. The service is used in some instances as the feeder link to some isolated communities who have established their own terrestrial digital transmitters.

It is a testament to the level of planning that despite the difficult terrain to cover terrestrially, number of VAST activations in metropolitan licence areas remains very low. At the end of May 2014, Brisbane had 0.6 per cent of households activated whereas all other metropolitan markets were less than 0.3 per cent, implying that either 99.4 per cent (Brisbane) or 99.7 per cent (others) of households receive their television terrestrially or via subscription platforms. In regional licence areas VAST activations remain below 2 per cent of households so 98 per cent of these large licence areas are covered by terrestrial television.

#### Australian digital TV enhancement lessons

- Before commencing analogue switch off, it is important to thoroughly review digital coverage to ensure underserved areas are rectified, changes in population patterns have been accommodated and coverage is planned for the future.
- Minimum signal levels used in coverage planning need to be reviewed to be consistent with changed spectrum arrangements.

# Part 5 – Analogue switch off

### 5.1 Introduction

Switching off a service is a relatively simple task. However, planning to ensure that the viewing public will not be impacted by the switch is complex. The government established a task force to plan the switch off of analogue services. This group had to liaise widely with broadcasters and other industry segments to ensure that all facilities were in place in preparation for the switch off. Government and broadcasters had a shared outcome, broadcasters wanted to know that they would not suffer a loss of audience on switch off, for government this audience represents the voting public so they wanted to ensure they were not affected by the switch.

#### 5.2 Digital switchover taskforce

In December 2007, the newly elected government replaced Digital Australia by establishing a Digital Switchover Taskforce (DSTF) to coordinate and oversee the transition to digital from analogue television.

Its objectives are to:

- advise government on policy settings, implementation and issues connected with digital switchover;
- develop and implement a programme framework, including a switchover timetable, to complete the switchover from analogue to digital television transmission in Australia by the end of 2013;
- manage an information and education programme explaining the switchover process to all Australians setting out what they will need to do and how to get further information; and
- convene meetings of an industry advisory group consisting of stakeholders including broadcasters, retailers, manufacturers, antenna technicians and public and commercial housing agencies, government departments – and coordinate these to utilize their expertise in delivering switchover by the end of 2013.

#### 5.2.1 Industry advisory group and working groups

In establishing the Industry Advisory Group and its working groups, the DSTF became the focal point for all activities related to analogue switch off. The DSTF established several working groups, including:

- Transmission and Spectrum Working Group: comprising representatives of each broadcaster, the Department and the ACMA.
- Satellite Implementation Working Group: comprising broadcasters who were involved in the satellite proposal for remote areas, the Department and the ACMA.
- Housing, Building and MDU Working Group: comprising representatives of some broadcasters, public and commercial housing agencies, antenna installer industry representatives and manufacturers.
- Supply Chain Working Group: comprising representatives of manufacturers and their industry associations.

#### **5.2.2** Government assistance schemes

The government had developed two assistance schemes to convert disadvantaged groups within the community; the Household Assistance Scheme (HAS) and Satellite Subsidy Scheme (SSS).

#### (i) Household Assistance Scheme

The Household Assistance Scheme<sup>34</sup> provided free help for eligible people to switch to digital TV. The assistance package included (free of charge)

- one high definition set-top box;
- installation and demonstration of the new equipment by a technician;
- if the eligible person owned their home, any necessary upgrades to your cabling external antenna or satellite systems;
- 12 months equipment warranty, free support and service.

Eligibility was based on receiving at the full rate one of the following government benefits:

- age pension;
- disability support pension;
- carer payment;
- veterans' affairs service pension;
- veterans' affairs income support supplement;

as long as the householder did not already have access to digital television.

#### (ii) Satellite Subsidy Scheme

This scheme<sup>35</sup> provided assistance to households that moved to the VAST satellite service as part of the switchover to digital TV and that previously relied on community-operated 'self help' analogue transmitters. The scheme closed on 10 January, 2014.

The scheme provided a subsidy for part of the cost of installation of VAST satellite TV equipment (including a satellite dish, a VAST-enabled set-top box and associated cabling) in households by qualified installers contracted by the Australia Government and who have experience in satellite dish installation. The subsidy of between AUD 200 and AUD 250 depending on location was paid directly to the installer, reducing the cost to the householder. In remote Indigenous communities, full assistance was provided without a household contribution being required.

A 12-month warranty on equipment and installation was also provided.

#### (iii) Resource allocation and publicity

From the government perspective, there was a need to coordinate the roll out of gap fillers and self help conversions in a way which is effectively integrated with the government assistance programmes. The HAS was scheduled to occur at or shortly after commencement of new digital services. In addition, the Satellite Subsidy Scheme (SSS) will be established for those self-help sites that are not confirmed for digital upgrade.

There were significant lead times involved in preparing and delivering these assistance programmes. Each involves engaging contractors to deliver services in an area and communicating with viewers so that they can opt-in to services from six months before switchover.

<sup>&</sup>lt;sup>34</sup> HAS Brochure, Digital Switchover Taskforce, November 2011 retrieved via www.headwaytas.net.au/attachments/article/145/HAS%20brochure.pdf

<sup>&</sup>lt;sup>35</sup> Satellite Subsidy Scheme, Digital Switchover Taskforce, December, 2011 retrieved from the Byron Shire Council website <u>www.byron.nsw.gov.au/</u>

Hence, at the meetings of the Transmission and Spectrum Working Group, the installation progress of each new digital sites was reviewed in detail to allow for Scheme resources to be scheduled as well as publicity campaigns engaged at the appropriate time. The Transmission and Spectrum Working Group met on a monthly basis from early 2010 until the end of analogue switch off in December 2013 to review the rollout.

# 5.2.3 Digital tracker

The DSTF commissioned the Digital Tracker surveys of households measuring the national uptake of digital TV and Australians' awareness and attitudes towards the switchover to digital TV<sup>36</sup>. The Digital Tracker measured and reported on the following five critical success measures to provide an indication of Australia's digital readiness:

- 1. Awareness (heard of switchover)
- 2. Understanding (knew how to convert to digital TV)
- 3. Attitudes (positive or negative to switchover)
- 4. Conversion (had converted main TV set to digital)
- 5. Satisfaction (with digital TV)

After an extensive development and testing phase in 2008, the first quarterly Digital Tracker was conducted in January to March 2009 with 9 900 respondents. The scope of the survey was all Australian households and interviews were conducted by telephone. The sample design was a random survey stratified by the 33 switchover areas.

Surveys were taken each quarter up until all regions had switched off the analogue service. A post switch off survey was undertaken in each region to gauge the final success of the programme.

The key result of household conversion from each survey has been included in Figure 8 in Section 3.4.

# 5.2.4 Publicity and labelling scheme

The government launched a campaign to improve digital television uptake in April 2009. The campaign was organised by the DSTF and featured television, radio and online advertisements, a Get Ready for Digital website <u>www.digitalready.gov.au</u>, point-of-sale information and training and accreditation for retail staff.

