Final report for InternetNZ

# Digital dividend spectrum: key issues for New Zealand

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NETWORK STRATEGIES
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# 0 Executive summary

New Zealand can anticipate significant economic and social benefits from the sub-1GHz radio spectrum becoming available from 2013. This spectrum, known as the 'digital dividend', is to be freed through digitisation of broadcast television. It is well suited for cost-effective and widespread deployment of mobile broadband services, delivering better coverage in rural and urban areas with fewer sites than required with higher frequency spectrum. The availability of this new spectrum is timely as global demand for wireless broadband access will experience explosive growth over the period 2011–2015, driven by the rapid increase in devices such as smartphones and tablets.

Policy makers must ensure that the spectrum allocation delivers optimal outcomes for consumers and society. This will depend heavily on how spectrum is packaged for auction and especially on the conditions attached to spectrum lots. For this there are many possible options.

Policy objectives for the allocation of the digital dividend in New Zealand are still being finalised, but key concerns are economic and technical efficiency, rapid deployment, wide coverage and encouraging competition. Social considerations are also important, including extending rural mobile broadband services.

There are trade-offs involved within this set of policy objectives. Economic and technically efficient allocation of the spectrum to achieve wide coverage and rapid deployment may not be consistent with the objective of improving market competition. For example, if one operator acquires more spectrum than others, via the objective of improving rural access to mobile broadband, then our market may become more concentrated.

Therefore to avoid undesirable and unintended consequences the impact of various options on competition must be considered. Outcomes driven solely by the business decisions of operators may not be consistent with consumer and public interest. To safeguard these interests, Government should undertake a detailed analysis of potential options for allocation using a total welfare standard which captures the wider costs and benefits. Existing spectrum holdings will also need to be taken into account.

Where there are trade-offs, decisions need to be made on our priorities. Only then can effective safeguards be implemented to ensure Government's key objectives will be achieved.

# Digital dividend spectrum: key issues for New Zealand

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# 1 Introduction

Digital dividend spectrum in the 694–806MHz range will become available in New Zealand by 2013, following digitisation of broadcast television channels. The digital dividend represents the next major allocation of spectrum to be made by the New Zealand government.

InternetNZ has commissioned Network Strategies Limited to investigate key issues in the allocation of digital dividend spectrum for New Zealand. The study objective is to identify issues that will be important in achieving the optimal overall outcome for the New Zealand community from the allocation of the digital dividend spectrum. To this end we have been asked to undertake research with a focus on:

- an appropriate conceptual framework to investigate approaches for maximising the benefit that the digital dividend spectrum will provide for New Zealand (Section 2)
- options for packaging the spectrum (Section 3)
- assessing the optimal outcome for rural dwellers (Section 4)
- alternative infrastructure models (Section 5).

So what makes digital dividend or sub-1GHz spectrum particularly attractive to operators? In comparison with spectrum at higher frequencies the sub-1GHz band:

- propagates more effectively in urban and rural areas resulting in better coverage
- requires fewer sites per square kilometre of coverage resulting in lower deployment costs
- has a greater ability to penetrate building walls improving indoor coverage significantly.

However an operator with spectrum in only the 700MHz band will most likely need complementary high frequency spectrum to support dense traffic areas. The ITU notes[1] (in the context of developing countries, but the principle is the same for any low traffic density area):

> Radio spectrum below 1 GHz is optimum for the needs of developing countries, due to the ability to serve larger rural areas from a single cell site compared to spectrum above 2 GHz. However, it is very challenging to find wide bandwidths below 1 GHz so "broadband" needs must be met primarily through spectrum above 2 GHz.

We conclude that a combination of low and high frequency bands is the preferred configuration for operators that have suitable spectrum. Consequently notwithstanding existing allocations that are usable for mobile broadband, the allocation of digital dividend spectrum will remain crucial to the future development of broadband wireless access networks in New Zealand.

Our study draws on local knowledge and relevant research as well as information from overseas experience. We also engaged in dialogue and discussions with industry players to inform our background knowledge. It should be noted that while it is beyond the scope of this study to provide comprehensive answers to all the issues that we identify, our aim is to compare and contrast possible approaches and outcomes. Our findings in this respect are summarised in Section 6. The exchange rates we have used for currency conversion throughout the report are listed in the Annex.

