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Valuation of public mobile spectrum at 1710-1785 MHz and 1805-1880 MHz

A report for the Department of Broadband Communications and the Digital Economy

28th June 2011

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1　Executive Summary

Spectrum licences at 1710-1785 and 1805-1880 MHz ("1800 MHz band") will be reissued upon expiry in 2013 either through renewal at an administratively determined price or through price based reallocation (e.g. auction). [1] Reissue will be subject to a price that provides an appropriate rate of return to the community and that reflects the scarcity and value of this important resource. This report seeks to value licences for the purposes of setting government expectations with regard to licence reissue prices.[2] If licensees fail to meet the Government's price expectations then the spectrum will be auctioned, therefore the value of spectrum yielded by an auction sets a lower bound on value. Licensees should be prepared to pay a premium for licence reissue because this removes the costs and uncertainty of engaging in an auction.

The spectrum licences to be valued are currently used to provide public mobile services (voice and data). It is assumed that the licences will continue to be used for these applications over the next 15 year licence period as the bands are used internationally for these applications.

There are three elements to the study:

·　A review of international evidence on the value of spectrum licences in the same or similar frequency bands as revealed in auctions and licence renewal processes elsewhere.

·　Modelling of values based on the projected revenues and costs of a hypothetical operator. A spreadsheet business model was constructed and calibrated against data and projections for the Australian market.

·　Consideration of the disruption costs that might be associated with auctioning licences and recommendation of a renewal price.

International evidence

The findings from a review of international evidence on spectrum value since the original auction of the Australian spectrum licences show that the original 1800 MHz auction results look reasonably high when compared with the results of more recent auctions. This suggests that a premium to these values would not be expected in future. The recent international benchmarks suggest that prices paid in auctions in markets comparable to Australia can be as high as A$0.23/MHz/pop (i.e. A$0.23 per MHz per person within the licensed geographic area).

Modelled values

Values were calculated based on a hypothetical incumbent operator and assuming that the market continues to support three operators. The value of the spectrum for a hypothetical operator having similar characteristics to the weakest of the three operators was modelled since this would most likely determine a hypothetical auction price and the government would not want to set prices at a level that might result in further industry consolidation. We have assumed that spectrum in the 1800 MHz band

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[1] Media release by Senator the Hon Stephen Conroy, Minister for Broadband, Communications and the Digital Economy, 4 March 2010. See http://www.minister.dbcde.gov.au/media/media_releases/2010/020

[2] The different approaches to calculating the opportunity cost of spectrum are discussed in "Opportunity cost pricing of spectrum", ACMA, April 2009

will be used primarily for the ongoing support of GSM services and provision of LTE services over the licence period.

To provide bounds on the value of the spectrum licences the following two measures were modelled:

· Cost reduction value: This is the value arising from the use of an incremental block of spectrum to reduce infrastructure costs. The cost reduction value is calculated by modelling infrastructure costs with and without additional spectrum. In congested areas additional spectrum allows more capacity to be deployed per site (and therefore fewer sites are required). It was assumed that the minimum block size for efficient deployment of LTE services is 2x10 MHz

· Full enterprise value: This is the net present value (NPV) of total business cashflows (i.e. revenues less costs) that a mobile operator earns from all of its spectrum holdings. This sets an upper bound on what might be charged on licence reissue. A price higher than this level would mean that the operator modelled would go out of business.

Licensees will be prepared to pay more than the cost reduction value for a licence because licence renewal removes the costs and uncertainty of going to auction (see Figure 1).

Figure 1: Range of spectrum value measures
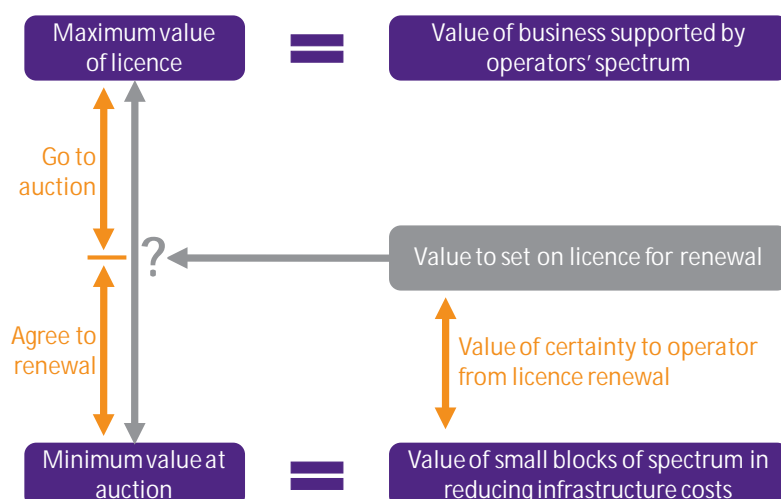
It was assumed that in future 3G services will be supplied using 800 MHz, 900 MHz and 2100 MHz spectrum and that LTE services will be supplied using 700 MHz, 1800 MHz and 2500 MHz spectrum. Values for low, medium and high market assumptions were estimated.

From the modelling it was found that the main drivers of value are:

· The forecast growth in ARPU expected across the mobile sector. Higher ARPU growth increases the full enterprise valuation but has no impact on the cost reduction valuation.

· The future growth in the data traffic that will be supported by the operators. This increases network deployment costs but is mitigated in part by the adoption of more spectrally efficient technology, namely LTE.

· Spectrum supply in the 700 MHz and 2500 MHz bands. Greater supply in these bands reduces overall deployment costs but reduces revenues available to operators using the 1800 MHz band for LTE.