In conjunction with manufacturers and importer of receivers, a labelling scheme for televisions was also launched to identify receivers in three categories as shown in Figure 10:

- 1. Digital TV Capable for analogue TVs which require a set top box
- 2. Digital TV Ready (Standard Definition) for TVs able to receive SD broadcasts
- 3. Digital TV Ready (High Definition) for TVs able to receive HD broadcasts



All elements of the DSTF work labelled the switch off of analogue services as the 'Digital Switchover'.

<sup>&</sup>lt;sup>36</sup> Data extracted from reports available at <u>www.communications.gov.au/television/digital\_tv\_in\_australia/</u> <u>digital\_switchover\_reports</u>

# 5.3 Digital switchover timetable

The DSTF issued a consultation paper in May 2008<sup>37</sup> seeking opinions on which legislative arrangements should be taken for the switch off of analogue services. A timetable was released in October 2008. Switch off was planned to occur by licence area as this followed dependant signal paths where often switching off the main transmitter would mute the following translators and re-transmitters and formed logical areas for public information campaigns. Actual switch off dates were set by the Minister as target windows of six months duration, then times were agreed between broadcasters and government to be a mutually acceptable time when no high rating or especially important programming was scheduled for broadcast and on a schedule that allowed for timely mobilisation of resources for the public information and assistance campaigns.

### (i) Testing government programmes – Mildura

The campaigns and plans were tested by switching off the Mildura licence area first. This is a smaller regional licence area. Post switch off surveys were conducted to provide feedback and modify the campaigns and plans. The remainder of the licence areas were switched off sequentially in a plan as shown in Table 5.

### (ii) Targets achieved

Table 5 shows the timetable regions, the windows originally set and the actual dates the analogue service was switched off in each region.

For the first two and a half years, switch off was by regional area for each state which formed the major regional licence areas, with a switch off event in each half of the year. New South Wales has two regional licence areas. Generally, a date was chosen in the latter part of the six month window.

In 2013 the switch off events were staggered as they covered the metropolitan areas (and Tasmania), so the affected populations were larger and hence the public information and assistance campaigns were more intense.

The only licence area to switch outside of its allotted window was Adelaide which actually switched early. Broadcasters had completed installation of gap filler transmitters in that area early and wanted to push back the Perth licence area as delays were experienced with approvals for some sites there. However, the DSTF did not want to push back the Perth switch off outside of its window due to the complicated requirements of changing legal instruments. As a result, some gap filler sites in the Perth licence area were not transmitting at the time of analogue switch off, but these commenced service shortly after. Most other gap fillers were ready in time, some commencing service on the switchover day.

<sup>&</sup>lt;sup>37</sup> DSTF, "Legislative framework for implementing a digital television switchover timetable", May 2008

Туре	Switchover Area	Window	Switchover Date		
VIC	Mildura / Sunraysia	1 January – 30 June 2010	30 June 2010		
SA	Broken Hill	1 July – 31 December 2010	15 December 2010		
SA	Riverland	1 July – 31 December 2010	15 December 2010		
SA	Mt Gambier / South East South Australia	1 July – 31 December 2010	15 December 2010		
SA	Spencer Gulf	1 July – 31 December 2010	15 December 2010		
VIC	Gippsland	1 January – 30 June 2011	5 May 2011		
VIC	North Central Victoria	1 January – 30 June 2011	5 May 2011		
VIC	South West Victoria	1 January – 30 June 2011	5 May 2011		
VIC	Goulburn Valley / Upper Murray	1 January – 30 June 2011	5 May 2011		
QLD	Wide Bay	1 July – 31 December 2011	6 December 2011		
QLD	Capricornia	1 July – 31 December 2011	6 December 2011		
QLD	Queensland Central Coast & Whitsundays	1 July – 31 December 2011	6 December 2011		
QLD	Darling Downs	1 July – 31 December 2011	6 December 2011		
QLD	North Queensland	1 July – 31 December 2011	6 December 2011		
QLD	Far North Queensland	1 July – 31 December 2011	6 December 2011		
NSW	Griffith / Murrumbidgee Irrigation Area	1 January – 30 June 2012	5 June 2012		
NSW	South West Slopes & Eastern Riverina	1 January – 30 June 2012	5 June 2012		
NSW	Illawarra and the South Coast	1 January – 30 June 2012	5 June 2012		
NSW	Central Tablelands & Central Western Slopes	1 January – 30 June 2012	5 June 2012		
NSW	ACT & Southern Tablelands	1 January – 30 June 2012	5 June 2012		
NSW	North West Slopes & Plains	1 July – 31 December 2012	27 November 2012		
NSW	Richmond / Tweed	1 July – 31 December 2012	27 November 2012		
NSW	Northern Rivers	1 July – 31 December 2012	27 November 2012		
NSW	Hunter	1 July – 31 December 2012	27 November 2012		
Metro	Tasmania	1 January – 30 June 2013	9 April 2013		
Metro	Perth	1 January – 30 June 2013	16 April 2013		
Metro	Brisbane	1 January – 30 June 2013	28 May 2013		
Metro	Melbourne	1 July – 31 December 2013	10 December 2013		
Metro	Adelaide	1 July – 31 December 2013	2 April 2013		
Metro	Sydney	1 July – 31 December 2013	3 December 2013		
Metro	Darwin	1 July – 31 December 2013	30 July 2013		
Remote	Remote Central & Eastern Australia	1 July – 31 December 2013	10 December 2013		
Remote	Regional & Remote Western Australia	1 July – 31 December 2013	25 June 2013		

# Table 5: Digital TV timetable by region

# 5.4 Digital broadcasting network

At the conclusion of analogue switch off, the broadcast network was fully digital. Additional sites had been integrated into the network as SFNs and the previously community operated facilities had been transferred to become under the control of the broadcasters.

The network structure is shown in Figure 11, incorporating an SFN for translators and showing the impact of subsequent policy decisions regarding enhancement of digital coverage and conversion of gap filler self help transmission sites. It should be compared to the previous analogue (Figure 2) and simulcast (Figure 7) structures to examine the scale of the changes.



#### Australia digital TV analogue switch off lessons

- Government should conduct regular surveys of households to check that the public have converted to digital.
- Close consultation is necessary between all stakeholders for a successful switch off of analogue services and planning is paramount.
- Well designed public information campaigns are needed to ensure the public convert in a timely manner.
- Assistance schemes are needed for lower socio-economic groups in the community to help them convert to digital.
- Setting target dates provides a firm goal to work towards for all stakeholders. However, the switch off dates should be set in a manner that it can reasonably be changed if project plans change due to unforeseen delays.

# Part 6 – Digital restack

## 6.1 Introduction

In June 2010, the Australia Government announced that a digital dividend of 126 MHz in the 700 MHz band spectrum (694-820 MHz), comprised of Australian UHF television channels 52 to 69, would be realised. The digital dividend is made possible by the move to digital-only television broadcasting under the digital television switchover program. The final step to realising the digital dividend is for a significant number of digital television services to be moved to new channels so that channels 52 to 69 can be cleared and made available for new services such as wireless broadband.