InternetNZ will publish this study with the intention of informing its members and the general public. It may also draw on our findings to inform its submissions to Government.

Although the study has been commissioned by InternetNZ the views expressed in this report are entirely those of Network Strategies.

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1 International Telecommunication Union, *Spectrum for IMT*, available at http://www.itu.int/ITU-D/imt-2000/DocumentsIMT2000/Spectrum-IMT.pdf.

# 2 Achieving an optimal outcome

## 2.1 Legislative and regulatory framework in New Zealand

Spectrum managers are required to make many decisions in allocating scarce spectrum resources amongst competing potential uses. This decision-making process must be governed by legislative and regulatory principles.

Section 12 of the *Radiocommunications Regulations 2001* (the Regulations) lists a number of factors that must be taken into account when determining whether to grant a radio licence, a general user radio licence or an exemption. These include:

- public interest considerations in achieving the maximum benefit from radiocommunications
- any agreement relating to radiocommunications entered into between New Zealand and other countries
- the technical compatibility of radio and spectrum licences in place with the radiocommunication service for which the radio licence or general user licence or the exemption is required
- any government policy made in accordance with section 112 of the *Radiocommunications Act 1989*.

Section 112 of the Act requires the Secretary[2] to have regard to government policy when exercising his or her functions, duties and powers under the Act in the granting of radio licences.

We note that the Radiocommunications Act does not have a general purpose, however the purpose statement of Part 2 (Designated services and specified services) of the *Telecommunications Act*[3] includes a number of relevant overarching aims and principles :

- to promote competition in telecommunications markets for the long term benefits of end-users of telecommunications services in New Zealand through regulating and providing for the regulation of the supply of certain telecommunications services between service providers
- in determining whether or not or to the extent to which any act or omission will result or will be likely to result in competition in telecommunications markets for the long term benefits of end-users, the efficiencies that will result or will be likely to result from that act or omission must be considered
- in determining the extent to which competition in telecommunications markets for the long term benefits of end-users is promoted consideration must be given to the incentives to innovate that exist for and the risks faced by investors in new telecommunications services that involve significant capital investment and that offer capabilities not available from established services.

Public policy objectives as identified by the Ministry of Economic Development (MED) indicate that price mechanisms or the facility to trade spectrum rights may not be appropriate for some spectrum uses[4]. These uses include, for example, services which are provided in the public interest (such as defence and security services) as well as services which are subject to international treaties. Services to meet government social policy objectives, such as those relating to broadcasting may also be subject to exceptions from

2 Secretary is defined in section 2 of the Act as "*chief executive of the department of State that, with the authority of the Prime Minister, is for the time being responsible for the administration of this Act.*" Currently radiocommunications in New Zealand is managed by the Ministry of Economic Development.

3 Telecommunications Act 2001 (New Zealand), section 18.

4 Ministry of Economic Development (2007), *The radiocommunications environment in New Zealand*, available at http://www.rsm.govt.nz/cms/policy-and-planning/spectrum-policy-overview/legislation/acts-and-regulations/the-radiocommunications-environment-in-new-zealand.

these price mechanisms and spectrum trading. The MED also states[5] that competitive neutrality is an underlying theme to the Act allowing new entrants a fair chance against existing users in the allocation of spectrum.

In April 2011 at a digital dividend scoping workshop MED staff indicated that there was a need to balance commercial and public interest in order to maximise the benefit that the spectrum will provide for New Zealand. MED also noted the need for additional spectrum capacity to meet consumer demand for data, in addition to two examples of public policy objectives which might imply that some spectrum may need to be reserved, namely:

- encouraging Maori participation in the knowledge economy
- ensuring adequate resources for radiocommunications for public protection and disaster relief.

In a more recent discussion paper on the digital dividend[6] the MED listed objectives that 'might be considered for allocation of the 700MHz band' as:

- an economically and technical efficient allocation of the 700MHz band that promotes competitive outcomes in the market for mobile broadband services
- realising the productivity benefits offered by new technologies, including through:
  - rapid deployment of next generation services to consumers
  - wide coverage of next generation services[7].

Further encouragement of competition in the mobile market is emphasised as a means of promoting 'innovation and efficiency gains to create benefits for end-users – in terms of better services, and lower prices'[8].