The medium scenario gives our best estimate of the cost reduction value (i.e. a lower bound on the value that might be realised if there were an auction for the spectrum). The estimates of the value of the 1800 MHz spectrum for the medium scenario are:

- $0.15/MHz/pop for the cost reduction valuation

- $0.47/MHz/pop for the full enterprise valuation.

Recommending a renewal price

The modelling results give a wide range of values under the different market scenarios. Values at the upper end of the range are not plausible based on international benchmarks. In setting Government expectations with regard to licence reissue prices, the following policy objectives should be taken into account:

- Promoting efficient spectrum use

- Obtaining a fair value for the public purse.

Efficiency points towards setting values that mimic the results of an auction (i.e. at or somewhat above the cost reduction value). A fair value is one that does not take all of the benefit that an operator might gain from spectrum use (i.e. is less than the full valuation), yet takes account of the value that an operator would attribute to avoiding an auction.

From an operator's perspective there are also costs and risks associated with auctions:

- Operators may not be able to retain current spectrum holdings which can result in retuning and subscriber migration costs

- Risk of higher competitive intensity as a result of new market entry

- Disruption to investment financing as a result of uncertainty about future spectrum holdings, and the potential delays associated with an auction

- Costs of management time in preparing for and participating in the auction.

These costs are specific to the spectrum band being considered and individual operators' circumstances and aspirations. We have not attempted to quantify these individual impacts; however recent international initiatives by operators in the 1800 MHz band show that it is an important band for the early deployment of LTE technology. For example the first commercial LTE network using 1800 MHz spectrum has been launched in Poland;[3] the European Commission has published coexistence rules for the band to facilitate use of the band by LTE technology[4] and it appears that the 1800 MHz will help facilitate international roaming.

To account for these factors and the option value that might otherwise raise auction prices we have assumed an uplift of 50% may be applied to the cost reduction valuation. **Taking account the mix of policy objectives, and the factors considered in the course of the valuation work, we recommend that a price of $0.23/MHz/pop is set for 1800 MHz licences in 2013 prices.**

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[3] http://www.mobyland.com/n8.html

[4] 2011/251/EU: Commission Implementing Decision of 18 April 2011 amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community. See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32011D0251:EN:NOT

2   Introduction

Spectrum licences at 1710-1785 and 1805-1880 MHz ("1800 MHz band") will be reissued upon expiry in 2013 either through renewal at an administratively determined price or through price based reallocation (e.g. auction). [5] Reissue will be subject to a price that provides an appropriate rate of return to the community and that reflects the scarcity and value of this important resource. An auction remains an option if the Minister for Broadband Communications and the Digital Economy (DBCDE) is not satisfied that renewal is in the public interest.

This report estimates the range of values for 1800 MHz spectrum that might be obtained at auction and recommends an appropriate price on renewal. The spectrum licences to be valued are currently used to provide public mobile services (voice and data). We have assumed that the licences will continue to be used for these applications over the next 15 year licence period as the bands are used for these applications internationally.

This report contains our findings and recommendations. The structure of the report is as follows

· Section 3 provides context for the valuation modelling. It describes the spectrum licences we are valuing, the circumstances of the original auctions and compares the amounts paid with international benchmarks from auctions and licence tenders at the time and more recently.

· Section 4 explains our approach to modelling spectrum value and the scenarios modelled (this is supported by Appendix A which describes the modelling approach and assumptions in more detail).

· Section 5 contains the modelling results for the market scenarios, commentary on our findings and our conclusions.

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[5] Media release by Senator the Hon Stephen Conroy, Minister for Broadband, Communications and the Digital Economy, 4 March 2010. See http://www.minister.dbcde.gov.au/media/media_releases/2010/020

3 Context

3.1 Values obtained in initial Australian auctions

The spectrum licences for the 1800 MHz frequency bands are due to expire as shown in Table 3-1. The licences were auctioned between 1998 and 2000. The total amount paid in the original auction for these licences (and subsequent auctions of unsold lots) was around $1.5bn. These payments reflected bidders' expectations of the likely profitability of services at the time of the auctions. To aid comparisons we have expressed all values as a value per MHz per person ($/MHz/pop) in the final column of the table.

Table 3-1: 1800 MHz spectrum auction revenues

Frequency band	Auction date	Expiry date	Auction revenue	$/MHz/pop
1800 MHz (1710-1745/1805-1850MHz)	1998 and 1999	June 2013	$158.3m	Range from 0.01-0.41 Mean for main capitals = 0.14
1800 MHz (1755-1785/1850-1880)	Mar 2000	May 2015	$1328m	1.26

Source: ACMA web site, Productivity Commission Report (2002), analysis by Plum Consulting

As can be seen in Table 3-1 the prices achieved in the two auctions differed considerably, with the second auction attracting revenues per MHz per pop that are around eight times as large as in the first auction. The main factors that changed in between the two auctions that could have had such a large positive effect on values were 1) the dotcom boom which reached its peak around the time of the second auction and 2) the presence of a serious competitor (OneTel) in the second 1800 MHz auction.

3.2 International auction and reissue values

The prices paid in auctions of 1800 and 1900 MHz spectrum licences are shown in Figure 3-1. The second 1800 MHz auction in Australia appears to be an outlier, in the sense that it delivered very high values relative to later 1800 MHz auctions. Canadian and US auctions of 1900 MHz spectrum at around the same time also yielded very high values; in the US broadband PCS auction values were around A$2.2 to A$10/MHz/pop and are omitted from Figure 3-1 to preserve clarity. Since 2002 the prices paid in 1800 and 1900 MHz auctions have been consistently lower.