Moving to the new channels has two major phases of work. The first was the development of revised channel plans and sequencing plans that identify the final channels that digital television services will move to and the order in which the moves will need to occur. The second was the implementation of those channel changes by broadcasters.

### 6.2 Restack and reallocation processes

The announcement of a digital dividend required two streams of work from government. Firstly, the spectrum needed to be cleared of existing services – the restack of digital television. Secondly, government wanted to convert the dividend into an asset that could be realised into consolidated revenue at auction.

## 6.2.1 Clearing the digital dividend

The processes for the ACMA to clear the digital dividend were given by way of Ministerial Direction – *Australian Communications and Media Authority (Realising the Digital Dividend) Direction 2010* – directing that the ACMA:

- clear part of the Broadcasting Services Band comprising 694-820 MHz as soon as possible after the analogue switch off;
- consider whether to vary a frequency allotment plan (FAP) under subsection 25 (2) of the BSA and that in the metropolitan areas there are no more than six channels available;
- consider whether to vary a licence area plan (LAP) so that the main digital services for both television and radio are broadcast in the same frequency band, e.g. VHF Band III, and for regional areas that the restack has the objective of minimal disruption and minimal financial impact on commercial and national broadcasters;
- to vary conversion schemes so that channel allotments are varied not using the digital dividend;
- set aside 14 MHz in VHF Band III for digital radio;
- they provide regular updates to the Minister; and
- they consider if Channel 27 should be expanded to a 7 MHz channel by adding 1 MHz at the lower end to become 519-526 MHz.

The resulting processes on the ACMA include the work already described above and are shown in the top half of Figure 12. These were to complete the restack and make spectrum available by 31 December 2014. Note should be made that although the government had set the timetable to auction the spectrum, the processes shown in Figure 12 to deliver the spectrum were a task for broadcasters.



### 6.2.2 Auctioning digital dividend spectrum

The processes for the ACMA to prepare the auction for spectrum could be considered as a separate case study. In summary, this spectrum was bundled with spectrum in the 2.6 GHz band, also to be cleared by broadcasters who use it for electronic news gathering links.

<sup>&</sup>lt;sup>38</sup> 14-15 March 2012 – Digital Broadcasting – a 2012 roadmap – speech by Giles Tanner, General Manager, Digital Transition Division, ACMA, to the Broadcasting Australia Conference and Expo 2012, Sydney Slide 7 www.acma.gov.au/~/media/mediacomms/Presentation/Powerpoint/Broadcast%20Sydney%20Expo.PPT



## (i) Preparing for the auction

In the lower half of Figure 12 are shown the regulatory processes for auctioning the digital dividend spectrum. To prepare a spectrum licence, the ACMA must first create a technical framework. As broadcasters were likely to be impacted by the new transmissions in the digital dividend spectrum, they were involved in the consultations undertaken to develop the technical framework. At the same time, Australian delegations to the regional spectrum group, the Asia-Pacific Telecommunity (APT) Conference Preparatory Group (APG) were involved in the development of what ultimately became known as the APT 700MHz band plan (see next Section) and this was adopted as the band plan for the spectrum auction.

The technical framework became part of the marketing plan defining such items as unacceptable interference and advisory guidelines for managing interference from transmitters and into receivers and these form part of the licence conditions. All of these processes were performed under the *Radiocommunications Act 1992*.

A separate consultation was undertaken by the ACMA to determine the auction lot size, determining the geographic boundaries and range of frequencies for each lot to be auctioned. The ACMA determined that they would auction nine 2 x 5 MHz Australia–wide lots consistent with the APT band plan.

### (ii) Auction result

After undertaking a combinatorial clock auction, Australia's two largest mobile telecommunication carriers were successful in securing 2 x 10 MHz (Optus) and 2 x 20 MHz (Telstra) and 2 x 15MHz remains unsold. The important technical consideration for broadcasters was the adjacent licence to Channel 51 would be Optus with a 10 MHz allocation, which sets the characteristic of out-of-band noise for the user equipment (UE) which may be mobile handsets or USB devices for laptop computers etc. While these devices may be manufactured to meet the 3GPP specification ETSI TS 36.101, slightly different limits apply in Australia.

# (iii) Adjacency issues of the 700 MHz Plan

The Spectrum Marketing Plan for the Digital Dividend Auction<sup>39</sup> has defined the limits on spurious and nonspurious emissions from transmitters operating in the band 703-748 MHz. The non-spurious levels are shown in Figure 14 along with the differences from the 3GPP specification.

<sup>&</sup>lt;sup>39</sup> Radiocommunications Spectrum Marketing Plan (700 MHz Band) 2012 <u>www.comlaw.gov.au/Details/F2012L02547</u>

The out-of-band emission levels were developed by the APT over the course of a number of meetings where a level of -34 dBm/MHz was set for protection to broadcast services. The 3GPP specifications have been updated to include a spurious emission limit of  $-26.2 \text{ dBm/6MHz}^{40}$  equivalent to -34 dBm/MHz. The standard emission mask has different break points and levels than the Australian mask (refer Figure 14)<sup>41</sup>.

The ACMA has applied tighter limits across the broadcast channels, lowering the limit to -40 dBm/MHz below 694 MHz but allowing this level to be relaxed to -34 dBm/MHz across channels 49, 50 and 51 in areas where there are no television services operating in those channels.



To know whether this level adequately manages the interaction between the adjacent services will only be known after the IMT services have been in operation for some time and the population of mobile terminals becomes representative across the community. Leading up to the APT meetings, broadcasters had put the case for much lower limits on out-of-band emissions, arguing that the levels should be set 10 dB lower (–50 dBm/MHz) to protect a viewer with suburban grade coverage interfered by a mobile device just over 10 metres from their antenna or a rural grade viewer 50 metres from their antenna.

The ACMA view was that probabilistic factors should also be considered which would lower the chance of interference occurring to what they considered an acceptable level, rather than just the deterministic factors presented by broadcasters.

# 6.3 Planning the restack

During the simulcast period, the broadcasting services bands had fifty seven 7 MHz channels to support 5 analogue television networks, 5 digital television networks, 2 future digital networks and 1 digital radio allocation. After switching off analogue, the replanning task for restack was to support 6 digital television networks and have 2 channels for digital radio in thirty two 7 MHz channels.

<sup>&</sup>lt;sup>40</sup> Band 28 in Table 6.6.3.2-1 of ETSI TS 136 101 V11.9.0 (2014-08)

<sup>&</sup>lt;sup>41</sup> 10 MHz case Table 6.6.2.1.1-1 of ETSI TS 136 101 V11.9.0 (2014-08)

A Restack Planning Advisory Group (RPAG) was established by the ACMA to consult industry on the restacking of digital television services. The RPAG was an informal consultative group for the regulator to seek industry views and consisted of representatives of all broadcasters and transmitter facility providers, some industry consultants and radio interests. The RPAG provided a forum for the ACMA and industry to discuss proposals relating to replanning of digital television channels to facilitate the restack as well as restack implementation and timing issues.

Restack provided an opportunity for the industry to review and clear the legacy of many planning decisions that had been taken over the years for very good reason at the time, but now, after analogue switch off, left anomalies in the broadcast system.