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5 *Ibid.*

6 Ministry of Economic Development (2011), *Digital Dividend: opportunities for New Zealand*, August 2011.

7 *Ibid*, page 3.

8 *Ibid.*

## 2.2 A conceptual framework

In order to achieve the objective of maximising the benefit of digital dividend spectrum to New Zealand it will be important to have a clear conceptual framework to inform the Government's decisions on the spectrum allocation. As we have seen, although there is a public interest criterion in the secondary legislation, there is limited guidance available as to what constitutes the public interest, and therefore it is difficult to draw inferences concerning how to assess the optimal economic and social outcome.

Economic welfare theory offers two standards that may be used in the context of spectrum assignment decisions.

*Consumer welfare standard* — The fundamental issue is the impact on the consumer (or potential consumer) of services. When evaluating regulatory options or scenarios it is necessary to take into account service availability and pricing, and all associated costs and benefits that the consumer may encounter. Under this standard the impact on operators and service providers (including costs they may incur as a direct result of the regulatory scenarios) is irrelevant.

*Total welfare standard* — The impact of regulatory scenarios is measured as the sum of the effects on consumers, producers and government, as well as the general social benefit for others in the community, with the requirement that all significant benefits and costs be given the same weight irrespective of the beneficiary's identity. Hence under this standard both private and public benefits (including externalities[9]) are taken into account. The aim is to choose the scenario that will generate the greatest net benefits for the community.

Note that the total welfare standard captures wider costs and benefits than the consumer standard. In particular social benefits are included in a total welfare analysis.

9 An externality is a by-product (either positive or negative) of an economic act which is not captured in terms of private economic benefit or cost.

In both cases the change in welfare arising from the regulatory options should be assessed. Note that it may not be possible to quantify the impact of all costs and benefits, particularly in relation to social aspects. Consequently the decision-making framework must accommodate both quantitative and qualitative analysis. Given that it may also be difficult to assess dynamic efficiency effects[10] using welfare standards, the framework should be flexible enough to include such effects where likely to be significant.

Historically market-based spectrum allocation has been used in New Zealand in the form of auctions and secondary trading, based on the premise that the highest bid will come from the organisation that values the spectrum most highly. In other words we rely on **private** valuation as the key to realising the value of spectrum. Such approaches may not capture consumer and public benefits associated with different potential uses of the spectrum. Hence in the case of the digital dividend we must ask whether there are any such issues that would justify Government intervention, in preference to reliance solely on market mechanisms.

Although the statements made to date by the MED place an emphasis on the interests of the consumer or end-user, it is also apparent that there are additional public policy objectives (for example, in relation to broadband in rural areas). This implies that a total welfare standard may represent an appropriate framework for decision-making with respect to allocation of the digital dividend. Hence while private valuation of the spectrum will be important, some additional safeguards or measures may also need to be considered to ensure that overall welfare is maximised.

## 2.3 A framework for analysis: overseas practices

Digital dividend policies will to a certain extent be dictated by countries' individual circumstances and characteristics. There may be different demographic, geographic, market, historical and cultural features that may affect the principles chosen to govern

10 A firm is dynamically efficient if over time it is able to respond in a timely, effective and innovative fashion to changes in opportunities. Other economic efficiency constructs reflect the more static considerations as to whether a firm can produce services at least cost (productive efficiency), and whether resources are allocated to highest value uses (allocative efficiency).

allocation of the spectrum. Proximity to other countries and regional considerations may also be important.

*Australia*

In Australia a number of objectives for spectrum management are given in Section 3 of the *Radiocommunications Act 1992*, including:

- maximise public benefit through efficient use of the radiocommunications spectrum
- make adequate provision for public defence, security, law and emergency services use of the spectrum, as well as for other public or community services
- have a responsive and flexible approach to meeting the needs of spectrum users
- encourage the use of efficient radiocommunications technologies
- support the communications policy objectives of the Commonwealth Government
- promote Australia's interests regarding international agreements where radiocommunications and spectrum use are concerned.[11]

However there is no clear definition of public interest in the Act nor is there any guidance in secondary legislative material. The Department of Broadband, Communications and the Digital Economy suggested[12] five possible public interest criteria in relation to the re-issue of expiring spectrum licences:

- promoting the highest value use for spectrum
- investment and innovation
- competition
- consumer convenience
- determining an appropriate rate of return for the community.