Figure 3-1: International evidence on value/ MHz/ pop at 1800 MHz

Value/MHz/pop of international 1800/1900MHz auctions in A$
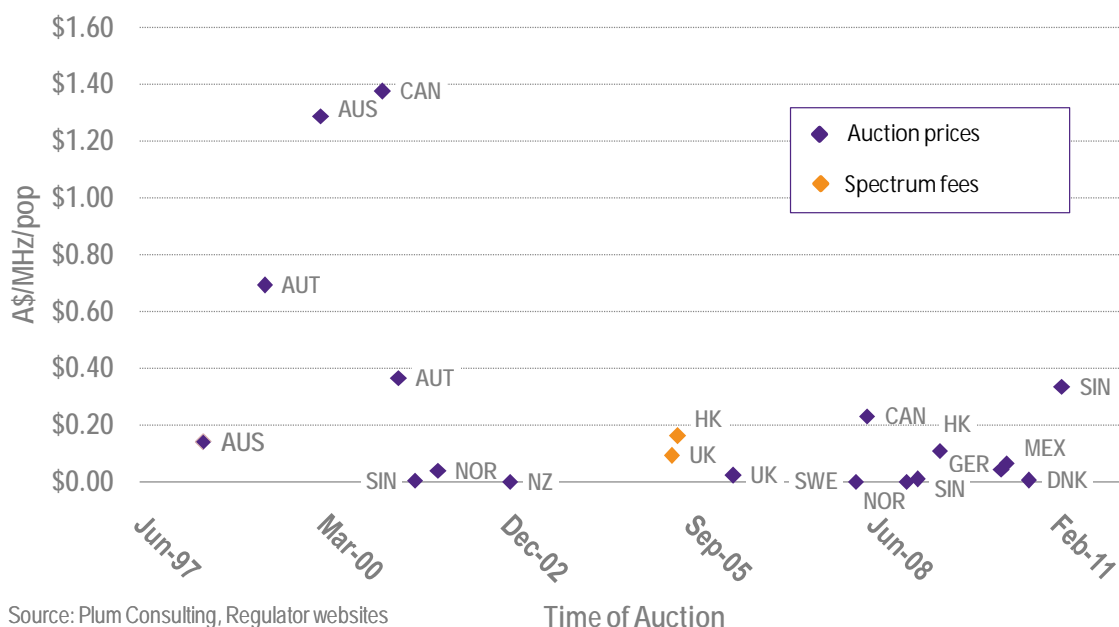
The recent auction in Singapore resulted in prices higher than other auctions since 2002, however, we do not consider Singapore to be a comparable market to Australia. Other benchmarks since 2002 have tended to lie within a range up to $0.23/MHz/pop.

3.3   Implications for reissue values

Changes in technology, spectrum supply and market conditions are likely to mean that the value of licences at the time of reissue could be very different from historical auction receipts. Here we consider the implications of the international evidence and specific aspects of the Australian context for reissue values.

International benchmarks suggest that the value of the 1800 MHz band is unlikely to exceed the original auction values. The recent international benchmarks suggest that prices paid in auctions in markets comparable to Australia can be as high as A$0.23/MHz/pop.

Given the range in the international benchmarks, we consider that bottom-up modelling is required to help establish values for the reissue of the 1800 MHz licences. Our approach to the modelling and the results are addressed in the next two sections of this report.

4 Valuation scenarios and approach

4.1 Introduction

In this section we describe our approach to valuing spectrum licences used to deliver cellular mobile services in the 1800 MHz band. We describe the scenarios and key assumptions made in the modelling. More detail is presented in Appendix A.

Spectrum is purchased by mobile operators to reduce costs and/or to increase revenues. Access to additional spectrum allows operators to reduce costs because fewer base stations are required. Additional revenues might also be earned if service quality improves or new applications and more traffic can be supported by the additional spectrum. We have assumed that spectrum in the 1800 MHz band will be used primarily for the ongoing support of GSM services and provision of LTE services over the licence period.

We are seeking to value licences for the purposes of setting government expectations with regard to licence reissue prices.[6] If licensees fail to meet the Government's price expectations then the spectrum will be auctioned, therefore the value of spectrum yielded by an auction sets a lower bound on value. Licensees should be prepared to pay a premium for licence reissue because this removes the costs and uncertainty of engaging in an auction.

4.2 Range of values

At a minimum the value revealed by an auction will be the value arising from the use of an incremental block of spectrum to reduce infrastructure costs – we call this the **cost reduction value**. The cost reduction value is calculated by modelling infrastructure costs with and without additional spectrum. In congested areas additional spectrum allows more capacity to be deployed per site (and therefore fewer sites are required). However, it should be noted that where no areas have capacity limited sites then adding spectrum has no impact on costs. It was assumed that the minimum block size for efficient deployment of LTE services is 2x10 MHz.

The **full enterprise value** of the spectrum is the net present value (NPV) of total business cashflows (i.e. revenues less costs) that a mobile operator enjoys from all of its assumed spectrum holding. This sets an upper bound on what might be charged for reissue. A price higher than this level would mean that the operator modelled would go out of business.

Licensees will be prepared to pay more than the cost reduction value for a licence because licence renewal removes the costs and uncertainty of going to auction (see Figure 4-1).