# 6.3.1 Core issues

## (i) Planning methodology

Over 930 services were identified as operating in Channels 52-69 that needed to be moved to a channel below 52. The eventual planning resulted in 1 299 services being restacked (including consequential moves, see below) in 367 transmission areas (there are over 580 terrestrial transmission areas in Australia). Faced with the massive planning task in a short timeframe, while resources were still being deployed on installing gap filler translators, the broadcasters developed a 'block' model plan which would offer coverage benefits and greatly simplify the planning of adjacent market services. The block planning approach takes a "green field" approach to channel allotments for each transmission site, placing all services at a site in one of five blocks of six contiguous channels. In the metropolitan markets during simulcast, digital services were broadcast on channels 11 and 12, so the viability of adjacent services was proven.



The ACMA had commenced their plans based on a "minimal moves" approach, in the belief that this would lead to the minimal cost for restack. This approach aims to minimise the number of channel moves by only changing the channel allotments where absolutely necessary. A necessary move is either: one where the current channel is in the digital dividend band, or a consequential move to make way for another service to move, with consequential planning work required as well. Previously, under "interleaved" planning services were widely spread across a band or across VHF and UHF Bands, this was sometimes not the case, but the remaining channel spreads were very wide.

In detailed studies modelling the channel changes required in Queensland, the ACMA found that 53 of 75 transmission sites had channels above channel 51 and at these sites there were a total of 198 channels in use that were above channel 51. Under the minimum moves approach, 46 services operating on a channel below 52 needed to also change channels (a 'consequential move'). Changing to the block plan required 83 consequential moves. Further modelling was undertaken based on the Queensland studies to estimate the differences in cost and time and any other benefits. As a result of these studies, the ACMA agreed to the block plan, finding the block plan would take slightly longer (15 per cent) to implement and may cost slightly more (9 per cent) to implement than the minimum moves, will result in similar levels of viewer cost and disruption, but the block model offers long term benefits including better and more equitable coverage, simpler and smaller receive antennas for viewers and master antenna television systems would be simpler and cheaper.

### (ii) Review of planning field strengths

All the original planning was on the basis of broadcasters using the DVB-T standard with transmission parameters of 8k, 64QAM, 2/3 forward error correction (FEC) and 1/8 guard interval (GI) to provide a 19.3 Mbit/s payload in a 7 MHz channel, but in order to accommodate the SD / HD simulcast, most broadcasters were transmitting 8k, 64QAM, 3/4 forward error correction (FEC) and 1/16 GI to achieve a 23 Mbit/s payload. Changing the FEC requires an increase in the minimum C/N (or co-channel protection ratio) by 1.6 dB.

Also, as the top frequency in the broadcast band was to be reduced from 820 MHz to 694 MHz, this will reduce the 20\*log(f) losses by 1.5 dB. Now that the frequency spread of the UHF broadcast services band had been reduced from 300 MHz to 174 MHz, consideration was given to having one planning value for the whole band rather than two previously (for Band IV and Band V).

Due to industry concerns, the ACMA decided to continue with the planning parameters that have been used to plan the introduction of digital television as set out in the ACMA DTTB Planning Handbook. However, due to the adoption of block planning some adjustment is unavoidable to the boundary of where the different UHF minimum median field strengths apply, so the break point was changed from between channels 35 and 36 to fall between channels 39 and 40, so each block of channels had a consistent planning value. Consistent with the reconfirmation of the existing technical planning parameters, the ACMA retained the assumed forward error correction (FEC) parameter for planning purposes at 2/3 FEC, instead of the proposal to adopt the 3/4 FEC value. However, recognising the proposal to break up wide area SFNs it adopted a 1/16 guard interval.

## (iii) Planning for DAB+

The Ministerial Direction (see Section 6.2.1) required 14 MHz to be set aside for DAB+. Several methods of sharing the VHF band with digital television services, but due to the different protection ratios involved between DAB and DAB, and between DAB and DTV, it was found that spectrum was better utilised if a sub-band could be developed so that DAB / adjacent area DTV co-channel arrangements were avoided.

Given that DAB+ digital radio services commenced in the five major capital cities in July 2009, and channel 9 analogue was to be switched off, a sub-band of VHF channels 9 and 9A are able to be left clear for digital radio use in metropolitan and regional areas.

### (iv) Other issues

Other key issues discussed were:

- channel assignment rules, important to broadcasters from the aspect of inputs to translators in one channel block, needing to avoid the adjacent channel to transmit in the next channel block;
- as mentioned in Section 3.5 (ii) different SFN configurations serving the same area had created problems for reception, so all SFNs between broadcasters were to be of the same structure; and
- channel planning in specific areas where spectrum is used more densely to agree on suitable channel arrangements.

# 6.3.2 Restack objectives

The RPAG was an important part of the process for the development of formal instruments but it did not replace public consultation on formal instruments. After discussion within the RPAG forum, particularly around the core issues, and a formal public consultation, in May 2011 the ACMA adopted a series of restack objectives and principles. The objectives were:

- 1 Clear the digital dividend band of broadcasting services as soon as practicable.
- 2 Plan for six digital channels at each transmission site<sup>42</sup>.
- 3 Plan for six VHF channels at all metropolitan main station sites.
- 4 Plan such that coverage of all six channels is similar.
- 5 Maintain or improve digital television coverage.
- 6 Simplify viewer reception of terrestrial digital television.
- 7 Establish spectrum planning arrangements that support future needs.
- 8 Retain 14 MHz of spectrum in VHF Band III for possible expansion of digital radio.
- 9 Comply with the legislated framework.
- 10 Consistent with the minister's direction, the ACMA should wherever possible:
  - a) minimize viewer costs and disruption;
  - b) minimize commercial and national broadcaster costs.

## 6.3.3 Restack planning principles

The restack planning principles were as follows:

Principle 1: Replan digital television services to use VHF channels 6-12 and UHF channels 28-51.

**Principle 2**: Create a digital radio sub-band, comprising VHF television channels 9 and 9A that is clear of digital television in metropolitan and regional licence areas. Where practicable, also avoid planning new services on these channels in remote licence areas.

Principle 3: Plan for six digital channels at each transmission site, except for

- i) licence area overlaps where two sets of three commercial services will require channels (a total of nine channels); and
- ii) where broadcasters operate from different sites but cover the same area.

**Principle 4**: Plan channels so that viewers in metropolitan and regional licence areas can receive all services using a single band antenna (i.e. plan all channels in either the VHF or UHF band). Consider the benefit of single band operation in other areas on a case-by-case basis. The current polarization of the existing transmissions in a particular band at each transmission site is to be maintained.

Principle 5: Plan all six services on channels within defined blocks of channels as follows<sup>43</sup>:

Block A: 6, 7, 8, 10, 11 and 12\* Block B: 28, 29, 30, 31, 32 and 33 Block C: 34, 35, 36, 37, 38 and 39 Block D: 40, 41, 42, 43, 44 and 45 Block E: 46, 47, 48, 49, 50, and 51.

\* Channels 9 and 9A may be used for digital TV in some remote areas.