The Australian Communications and Media Authority (ACMA) – the spectrum management authority in Australia – has developed spectrum management principles

11 *Radiocommunications Act 1992*.

12 Department of Broadband, Communications and the Digital Economy (2009) *Public Interest Criteria for the re-issue of spectrum licences*, discussion paper, April 2009.

consistent with the theme of maximising overall public benefit. These principles aim to maximise welfare, using as a yardstick the total welfare standard[13]. These principles are:

- allocate spectrum to highest value use or uses
- enable and encourage spectrum to move to its highest value use or uses
- use the least cost and least restrictive approach to achieving policy objectives
- to the extent possible, promote both certainty and flexibility
- balance the cost of interference and the benefits of greater spectrum utilisation.

The total welfare standard, in conjunction with the above principles, has been used to guide Australian decisions regarding allocation of the digital dividend spectrum.

*Canada*

The *Department of Industry Act*[14] and the *Radiocommunication Act*[15] give Industry Canada powers to administer spectrum rights in Canada. The policy objective of the *Spectrum Policy Framework for Canada*[16] is to maximise the economic and social benefits that Canadians derive from the use of the radiofrequency spectrum. The Spectrum Policy Framework also adopts the following Enabling Guidelines:[17]

- market forces should be relied upon to the maximum extent feasible
- spectrum should be made available for a range of services in the public interest
- spectrum should be made available to support Canadian sovereignty, security and public safety needs
- any regulatory measures should be minimally intrusive, efficient and effective

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13 See Burdon, R. (2008), *Maximising public benefits derived from use of the spectrum*, Telecommunications Journal of Australia, volume 58, Number 2-3, 2008.

14 Department of Industry Act SC 1995 c 1.

15 Radiocommunication Act RSC 1985 c R-2.

16 Industry Canada (2007) *Spectrum Policy Framework for Canada,* June 2007, see http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/spf2007e.pdf/$FILE/spf2007e.pdf.

17 *Ibid.*

- regulations should be open, transparent and reasoned, as well as developed through public consultation when appropriate
- spectrum management practices should minimise the administrative burden and be responsive to changing technology and market place demands
- Canada's spectrum resource interests should be actively advanced and defended internationally
- spectrum policy and management should support the efficient functioning of markets by:
  - permitting flexible use of spectrum to the extent possible
  - harmonising spectrum use with international allocations and standards, except where Canadian interests warrant a different determination
  - making spectrum available for use in a timely fashion
  - facilitating secondary markets for spectrum authorisations
  - clearly defining the obligations and privileges conveyed in spectrum authorisations
  - ensuring that appropriate interference protection measures are in place
  - reallocating spectrum where appropriate, while taking into account the impact on existing services
  - applying enforcement that is timely, effective and commensurate with the risks posed by non-compliance.

*France*

The French Government specified the following principles for use of digital dividend spectrum[18]:

- promotion of diverse service delivery
- improvement of national digital coverage
- provision of equal access to electronic communications networks
- development of effective public service radio links
- optimal management of the spectrum.

18 See http://www.legifrance.gouv.fr/affichTexte.do;jsessionid=FD6D4AEE44C4D93B27CCFF69AD681E6C.tpdjo03v_3?cidTexte=JORFTEXT000000248397&categorieLien=id.

There was also a provision that the majority of the spectrum should remain dedicated to broadcasting services.

The French spectrum manager ARCEP subsequently commissioned a study[19] to examine the most efficient use of digital dividend spectrum in France. The study considered the trade-offs involved in a scenario in which the spectrum is shared between mobile broadband and digital terrestrial television (DTT) and an alternative scenario which focussed on providing more resources to broadcasting. The incremental gain in social welfare from the shared use scenario amounted to over EUR25 billion (NZD43 billion) between 2012 and 2024. At the macro level the shared use scenario was estimated to lead to a net increase in GDP of EUR7.1 billion (NZD12.1 billion) over the same period, compared to EUR2.3 billion (NZD3.9 billion) for the alternative broadcasting scenario. Note that likely productivity gains from mobile broadband were not taken into account, and hence these estimates may be conservative.