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[6] The different approaches to calculating the opportunity cost of spectrum are discussed in "Opportunity cost pricing of spectrum", ACMA, April 2009

Figure 4-1: Range of spectrum value measures
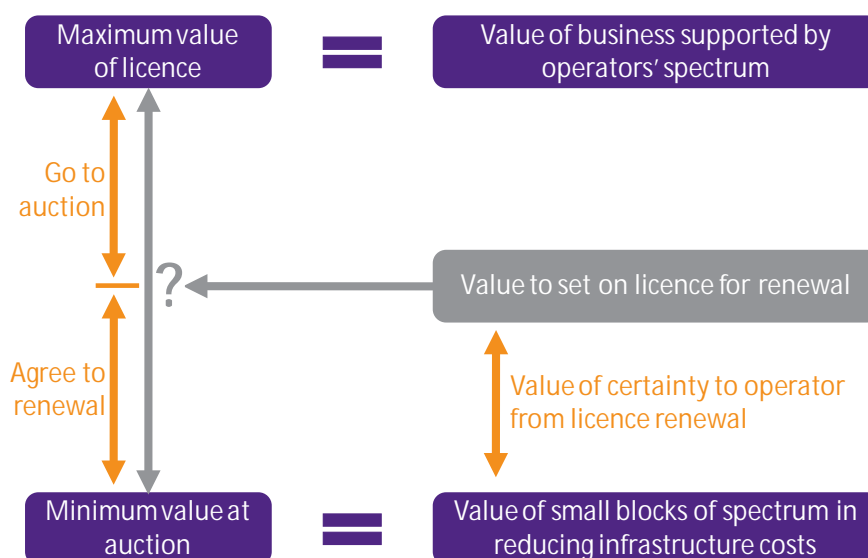
In principle mobile operators are also likely to value the investment and operating flexibility that access to additional spectrum provides when faced with uncertainty over future technology and market performance – this is often called the option value of spectrum. In practice the option value is only known by the operator and so we do not attempt to estimate its value. This means our cost reduction value estimates can be expected to be a lower bound on operators' willingness to pay for spectrum.

4.3   Major assumptions used for modelling value estimates

The 15 year licences are due to expire in 2013 hence it is necessary to construct a view about the future development of the mobile sector over the period out to 2028. For our analysis we assumed that there would continue to be three incumbent mobile operators in the mobile market and that each operator's 3G coverage will be extended to match 2G coverage. In the longer term LTE will also extend to this level of coverage. Coexistence is assumed to be permitted for all spectrum bands.[7]

We have considered three scenarios to describe the possible evolution of the market environment as detailed in Table 4-1.

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[7] It is assumed that this has a negligible impact on value because the process of global standards setting ensures harmful interference does not arise from allowing new devices in bands currently harmonised globally for mobile services. In this regard we note that the market benchmarks from other countries we refer to in Section 3 all permit some degree of co-existence (i.e. do not guarantee exclusivity).

Table 4-1: Market scenario definition

| Value	Low	Medium	High
Population growth (year on year)	1.0%	1.2%	1.6%
ARPU growth	-0.5% p.a.	0% p.a.	0.5% p.a.
Handset penetration	Linear growth to 120% in 2013, flat thereafter		
Wireless modem penetration in 2014	22%	27%	32%
GSM refarming	Linear decline in penetration (7.5% per year)		
LTE penetration	50% in 2021, 94% in 2028		
Data growth (see Figure 4-2)	Aligned with the ABI Research mobile traffic forecast (2011)[8]	Mid way between the high and low scenarios	Aligned with Cisco mobile traffic forecast (2011) [9]

A major driver of both cost reduction and full enterprise valuations is the data traffic forecast for the period of the licence. For the high scenario, we have adopted the Cisco 2011 forecast for Western Europe as being representative on a per capita basis of optimistic traffic levels in Australia. For the low scenario we have adopted the ABI Research forecast. The traffic profile for the three market scenarios are extrapolated using a Gompertz curve as shown in Figure 4-2 which also illustrates the data forecasts made by IDATE for the UMTS Forum in May 2011[10].

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[8] See: http://www.abiresearch.com/products/market_data

[9] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010-2015. Dated 1 Feb 2011 and retrieved 6 June 2011. http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

[10] Mobile traffic forecasts 2010-2020: A report by the UMTS Forum, Executive summary. Prepared by IDATE May 2011.

Figure 4-2: Estimated total forecast mobile traffic in Australia 2010-2028
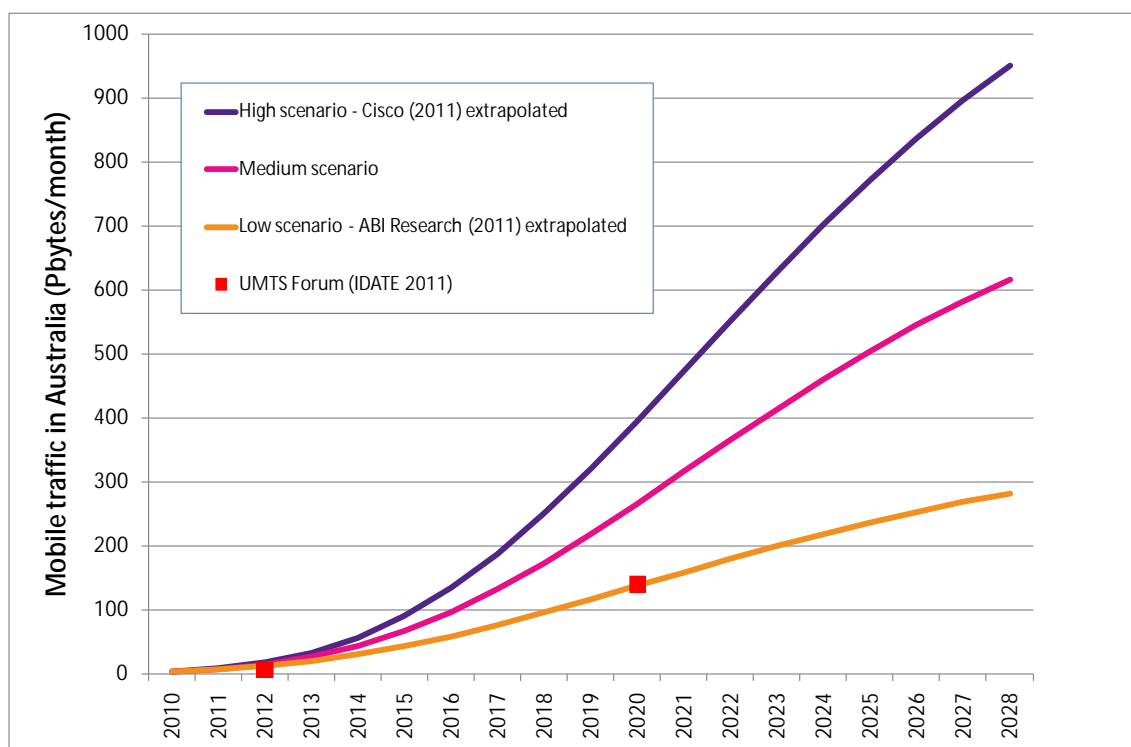
Sources: Cisco, ABI Research, UMTS Forum and Plum estimates