<sup>&</sup>lt;sup>42</sup> In licence area overlap regions, nine services per site would be planned at existing transmission sites.

<sup>&</sup>lt;sup>43</sup> In remote areas where there was no spectrum scarcity, a Block BC, Block DE plan was used to leave channels clear between digital channels and hence relax antenna combiner specifications.

Principle 6: Assign channels within a block as follows.

VHF: Existing VHF services to retain current channels unless they have to move to clear channels 9 and 9A under Principle 2. New or changed channel assignments do not need to follow any particular order, except in all Metropolitan areas where SBS should move to channel 7. Where it is possible without moving existing services, channel 10 should be the unassigned channel to align with the metropolitan area unassigned channel.

UHF: Channel assignments should be made after considering and balancing a number of objectives including:

- avoiding off-air input issues (adjacent channel and N+5);
- avoiding changes to existing services within the block;
- using the unassigned channel to remove restack timing constraints and manage band edge interference potential.

If none of the above issues apply, UHF channels should be assigned in the following order: SBS, ABC, Seven (or affiliate), Nine (or affiliate), Ten (or affiliate), Unassigned.

*Principle 7*: In selecting the channel block for a transmission site:

- Consider the channels used by existing digital services and any information available on the operating frequency range of broadcaster transmission equipment.
- Avoid use of a block outside the likely bandwidth of viewer antennas. In particular, avoid Block B where there is no current or past use of UHF Band IV channels. Where this cannot be avoided, minimize the total population affected.
- Wherever sites utilize UHF channel blocks, attempt to place high power services on lower UHF channel blocks.

**Principle 8**: Break up wide area single frequency networks (SFNs) known to have associated reception problems and minimize use of new SFNs where possible.

**Principle 9**: Plan on the basis of broadcasters using the DVB-T standard with transmission parameters of 8k, 64QAM, 2/3 forward error correction (FEC) and 1/16 guard interval.

The co-channel protection ratio used for planning is: 20 dB.

The minimum median field strengths used for planning is shown in Table 6:

Table 6: Minimum	median field	strengths for	restacked digital	television	planning	(dBr	uV/m	)
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	VHF (Block A) (174-230 MHz)		UHF (Blocks B and C) (526-610 MHz)			UHF (Blocks D and E) (610-694 MHz)			
	Rural	Sub- urban	Urban	Rural	Sub- urban	Urban	Rural	Sub- urban	Urban
Minimum median field strength (dBuV/m)	44	57	66	50	63	71	54	67	74

**Principle 10**: Equalize transmissions across all broadcasters as far as practicable through planning on the basis of equal ERP levels, identical antenna patterns, closely sited transmitters and all broadcasters having the same SFN arrangement.

**Principle 11**: Determine the timing constraints on channel availability and specify a minimum window of six months, where practicable, when both the current digital and the final digital channels are available. When all sites and timing windows are considered together, they should result in the digital dividend channels (52-69) being cleared as soon as practicable, and by the end of 2014 at the latest.

## 6.3.4 Television licence area plans

Following discussions with the industry through the RPAG, the restack channel planning proposals were codified in legislative instruments known as Television Licence Area Plans (TLAPs). These instruments identified the channel allotments each digital television service would need to move to, if it needs to change, and by when the changes need to be made. The draft instruments were made available for a period of formal public comment before being considered for approval by the ACMA. Refer to Section 1.6.2 (iii) for a discussion on TLAPs and the Australian planning regime.

# 6.3.5 Indicative restack channel chart

Detailed restack channel planning work commenced in 2011 and continued until late 2012. In the early stages of channel planning, to provide a framework that allowed the detailed channel planning for each licence area to proceed relatively independently, a 'key sites indicative channel plan' was developed. It has now been superseded by a more comprehensive *Digital Television Channel Chart* that consolidates in a single spreadsheet the detailed channel planning work that the ACMA has performed for each of the television licence areas.

## 6.4 Implementing the restack

In order to minimise viewer disruption, all changes to affected services at a transmission site would need to occur simultaneously. This required a high level of industry cooperation and coordination. The ownership structure of equipment and transmitter sites in Australia is quite complex. The site owner may be a broadcaster or a transmission facility provider who leases equipment room space and tower space to each broadcaster (or if they have arrangements with another facility provider, with the provider). The common transmission equipment, the combiner, feeders and transmitting antenna array may be owned by one party and an access fee charged to the other broadcasters. The common interface point between broadcaster's systems is into the combiner. Hence regardless of the implementation method used, that a paradigm shift from the legacy, largely individual broadcaster, method of implementing changes to infrastructure, to a more holistic industry level approach will be necessary to achieve restack in the desired timeframe.

After negotiations with the industry, the Australia Government committed to:

- relocate commercial and national broadcaster digital television services to their new channels by retuning, replacing or otherwise modifying transmission equipment to operate below UHF channel 52 (694 MHz);
- provide a project and implementation manager to manage channel changes nationally; and
- conduct a public education/information campaign about the need to retune receivers.

#### Program implementation manager

The government appointed a Program Implementation Manager (PIM) in mid 2012 to act on behalf of the government and liaise with all broadcasters and infrastructure owners to put in place all necessary actions to restack digital services.

The programme was in two phases:

- Phase 1 Develop a Timeline: liaising with all affected parties, identifying top level scope of works for sites which involve a technical evaluation, develop an installation approach, gauge industry capacity to make the changes, report TLAP windows to the ACMA by July 2012 and deliver a final plan by November 2012.
- Phase 2 Implement the plan: including developing technical specifications, purchasing all equipment, detailing scope of works and bills of material for each site, engaging contractors to undertake the work, making payments and reporting to the government.

As this programme was to modify the assets (transmitters etc.) of each broadcasting company or facility provider, detailed legal contracts were required.

Broadcasters required service outages to be of a minimum duration for implementing the changes. Outage 'windows' were agreed between midnight and dawn with a backup time during the middle of the day. Periods where significant programming was scheduled were excluded from the outage times.

Some of the transmitters to be retuned were over 10 years old. Investigations showed these could not be retuned within a short timeframe to meet the minimal outage requirements and required specialist original manufacturer skills. Product development in the intervening time made it easier and without a cost penalty to replace rather than retune many transmitters.

Digital / digital simulcasts were agreed at a number of sites servicing areas of high populations of multi dwelling units (MDUs) where it was considered likely there were channelised headends which needed modification by antenna installers, hence and viewers were not able to retune their receivers at a nominated time.

The project required the commissioning of installation teams contracted from industry, manufacturers and overseas resources to undertake the work in a two year period. Approximately 400 transmitter sites were involved in the project affecting over 1 200 transmitters, plus input signal receiving equipment.

The interdependencies of channel allotments between transmitter sites was immense. Channels at some sites need to be cleared before an adjacent site is able to be restacked onto its final block of channels, a 'domino effect' of interactions impacted on the project plan. Generally sites were visited twice; all installation work undertaken which did not result in a channel change was undertaken at least 6 weeks prior to the scheduled retune date. A firm retune date was then set and the viewer communications campaign commenced to inform the public of the retune date. The site was then re-visited and equipment connections swapped and transmitters retuned where practicable during an outage to effect the restack. Retuning of combiners on site was not considered feasible, so replacements were purchased and swapped out.