The study concluded that sharing of the digital dividend frequencies was possible and that the greatest economic value would be reaped via a shared use plan rather than focussing on broadcasting alone. Furthermore, such a plan would be consistent with the key principle of optimising management of the spectrum. In France there is a significant rural population with no access to broadband services. Consequently the Government views efficient use of the digital dividend spectrum as a driver for achieving nationwide broadband coverage. Further details of the coverage obligations for the digital dividend spectrum are provided in Section 3.4.

*Ireland*

The Commission for Communications Regulation (ComReg) in Ireland issued a draft decision in August 2011 (the draft decision), following consultations, on the best way to assign three spectrum bands (800, 900 and 1800MHz). The draft decision is guided by ComReg's statutory functions, objectives and relevant duties in relation to Ireland's radio frequency spectrum. Recent legislation adopted at the European Union level liberalised the 900MHz band and harmonised the 900 and 1800MHz bands making it possible to

19 Analysys Mason and Hogan & Hartson (2008), *Valuation of the digital dividend in France*, 27 May 2008.

introduce other terrestrial systems capable of providing electronic communication services that can co-exist with GSM systems in these bands. Previously the 900MHz band could only be used to provide GSM services.

ComReg's Regulation Impact Assessment (RIA) Guidelines and assessment against statutory objectives were used to inform and provide a consistent framework for its analysis. The statutory objectives in the management of spectrum in Ireland include:

- promoting competition
- contributing to the development of internal markets
- the promotion of the interests of European Union citizens.

The five steps to ComReg's RIA are:

- identifying the policy issue and objective
- identifying and describing regulatory options
- determining impacts on stakeholders (particularly consumers and industry stakeholders)
- determining impacts on competition (in the award process but also in the retail market)
- assessing the impacts and choosing the best option.

The provisions relating to the management of the radio frequency spectrum were grouped by ComReg as follows:

- general competition provisions
- contribution to the development of the internal market
- promotion of the interests of European Union citizens
- efficient and effective management of spectrum
- regulatory principles
- relevant policy directions and policy statements
- general guiding principles in terms of spectrum management, setting of fees and licence conditions:
  - objective justification
  - transparency
  - non-discrimination

– proportionality.

In terms of general competition provisions ComReg outlined its core statutory objective under Section 12 of the *Communications Regulation Act* (the Act) of promoting competition as:

- ensuring that users derive the maximum benefit in terms of choice, price and quality
- ensuring that there is no distortion or restriction of competition in the electronic communications sector
- encouraging the efficient use of and ensuring effective management of radio frequencies
- ensuring that elderly users and users with special social needs derive the maximum benefit in terms of choice, price and quality
- ensuring that in the transmission of content there is no distortion or restriction of competition in the electronic communications sector.

In order to safeguard competition and best promote competition to the benefit of consumers ComReg considered which option would maximise competition in the allocation of spectrum and also in retail markets. Relevant questions in this regard were whether the considered options would lower barriers to entry and whether inefficient administrative assignment of spectrum would be avoided.

ComReg, in its analysis of which option would promote the interests of end users considered whether the award of spectrum would minimise potential disruption or exclude the likelihood of new entry. Users also needed to derive a maximum benefit in terms of price, choice and quality.

The interests of all users of the radio frequency spectrum, including commercial and non-commercial users, were taken into account when assessing which option would most promote the efficient use and effective management of spectrum. ComReg endeavoured to minimise significant aggregation of risk for bidders, maximise efficient entry and lower barriers to entry. International developments and activities of other European member states were also relevant.

In order to promote efficient investment and innovation in new and enhanced infrastructures ComReg considered that those who most value the spectrum rights would win the auction. Annual spectrum usage fees and payments made in the auction would offer appropriate incentives to invest in infrastructure and provide services using the spectrum acquired by the winning bidder.

ComReg also noted that without regulatory intervention certain geographic areas such as remote and rural areas would not receive the same degree of access and coverage as other areas which are more desirable by operators such as urban locations. ComReg therefore decided that coverage obligations should be incorporated into rights of use assignment under the current process.

*Sweden*

The Swedish Government saw the excellent propagation characteristics of frequencies in the digital dividend spectrum band as an opportunity to advance the national broadband policy. As such, coverage obligations were imposed on one of the licences. Permanent homes and places of business without broadband connections would be entitled to receive mobile broadband connections under these obligations. The Swedish regulator estimated approximately 1000 to 1500 such connections would be required. Further details are provided in Section 3.4 below.