4.4 Typical operator valuation

Our valuations are intended to represent the commercial valuation that might be made by an incumbent operator therefore we consider that a reasonably conservative valuation would be undertaken. Spectrum is to some extent substitutable in its ability to provide 3G and LTE services. It follows that the valuation approach should consider the fact that other spectrum bands may be used to deliver the same service if an incremental amount of spectrum in one band is not obtained (i.e. the costs are spread across all bands capable of delivering the same services).

To accommodate this we have modelled bands together that are likely to deliver the same services: specifically we have assumed that the 700 MHz, 1800 MHz and 2.5 GHz bands will be used to deliver LTE services since they are more readily usable by wider bandwidth carriers. For this group of spectrum bands we have assumed that the hypothetical operator will deploy a single network and that the total revenues and traffic attributed to LTE services can be spread across the group of three bands.

Together the 700, 1800 and 2500 MHz bands contain a total 350 MHz of harmonised spectrum used by cellular mobile. We modelled the NPV of the hypothetical incumbent operator's business case with a third of this spectrum (117 MHz) and an incremental 20 MHz (i.e. 2x10 MHz). We consider the case where the typical operator has 27% market share, based on the lowest current market share of the incumbent mobile operators.

4.5 Modelling results

In assessing the cost reduction value where the spectrum is assumed to give only capacity enhancement we have assumed that the hypothetical operator will gain access to sufficient 700 MHz spectrum to provide long range coverage in rural areas and provide deep in-building penetration in urban and suburban areas.

All NPVs are calculated in 2013 prices for ease of comparison. Values are expressed as a value per MHz per person ($/MHz/pop) so they can be compared with the benchmarks discussed in Section 3. The results for the three market scenarios are detailed in Table 4-2.

Table 4-2: Estimates of capacity related auction values for the 1800 MHz band

Market scenario	Cost reduction value due to capacity provision	Full enterprise valuation
Low scenario	$0.0/MHz/pop	$0.19/MHz/pop
Medium scenario	$0.15/MHz/pop	$0.47/MHz/pop
High scenario	$0.28/MHz/pop	$0.66/MHz/pop

Source: Analysis undertaken by Plum Consulting

We consider the medium scenario to be our best estimate of the cost reduction valuation and a lower bound on values that would emerge in an auction. It should be noted that there is considerable variation in the low and high scenarios for the capacity related component of value.

In summary, our analysis suggests that incumbent MNOs would have a minimum value at auction of $0.15/MHz/pop for the 1800 MHz band. The corresponding full enterprise valuation is $0.47/MHz/pop.

5   Conclusions

The results of our modelling suggest that operator valuations may lie within a range bounded by:

·   A cost reduction valuation of $0.15/MHz/pop, and

·   A full enterprise valuation of $0.47/MHz/pop

These results are our best estimate of operators valuations based on a medium scenario. The modelling results give a wide range of values, and those towards the high end are not plausible when compared with the experience in spectrum markets over the last 10 years. The cost reduction valuation lies within the range of recent benchmarks.

In considering where in the range to set an offer price for licence reissue we have taken into account policy objectives in respect of:

·   Promoting efficient spectrum use.

·   Obtaining a fair value for the public purse.

Efficiency points towards setting values that mimic the results of an auction (i.e. at or somewhat above the cost reduction value). A fair value is one that does not take all of the benefit that an operator might gain from spectrum use (i.e. is less than the full valuation), yet takes account of the value that an operator would attribute to avoiding an auction.

There are potentially substantial disruption costs to both operators and consumers if an auction is used to licence spectrum rather than renew licences. The most quantifiable consumer costs are associated with loss of coverage in remote rural areas and the potential need for an operator to migrate users from one band to another as a result of obtaining different spectrum to that currently held. While we consider the probability of such disruption is low or could be mitigated in the auction design process, there is a risk of unforeseen events in an auction process.

From an operator's perspective there are potential advantages and disadvantages from going to auction. On the positive side, an auction is an opportunity for operators to gain more spectrum and they may perceive that final prices will be lower than a reissue price. However there are also costs and risks associated with auctions:

·   Operators may not be able to retain current spectrum holdings which can result in retuning and subscriber migration costs.

·   Risk of higher competitive intensity as a result of new market entry

·   Disruption to investment financing as a result of uncertainty about future spectrum holdings, and the potential delays associated with an auction

·   Costs of management time in preparing for and participating in the auction.