Some sites required a band change from VHF to UHF or vice versa. These sites involved extensive work and extended outages. Some sites also required transmit antenna replacements as the restacked channels were outside of the operating range of the original antenna. Extended outages were required at these sites as well.

Although the PIM was funded by government, documentation such as scopes of work and bills of materials were approved by the broadcast engineering staff. This workload of documentation and the need to visit sites for acceptance testing has placed a large burden and been costly to broadcasters and facility providers.

The Australia Government expects that the channel changes will be completed by 31 December 2014.

A channel change timetable schedule that advises of nationwide activities and particularly public retune dates is published on the website of the Department of Communications<sup>44</sup> and is fed into the public information campaign.

# 6.5 Public information campaign

The restack programme affected the very large majority of Australian television viewers. Viewers did not need to purchase new television reception equipment, but have generally needed to retune their existing television, set top box or digital recorder to be able to continue viewing free-to-air services that have undergone a channel change. Therefore a very widespread public information campaign was required to deliver the message to viewers that at a nominated time, they needed to have their receiver rescan for digital television services.

The message needed to be delivered in a simple, clear and concise manner. The industry jargon of rescanning a television was seen as confusing, but 'retuning' was a well understood term with connotations of the analogue days of 'tuning' a set.

<sup>&</sup>lt;sup>44</sup> <u>www.communications.gov.au/television/achieving\_the\_digital\_dividend\_-\_restack</u>

An animated stylised figure of a talking remote control was used as the centrepiece of the campaign. "Roy the Remote" focussed the public's attention that the retune action would be undertaken using their remote control. "Roy" was used in press advertisements, television commercials and video promotions to convey the messages about what to do and when to retune.



Extensive website resources were developed to provide additional information for the campaign including a geographic information system whereby householders could enter their address and specific timing and tuning information for their location was displayed. Visit <u>http://retune.digitalready.gov.au/</u> for more information.

# 6.6 Planning and implementation example

An example of the changes to transmitter configurations, and special cases considered, is provided in the Plots in Figure 17 in this Section.

The Sydney licence area has translators at Manly and Kings Cross and Bouddi, Gosford and Wyong which are in an area known as the Central Coast of the state of New South Wales and a licence area overlap with Newcastle (located to the north of Sydney), so these sites transmit 8 services today (future planning is for 9 services). In each figure, the translators at Manly, Bouddi and Gosford are shown as "Sydney translators" while the most distant site at Wyong is shown in the line above as an "Adjacent Licence Area Transmitter" as in analogue mode it shared channels with Manly. Additionally, a community television channel is broadcast in digital on a temporary channel allotment (channel 29) from one of the main Sydney transmitter sites. For simplicity, the nearby Kings Cross site is not shown. The other "Adjacent Licence Area Transmitter" site in this example is the main Newcastle site.

Again, not shown for simplicity is another adjacent licence area transmitter site, Wollongong, located to the south of Sydney and has many co-channel assignments with Newcastle, but the Wollongong transmissions need to be considered in planning for this area as its transmitter does reach across Sydney and is able to be received in digital across many localities served by the Manly transmitter.

The nomenclature used for each transmitter is its three letter station call sign, followed by the channel number, then the transmission site name. Where assignments are in an SFN, only the first letter of the site is shown. E.g. Bouddi, Gosford and Wyong are operated as an SFN in digital mode, so the site names are shortened to B G W.

Note that the Sydney main transmitters operate on VHF channels and are not shown in this example which only illustrates services operating on UHF channels.



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Plot 1 shows the channel assignments during the simulcast period. Note the spectrum congestion.



Plot 2 shows the digital channels that remain after analogue switch off was completed.



Plot 3. Manly serves an area that has a high concentration of MDUs, so a digital simulcast was undertaken as part of the restack project to allow time for MDU master antenna television systems, which may have channelised headends, to be modified by installation staff. Block B is fully occupied at this stage.



Plot 4, TEN45 and ATN48 switched off and Newcastle restacks to Block C and clears Blocks D and E ready for the Central Coast Restack.


Plot 5, Central Coast digital services restack into Blocks D and E, splitting the troublesome SFN that was on ABC37. Digital dividend spectrum is available for new services.



#### Australian digital TV restack lessons

- The appropriate size of "digital dividend" that can be released should be studied to ensure that adequate spectrum remains available to maintain a high quality television broadcasting service.
- "Block model" planning has been successful, reducing planning time and resources and providing better more consistent reception by households.
- The complexity of a restack of television channels should not be underestimated.
- Restack is technically very complex, but needs to be communicated to the public as a simple process.
- The key message for the public to retune on a single switchover day can be successful.
- The need for digital / digitals simulcasts should be considered for sites that serve high populations of MDUs.
- A high level of industry cooperation and coordination is required for a successful restack.
- It should not be assumed that transmitters may be simply changed to another channel.
- Appropriate conditions should be set for the new services that are to occupy the digital dividend spectrum so that there is preferably no or minimal impact on broadcasting services.

# Part 7 – Summary and conclusions

# 7.1 Summary

The Implementation of Digital Terrestrial Television Broadcasting in Australia has been undertaken in five stages over a period of 21 years, with many stages overlapping.

Initial investigations were conducted jointly by representatives of government and broadcasters, but once the decision had been made, it was the broadcasting community who financed and provided resources for implementation of digital services. This pattern continued during the digital enhancement stage. Broadcasters have been the beneficiaries of these stages, providing a more flexible broadcast system offering more programmes the viewing public at a higher broadcast quality, so, in addition, the public have been beneficiaries of these Stages for the cost of a new television receiver.

After the digital broadcasting system was established, the following two stages of analogue switch off and digital restack were led and funded by the government as they were the beneficiary of these actions, the auctioning of cleared spectrum converting a spectrum asset into government consolidated revenue.

This shift in leadership, funding and resources for the conversion project are demonstrated in Table 7. Note that many of the stages will overlap each other.

Stage / Duration	Stage Leader	Activity	Funding	Resources
Preparation & Planning (8 years)	Government & Broadcasters	Initial Work		Government & Broadcasters
		Domestic Planning		Government / ACMA
		Standards Development		Government, Broadcasters & Industry
		Installation & Operation	Broadcasters	Broadcasters
(7 years)	Broadcasters	Market Survey		Industry
(7 years)		Public Information Campaign	Broadcasters	Broadcasters
Digital	Broadcasters	Planning	Broadcasters & Government	Broadcasters & Government
Enhancement		Implementation	Broadcasters	Broadcasters
(8 years)		Public Information Campaign		Integrated with ASO messages
	Government	Planning	Government	Government & Broadcasters
Analogue Switch		Implementation		Broadcasters
(6 vears)		Assistance Schemes	Government	Contracted by Government
(0 ) 00.0)		Public Information Campaign	Government	Government
Digital Restack (5½ years)	Government	Planning	Government	Government & Broadcasters
		Implementation	Government	Contracted by Government & Broadcasters
		Public Information Campaign	Government	Government

#### Table 7: Leadership, Funding and Resources for Implementing DTTB in Australia

# 7.2 Key lessons

The key success factors of the conversion of broadcasting to digital in Australia have been:

- the maintenance of a close working relationship between government and broadcasters;
- open communication with the public, to seek feedback on reception conditions and communicate changes;
- the development of standards to modify a 'tool kit' of international standards to incorporate local requirements;
- planning each stage is key, every detail must be examined.