*United Kingdom*

The overarching principles for spectrum management in the UK are contained in the *Communications Act 2003* and the *Wireless Telegraphy Act 2006*. These include:

- to further consumer interests via the promotion of competition
- to ensure optimal use of the radiospectrum
- to encourage investment and innovation
- to encourage the availability of high-speed data services throughout the country
- the requirement that Ofcom (the UK spectrum manager) has regard for future demand for spectrum, and promotes competition and innovation in the supply of services.

The UK Government has endorsed a market-based approach to digital dividend on the basis that it maximises overall welfare. In particular the approach is consistent with increasing opportunities for competition and innovation, and creates strong efficiency incentives[20].

> …our objective is to maximise the total value to society that using this spectrum is likely to generate over time. This includes not just the value that each of us derives as a consumer of services but also the wider value that wireless communications services can create by contributing to broad social goals like inclusion and promoting informed democracy. It is not our objective to raise revenue from managing the spectrum, nor, given our statutory duties, is this a relevant consideration for us.[21]

Consequently service and technology neutrality have been adopted as guiding principles, together with minimising restrictions on use while ensuring that interference is avoided and international obligations are met. In addition, Ofcom is required to undertake an assessment of the competitive implications of the digital dividend award, including an examination of the potential for new market entry.

*United States*

The Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) are responsible for the regulation of radiofrequency spectrum in the United States and work in collaboration. While the former administers spectrum for non-Federal use such as for local governments and businesses, the latter administers spectrum for Federal use such as that used by the defence forces and the Federal Bureau of Investigation (FBI).[22]

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20 See Ofcom (2009), *Digital Dividend: clearing the 800MHz band*, 30 June 2009.

21 *Ibid*, paragraph 2.17.

22 See http://transition.fcc.gov/oet/spectrum/.

The *Communications Act 1934*[23] established the FCC and gave it broad powers to regulate spectrum "in the public interest." The FCC's six core principles of effective spectrum management[24] include:

- maximising the efficient use of radiofrequency spectrum
- ensuring that spectrum is made available for new technologies / services and that flexibility is preserved to adapt to new market demands
- developing a fair, efficient and transparent process for awarding spectrum licences
- making allocation and licensing assignments based on market demands
- promoting competition
- ensuring that spectrum is available for important public benefits such as health and safety.

Public needs and benefits, technical considerations and equipment limitations are the main factors considered when determining the allocation of spectrum amongst competing interests:[25]

*Public need and benefit considerations*

- Dependence of the service on radio (as opposed to wireless or fibre)
- The market demand for the service
- The relative social and economic importance of the service, including safety-of-life and protection-of-property factors
- The degree of public support which is expected for the service as well as its probability of establishment
- The impact of new services on existing investment in the proposed frequency band.

23 The Communications Act 1934 47 USC § 151.

24 Federal Communications Commission (1999), *Connecting the globe: a regulator's guide to building a global information community*, Ch. VII, see http://transition.fcc.gov/connectglobe/sec7.html.

25 *Ibid.*

| | |
|---|---|
| *Technical considerations* | • The necessity for the service to use particular portions of the spectrum (including propagation characteristics and compatibility with other services within and outside the selected frequency band)<br>• The amount of spectrum required<br>• The signal strength required to provide a reliable service<br>• The relative amount of radio and other electrical inference that is likely to be encountered as a result of the service<br>• The viability of the technology that will be used. |
| *Equipment limitation considerations* | • The upper practical limits of the useful radio frequency spectrum and what higher limit can be expected in the future due to technological advancements<br>• The amount of spectrum required<br>• The signal strength required for a reliable service<br>• The relative amount of radio and other electrical interference likely to be encountered<br>• The viability of the technology. |

The FCC considers that a market based approach to licensing through auctioning spectrum rights has the following advantages:[26]

- increasing speed by minimising delay and inefficiencies
- transparency through clearly established rules and procedures and definitive outcomes
- promotion of efficient and high-value use of spectrum by allocating spectrum rights to those who value it the most
- preservation of public interest by allocating licences to those who value it the most in the first instance allowing the public to recover the full value of the spectrum.