These costs are specific to the spectrum band being considered and individual operators' circumstances and aspirations. We have not attempted to quantify these individual impacts; however recent international initiatives in the 1800 MHz band show that it is an important band for the early deployment of LTE technology. For example the first commercial LTE network using 1800 MHz spectrum has been launched in Poland;[11] the European Commission has published coexistence rules

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[11] http://www.mobyland.com/n8.html

for the band to facilitate use of the band by LTE technology[12] and it has been suggested that the 1800 MHz will facilitate roaming.[13] [14] [15] There is also strong interest in LTE deployment in the 1800 MHz band in Australia.[16] [17]

To account for these factors and the option value that might otherwise raise auction prices we have assumed an uplift of 50% may be applied to the cost reduction valuation. **Taking account the mix of policy objectives, and the factors considered in the course of the valuation work, we recommend that a price of $0.23/MHz/pop is set for 1800 MHz licences in 2013 prices.**

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[12] 2011/251/EU: Commission Implementing Decision of 18 April 2011 amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community. See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32011D0251:EN:NOT

[13] http://www.dailywireless.org/2011/04/18/eu-global-lte-roaming-at-1-8-ghz/

[14] http://www.lte.tmworld.com/blog/1800-mhz-intercontinental-lte-roaming

[15] http://www.computerworld.com/s/article/9215848/Recycled_spectrum_to_help_realize_global_LTE_roaming

[16] http://www.ericsson.com/news/110530_telstra_switches_on_first_lte_network_244188810_c

[17] http://www.theaustralian.com.au/australian-it/telstra-turns-on-4g-service-in-four-cities/story-e6frgakx-1226061445037

Appendix A: Modelling assumptions

A.1 Revenue forecasts

A.1.1 Population

Population forecasts are produced by the Australian Bureau of Statistics (ABS) and these are presented in the Intergenerational report 2010.[18] This predicts a single average growth rate of 1.2% per annum for the period 2010 to 2050.

The ABS most recent population forecasts project growth rates for the period to 2030; the growth rates range from 1% p.a. (low growth scenario), 1.2% p.a. (mid growth scenario) and 1.6% p.a. (high growth scenario). The higher population growth scenario has a younger population and hence a higher share of the population of working age.

To span the range of population growth forecasts reported above we have used the following low, medium and high population growth scenarios in our work:

· Low scenario: Population growth 1.0% p.a.

· Medium scenario: Population growth 1.2% p.a.

· High scenario: population growth 1.6% p.a.

The population growth will be applied to the current population of Australia which was estimated at 22.5 million for year end 2010 based on ABS statistics.

A.1.2 Subscriber penetration rate

We considered two broad groups of subscribers that make up the subscriber base: handheld subscribers that make use of mobile service over handheld, voice-enabled devices and subscribers that only use mobile broadband data through non-voice devices such as wireless modems. At the end of 2010, population penetration of handheld subscribers was 105%, and population penetration of mobile broadband subscribers was 19%.[19] We have assumed that by 2015, aggregate mobile penetration will reach 152%.

Consistent with these forecasts we have assumed that:

· Handset penetration will rise to 120% in 2013 and be constant thereafter

· Wireless modem penetration will rise to:

    – 22% in the low scenario in 2015 and remain constant thereafter

    – 27% in the medium scenario and remain constant thereafter

    – 32% in the high scenario and remain constant thereafter

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[18] *http://www.treasury.gov.au/igr/igr2010/report/pdf/IGR_2010.pdf*

[19] Calculated from the total number of wireless broadband customers reported by Telstra, Optus and VHA's periodic report for year-end 2010.

Both 3G and LTE technologies will support wireless modem use.

A.1.3 Split of subscribers between technologies

Over the next 15 year licence period we expect the provision of 2G services to terminate, 3G will expand and LTE services will dominate by the end of the period. Our assumed timings are as shown in Table A-1.

Table A-1: Technology timings

Technology	Timing
2G handsets	Penetration declines at 7.5% per annum until services cease in 2016
3G handsets	Penetration of services peak in 2016
LTE handsets	Launched in CBDs in 2011 with large scale take up from 2013 onwards. 50% penetration achieved in 2020
Wireless modems	Assumed to be distributed between 3G and LTE in the same proportion as handsets

Source: Plum assumptions

A.1.4 Average revenue per user

In general levels of ARPU have been relatively constant in recent years. Following two consecutive years of steady ARPU growth between 2006 and 2008, growth of market ARPU declined between 2008 and 2009, and ARPU fell between 2009 and 2010.

We have adopted the current mobile sector averages for the split between prepaid and postpaid subscriptions and we have assumed that this distribution will persist over the 15 year licence period. The sector average levels of ARPU are also adopted for the typical operator modelled. This is $23.8/month for prepaid and $72.4/month for postpaid ARPU. [20] For 3G mobile broadband subscriptions we have assumed that current ARPU is $30/month which is at the lower end of the tariffs offered by 3G operators. LTE mobile broadband is assumed to command a 50% premium above the 3G mobile broadband ARPU.

We have adopted the following real growth assumptions which are assumed to apply for both prepaid and postpaid subscriptions.

· Low scenario: – 0.5% year on year growth

· Medium scenario: 0% year on year growth

· High scenario: + 0.5% year on year growth

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[20] Market prepaid and postpaid ARPU numbers are calculated based prepaid and postpaid ARPU figures reported by SingTel Optus and Telstra in their periodic financial reports in 2010.