The key lessons learned:

- set regular reviews to examine if policy and technical goals are being achieved;
- survey households from an earlier stage to judge the success of the conversion;
- setting target dates provides a firm goal for all parties to work towards;
- effort is needed to educate the public from 'analogue' to 'digital' thinking; influencing perceptions of degraded reception ('digital cliff'), channels to services and new features;
- every householder's reception conditions are different, a variety of causes and solutions to reception issues need to be developed;
- with respect to analogue switch off and the digital restack:
  - o review digital coverage before considering the size of a digital dividend;
  - o use the restack to address legacy broadcast planning issues;
  - o a common retune day can be successful for a small group of sites only after considerable planning.

# 7.3 The future

The broadcasting industry was able to make the transition from analogue to digital only because spectrum was available (as "taboo" channels were unable to be used by other analogue services) within the bands compatible with television receivers.

However, the result of this project, digital services have consumed nearly all available remaining spectrum after releasing the "digital dividend" spectrum, so this option is not available for the next ultimate change in broadcasting technology.

The first nearly 20 years of Australian television were black and white analogue broadcasts. Colour was added in 1975 and stereo sound in the mid 1980s, all based on compatible modulation schemes. The introduction of digital in 2001 was the first time additional spectrum was required for a technology change and while some encoding changes could be made on the existing platforms e.g. to use advanced coding such as H.264 AVC, the current broadcast modulation platforms will not support sufficient payloads for the next quantum leap in technology. Based on history, television has a major technology change on average every 15 years, so the next change is imminent.

That leap is developing to be 4K video. Already many Australian video production companies are producing content in 4K. As Australians have shown with many technologies in the past, for example the acceptance of HDTV, they will want UHDTV in the future.

Hence, yet another new modulation platform will be required. DVB-T2 builds on lessons learnt by the members of the DVB Project and would offer in an Australian environment a capacity increase of approximately 40 per cent, combined with the better encoding algorithms in H.265 HEVC, could make terrestrial transmission of 4K feasible. DVB-T2 receivers have been in production for the last few years. H.265 HEVC decoding is in a prototype phase so it will not be long before the product is available.

Australian broadcasters have already begun a detailed technical examination of H.265 HEVC coding and use of DVB-T2 modulation, but any formal move to this as a broadcasting standard would first be subject to government approval. But, as was the case for the transition to DVB-T, there will be many challenges to overcome, particularly in a constrained spectrum environment that now exists in the broadcasting bands.

# 7.4 Conclusions

What started out as an engineering-led concept to deliver to the viewing public higher quality broadcast pictures and sound has opened up challenges and opportunities that are inherent with any disruptive technological change. The transition to digital television has touched in some way every Australian; whether it be their need to purchase a new television receiver to continue to watch the shows they like or change the time they watch those shows as digital recorders have made "time shifting" a reality, businesses that have been rejuvenated implementing the changes, competitive media outlets who have had to change their business models or even to minority groups such as the hearing impaired who now enjoy a wider variety of captioned programmes. The impact has been greatest on two groups; broadcasters and government. The issues for government have been immense to chart a course through the political, social, economic and technological issues.

For broadcasters, every part of their business operations have changed. Changes have been required from camera to transmitter and every piece of equipment along the system chain. Delivering better pictures and sound to the viewer only highlighted the limitations in equipment used for contributing programmes to the broadcaster. More services have been added by each broadcaster, the presentation facilities for each service have changed from a local operation to aggregated national operations. The digitisation of studios has led to new workflows allowing more rapid response to breaking news stories, shortened production times and added flexibility as to what to put to air.

Has the transition been a success? Undoubtedly the answer is in the affirmative. Analogue has been switched off, very few, if any viewers were lost in the conversion to digital television. Whilst the timeframe might be considered long by some commentators, it must be remembered that Australia was one of the "early adopters" of digital television and conversion rates only increased when consumer technology features and price points matched the public's expectations of the new system. Others have benefitted from the process as well though the work undertaken jointly by broadcaster's and the regulator's engineering work refining the platform and offering that as contributory work to the ITU-R for other Administrations to build their systems on the work done in Australia.

# **Glossary of abbreviations**

3GPP	3rd Generation Partnership Project (a project of 6 telecommunication standard development organisations)
64-QAM	64-state Quadrature Amplitude Modulation
ASO	Analogue Switch-Off
ATSC	Advanced Television Systems Committee
AVC	Advanced Video Coding
C/N	Carrier to Noise ratio
COFDM	Coded Orthogonal Frequency Division Multiplex
CRT	Cathode Ray Tube
DAB	Digital Audio Broadcasting
DAB+	Digital Audio Broadcasting, improved system
DTTB	Digital Terrestrial Broadcasting
DVB	Digital Video Broadcasting
DVB-T	Digital Video Broadcasting – Terrestrial
DVB-T2	Digital Video Broadcasting – Second Generation Terrestrial
EPG	Electronic Program Guide
EIRP	Effective Isotropic Radiated Power
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
FEC	Forward Error Correction
FTA	Free To Air
GPS	Global Positioning System
HDTV	High Definition Television
HEVC	High Efficiency Video Coding
IBA	Independent Broadcasting Authority
IDTV	Integrated Digital Television set
IEC	International Electrotechnical Commission
ISDB-T	Integrated Services Digital Broadcasting-Terrestrial
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU/BDT	International Telecommunication Union/Telecommunication Development Bureau
ITU-D	International Telecommunication Union – Development sector
ITU-R	International Telecommunication Union – Radiocommunications sector
JTC	Joint Technical Committee
MHz	Mega Hertz
LCD	Liquid Crystal Display

LTE	Long Term Evolution
MAC	Multiplexed Analogue Component
MATV	Master Antenna Television System
MPEG	Moving Picture Experts Group
MPEG-4-AVC	Moving Picture Expert Group – Advanced Video Coding
OFDM	Orthogonal Frequency Division Multiplex
ОоВ	Out of band
PAL	Phase Alternating Line; analogue colour TV system
PSI	Program Specific Information
QEF	Quasi Error Free
QPSK	Quadrature Phase Shift Keying
RF	Radio frequency
SDTV	Standard Definition Television
SFN	Single Frequency Network
SFN	Single Frequency Network
SI	Service Information
TS	Transport Stream
Тх	Transmitter
UHF	Ultra High Frequencies
VHF	Very High Frequencies
VSB	Vestigial Side Band
USB	Universal Serial Bus