A.1.5 Market shares

The hypothetical incumbent operator is assumed to have a market share of 27% in each of the bands modelled throughout the period under study, based on the lowest market share of the incumbent mobile operators (VHA).

A.2 Cost assumptions

A.2.1 Capital and operating costs

Capital cost assumptions are detailed in Table A-2.

Table A-2: Capital cost assumptions

Item	Description
Site quantities	A minimum number of sites to achieve 95% population coverage in the band being considered. These site numbers are estimated for three environment categories (urban, suburban and rural)
Rollout	For LTE network rollout we have assumed that for an incumbent operator coverage of urban and suburban areas is staged over 5 years. For rural areas it is staged over 10 years.
Site establishment costs	New sites are assumed to be $110k for site establishment.
Network equipment	Network equipment and backhaul equipment is deployed at each site. Installed equipment costs per site are assumed to be $146k.
Equipment lifetime	Network equipment is assumed to have a lifetime of 10 years, therefore 10% of sites are re-equipped each year and 10% of the core network costs are incurred each year
Existing network	The 3G network is assumed to already exist and have a value of 50% of its replacement cost.
Residual value	The 3G network is assumed to have no residual value at the end of the 15 year licence period. The LTE network is assumed to have a residual value of 50% of historic deployment cost.

Source: Plum assumptions

Operating cost assumptions are detailed in Table A-3.

Table A-3: Operating cost assumptions

Item	Description
Handset subsidies	Handset subsidies of A$179 per terminal are applied to all new additions and churned subscribers.[21]
Churn	Churn was assumed to be 21% of total subscribers per annum for the purposes of analysis.[22]
Network maintenance	Network maintenance will be estimated at 12% of cumulative capital network equipment costs
Site rental	Site rental will be driven by the total number of sites and typical base station site rents for Australia. We assumed $20,000/site/year.
Core network costs	Annual core network costs were based on 155 Mbit/s leased line prices
Marketing and admin	Marketing and admin costs were assumed to be 39% of service revenues.
Interconnection	Interconnection costs were assumed to be 17% of service revenues.

Source: Plum assumptions

A.2.2   Site quantities and traffic distribution

The number of sites currently deployed by the operators is important for the study. It shows the number of sites available to each operator and an indication of the minimum number of sites required to achieve (almost) national population coverage.

The breakdown of sites by operator and environment are detailed in Table A-4. In general the Urban area category comprises the Central Business Districts of Sydney, Melbourne, Brisbane, Perth and Adelaide. Suburban areas are the metropolitan areas of these cities plus towns having a population greater than 10,000. The remainder areas having mobile coverage areas are assumed to be rural.

Table A-4: Number of sites by operator

Environment	Telstra	Optus	VHA	Typical operator
Sites				
Urban	483	369	387	369
Suburban	2662	2217	2855	2217
Rural	5723	4106	2847	2847
Notes				
Source: ACMA assignment database (June 2011)				
Derived from a list of unique site identifiers in the ACMA assignment database. "Typical" operator site numbers are based on the lowest number of sites in each environment.				

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[21] Derived from the average of VHA's reported year average for 2010 ($145/sub) and Optus' average of the 4 quarterly figures for 2010 ($213.5/sub).

[22] From SingTel's quarterly MD&A reports for 2010 in which monthly churn ranges from 1.5% to 1.7%.

To understand the impact of traffic growth on the network, the traffic is distributed across urban, suburban and rural areas. We have assumed that traffic will be distributed according to population density. The estimated population distribution across urban, suburban and rural areas is shown in Table A-5.

Table A-5: Distribution of population by area type

Area type	Estimated population	Proportion of total population
Urban	1,781,500	8.1%
Suburban	15,567,000	70.4%
Rural	4,759,000	21.5%

Note: Urban population also includes workforce and visitors Data were obtained from:

www.citypopulation.de (based on 2006 Australian census data)..
http://cityofsydney.nsw.gov.au/AboutSydney/CityResearch/AtAGlance.asp
http://www.melbourne.vic.gov.au/info.cfm?top=66&pa=779&pg=900
http://www.brisbane.qld.gov.au/bccwr/about_council/documents/sept07_context_brisbane_mass_transit_investigation_lmt.pdf

Traffic estimates are formed by forecasting the average traffic per subscriber for 2G, 3G and LTE services and distributing the subscriber base across environments in proportion to population.

A.2.3 Traffic growth assumptions

Traffic is expected to grow substantially in the period to 2028. Voice traffic growth has declined in recent years and we have assumed that voice growth will slow from 4.4% in 2010 to zero growth in 2016. There is considerable uncertainty regarding mobile data volumes demanded over the next few years and growth in the longer term is even more speculative since it relies on as yet unknown services and applications. We have taken a top down approach to modelling mobile data traffic. We start with a forecast for total mobile data traffic in Australia and then break split this total between 3G and LTE technologies.

A range of forecasts for global mobile data growth were considered. To perform the analysis we adopted the Western Europe data volumes per person, since we consider these more typical for Australia rather than the average across the Asia Pacific region. The forecasts from Cisco Systems[23], ABI Research[24] and IDATE[25] cover the period 2011 to 2015 for Western Europe.

The Cisco and ABI forecasts were projected over the licence period by fitting a Gompertz curve then scaling to Australia by population. We have adopted the Cisco and ABI forecasts as the traffic forecast for our high and low scenarios respectively. The medium forecast is mid-way between these two forecasts.

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[23]Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010-2015. Dated 1 Feb 2011 and retrieved 6 June 2011. http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

[24] http://www.abiresearch.com/products/market_data

[25] Mobile traffic forecasts 2010-2020: A report by the UMTS Forum, Executive summary. Prepared by IDATE May 2011.