# Specific Australian abbreviations

ABA	Australian Broadcasting Authority (now part of ACMA)
ABC	Australian Broadcasting Corporation
ACA	Australian Communications Authority (now part of ACMA)
ACMA	Australian Communications and Media Authority
DBCDE	Department of Broadband, Communications and the Digital Economy (became Dept. of Communications)
DCITA	Department of Communications, Information Technology and the Arts (became DBCDE)
DSTF	Digital Switchover Task Force
DTCPCG	Digital Television Channel Planning Consultative Group
FACTS	Federation of Australian Commercial Television Stations
SBS	Special Broadcasting Service
SMA	Spectrum Management Authority (merged into the ACA)

## Acts

BSA	Broadcasting Services Act 1992
RCA	Radiocommunications Act 1992

#### Instruments

СТС	Commercial Television Conversion Scheme
DCP	Digital Conversion Plan
LAP	Licence Area Plan
NTC	National Television Conversion Scheme
TLAP	Television Licence Area Plan

# References

#### Australia Government

#### Legislation and legislative instruments

Radiocommunications Act 1992 www.comlaw.gov.au/Details/C2013C00586

Broadcasting Services Act 1992 as amended www.comlaw.gov.au/Details/C2014C00649

Broadcasting Legislation Amendment (Digital Television) Act 2006 www.comlaw.gov.au/Details/C2008C00351

Bills Digest No. 178 1997-98 Television Broadcasting Services (Digital Conversion) Bill 1998 www.aph.gov.au/Parliamentary\_Business/Bills\_Legislation/bd/BD9798/98BD178

Broadcasting Services (Technical Planning) Guidelines 2007 as amended www.comlaw.gov.au/Details/F2009C01061

Radiocommunications Spectrum Marketing Plan (700 MHz Band) 2012 www.comlaw.gov.au/Details/F2012L02547

#### **Government departments**

Australian Bureau of Statistics, Population Clock <u>www.abs.gov.au/</u>

Australian Government, "DCITA, READY, SET, GO DIGITAL A Digital Action Plan for Australia", November 2006

S Conroy (Minister for Broadband, Communications and the Digital Economy), "Digital television Australia-wide", media release, 11 January 2010

Department of Communications, *Corporate Plan 2014-17*, <u>www.communications.gov.au/ data/assets/</u> pdf file/0017/214064/Corporate Plan PDF WEB.PDF

P. Spence, "The Australian Regulatory Environment, The Digital Role of the Department of Broadband, Communications & the Digital Economy", <u>www.acma.gov.au/webwr/ assets/main/lib311250/</u> <u>the aust regulatory environment-dbcde.pdf</u>

Switchover Taskforce, *HAS Brochure*, November 2011 retrieved via www.headwaytas.net.au/attachments/article/145/HAS%20brochure.pdf

Digital Switchover Taskforce, *Satellite Subsidy Scheme Brochure*, December, 2011 retrieved from the Byron Shire Council website <u>www.byron.nsw.gov.au/</u>

Digital Switchover Taskforce, "*Legislative framework for implementing a digital television switchover timetable*", May 2008

Digital Switchover Taskforce, "*Digital Tracker Surveys*", <u>www.communications.gov.au/television/</u> <u>digital tv in australia/digital switchover reports</u>

#### Australian Communications and Media Authority (and its predecessor organisations)

Australian Broadcasting Authority, Specialist Group on Digital Terrestrial Broadcasting, *Digital terrestrial television broadcasting in Australia*, First report, ABA, 1995

Australian Broadcasting Authority, Specialist Group on Digital Terrestrial Broadcasting, "Digital terrestrial television broadcasting in Australia : final report of the Australian Broadcasting Authority Digital Terrestrial Television Specialist Group."

G. Tanner, *Digital Broadcasting – a 2012 roadmap*, speech presented at the Broadcasting Australia Conference and Expo 2012, <u>www.acma.gov.au/~/media/mediacomms/Presentation/</u> <u>Powerpoint/Broadcast%20Sydney%20Expo.PPT</u> ABA (now ACMA), DTTB Planning Handbook – March 2005.

www.acma.gov.au/~/media/Licence%20Issue%20and%20Allocation/Publication/pdf/Digital%20Terrestrial %20Television%20Broadcasting%20Planning%20Handbook%20including%20technical%20and%20general %20assumptions.pdf

ACMA, Final Licence Area Plans, available from <u>www.acma.gov.au/Industry/Broadcast/Spectrum-for-broadcasting/Spectrum-radio-broadcasting/final-licence-area-plans-broadcast-planning-acma</u>

ACMA, Licence area populations in the ACMA BSA Section 30 Schedule www.acma.gov.au/webwr/aba/licplan/planning/licareas/documents/bsa\_92\_s30\_schedule.pdf

ACMA Licence Area Definitions <u>www.acma.gov.au/Industry/Broadcast/Spectrum-for-broadcasting/Spectrum-digital-television/broadcasting-licence-areas-television-acma</u>

#### **Australia Industry**

Australian Broadcasting Corporation, *Code of Practice 2011 (revised in 2014)* <u>http://about.abc.net.au/reports-publications/code-of-practice-2014/</u>

FACTS, Digital Terrestrial Television Report of the DTTB Selection Panel, June, 1998

Free TV Australia, *Commercial Television Industry Code of Practice – January 2010 (incorporating amendments to July 2013)* <u>www.freetv.com.au/content\_common/pg-code-of-practice-.seo</u>

Free TV Australia, "Free TV Today", October 2014, <u>www.freetv.com.au/content\_common/pg-free-tv-stats-and-graphs.seo</u>

Free TV Australia, OP-40 Issue 3 – December 2012 – updated, Allocation of DVB Service Information Codes for Australia

Free TV Australia, OP 41 Issue 7 – February 2013, LCN Descriptor

#### **ITU-R reports and Recommendations**

ITU-R Recommendation BT.500-13 (01/2012), Methodology for the subjective assessment of the quality of television pictures

Recommendation ITU-R BT.1368-11 (02/2014), Planning criteria, including protection ratios, for digital terrestrial television services in the VHF/UHF bands

ITU-R Recommendation BT.1735-2 (02/2014), Methods for objective reception quality assessment of digital terrestrial television broadcasting signals of System B specified in Recommendation ITU-R BT.1306

ITU-R Report BT.2140-7 (04/2014), Transition from analogue to digital terrestrial broadcasting

#### **Technical standards**

Standards Australia, Digital television – Terrestrial broadcasting Part 1: Characteristics of digital terrestrial television transmissions AS4599.1-2007.

Standards Australia, Digital television – Requirements for receivers Part 1: VHF/UHF DVB-T television AS4933.1.

Standards Australia, Coaxial cable and optical fibre systems for the distribution of analogue and digital television and sound signals in single and multiple dwelling installations AS/NZS 1367:2000

ETSI TS 136 101 V11.9.0 (2014-08) LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101 version 11.9.0 Release 11)

#### **Other references**

Dr Rhonda Jolly, *Going digital: tracing the transition to digital terrestrial television in Australia*, RESEARCH PAPER NO. 7, 2010-11, 19 November 2010, Parliament of Australia Parliamentary Library

J Given, 'Taking a punt with TV', The Sydney Morning Herald, 26 March 1998, p. 19

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