The projected monthly traffic volume for Australia is shown in Figure A-1 for all the scenarios.

Figure A-1: Estimated total forecast mobile traffic in Australia 2010-2028
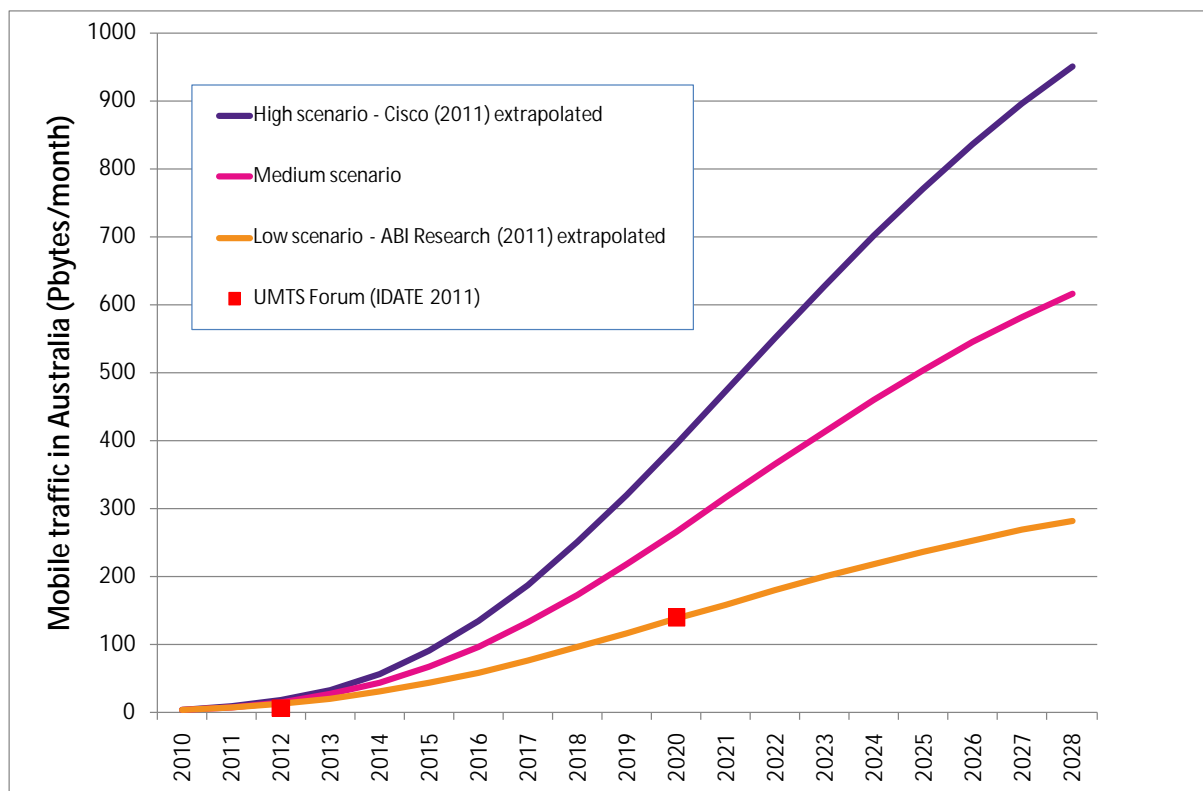
Source: Cisco, ABI Research, UMTS Forum and Plum estimates

The monthly projections are converted to busy hour figures by assuming 30 days in each month and 7.5% of daily traffic will occur in the busy hour.

A.3   Network efficiency

The traffic demand is converted into infrastructure demand using a set of spectral efficiency assumptions and network efficiency assumptions. These are detailed in Table A-6 and Table A-7 respectively.

Table A-6: Spectral efficiency assumptions

Service	Spectral efficiency in bits/Hz/cell	Comments
GSM voice	0.032	Throughout the licence period
WCDMA voice	0.114	Throughout the licence period
LTE voice	0.114	Throughout the licence period
3G data	0.48 – 1.1 *	Spectral efficiency rises linearly to 2021 to 2015. Level thereafter
LTE data	1.36 – 2.2 *	Spectral efficiency rises linearly between 2013 and 2032. Level thereafter
* Values sourced from the FCC National Broadband Plan. See http://www.broadband.gov/plan/ and ITU-R Recommendation M.2134		

Table A-7: Network efficiency assumptions

Aspect of deployment	Efficiency factor	Comments
Utilisation factor	60%	Caters for imperfect matching of traffic demand to network capacity and build ahead.
Asymmetry factor	63% to 56%	Represents the effective loading given that traffic is highly asymmetric with heavy bias in the downlink direction.
Multiple operator factor	80%	Allows for the misalignment in spectrum holdings between operators relative to market shares.
QoS loading factor	100% to 74%	Usable capacity for mean traffic so that high bandwidth services can be provided with adequate QoS. Factor reduces linearly from 2013 to 2016.

Source: Plum assumptions

These spectral efficiencies defined in Table A-6 are multiplied by the network efficiency factors in Table A-7 to form an estimate of overall network efficiency.

A.4   Discount rate

We have used a commercial nominal pre-tax discount rate of 12 % for the analysis, which is based on values adopted by the Australian Competition and Consumer Commission (ACCC) for analysis of mobile termination rates.

A.5   Inflation

All modelling is in nominal terms. An inflation rate of 2.5% has been adopted as predicted in the Intergenerational report 2010 for the period 2015 to 2046. [26]

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[26] http://www.treasury.gov.au/igr/igr2010/ Appendix D: IGR 2007 Projections