The FCC believes that:

> … licensing mechanisms based on competitive bidding should be considered an integral part of an overall approach to spectrum management that is based on the idea that market

26 *Ibid.*

> forces, not government regulators, are better able to decide what services and technologies consumers will want. For example, auctions combined with partitioning and disaggregation (though which a licensee can sell or lease part of their entire spectrum) allow potential licensees to more closely match market demands with their planned systems.[27]

However the FCC makes exceptions to the competitive bidding process in cases where it considers that auctions will not be the appropriate spectrum allocation method. For example, in the absence of mutual exclusivity, auctions may not be necessary as the licence can be more easily assigned without considering any competing interests. Public policy goals (such as public safety, national defence) may not be well-served by auctioning the spectrum rights either. The most efficient and effective allocation of spectrum may also occur through the shared use of spectrum, and reimbursement methods can ensure that the public is adequately compensated for the use of the resource in these circumstances.[28]

## 2.4 What is the highest value use in New Zealand?

The global demand for wireless broadband access is expected to explode over the period 2011–2015. This demand is primarily being driven by the proliferation of devices such as smartphones and tablets (Exhibit 2.1).

27 *Ibid.*

28 *Ibid.*

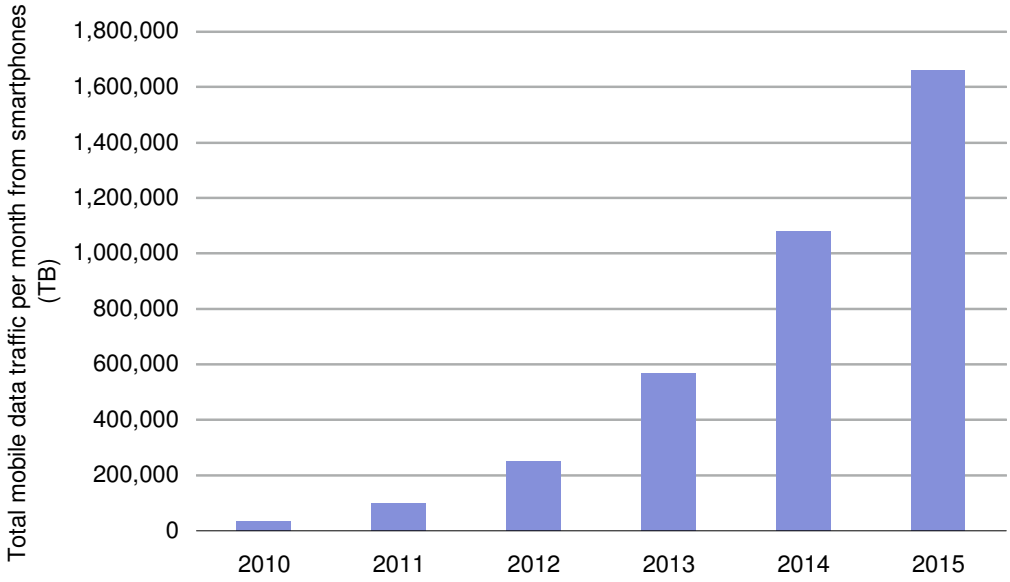


***Exhibit 2.1:*** *Global mobile data traffic generated from smartphones, 2010–2015 [Source: Cisco]*

The Cisco Visual Networking Index forecast for New Zealand[29] indicates that mobile data traffic will grow three times faster than fixed IP traffic from 2010 to 2015, with a compound annual growth rate of 119%. Whereas mobile data traffic was just 1.7% of total IP traffic in 2010, it is expected to be 16% of total IP traffic in 2015. The average mobile connection is anticipated to generate 2.6GB of mobile data traffic per month in 2015 compared to 75MB in 2010.

The primary resource required to support the projected mobile broadband traffic growth will be the availability of sufficient radio spectrum. As we have already noted, the optimal mix of spectrum for coverage and capacity consists of both sub-1GHz and higher frequencies. In France and Germany multi-band auctions have included both digital dividend and 2.6GHz (and sometimes other bands). Multi-band auctions have also been proposed for Australia, Portugal, Switzerland and the United Kingdom.

29 See Cisco (2011), *VNI forecast highlights*, available at http://www.cisco.com/web/solutions/sp/vni/vni_forecast_highlights/index.html#~Country.

Several other countries have already auctioned higher frequencies prior to digital dividend, including the Netherlands, New Zealand and Sweden. In total the MED has already allocated 800MHz of spectrum in the sub-4GHz band to nine entities illustrated in Exhibit 2.2.

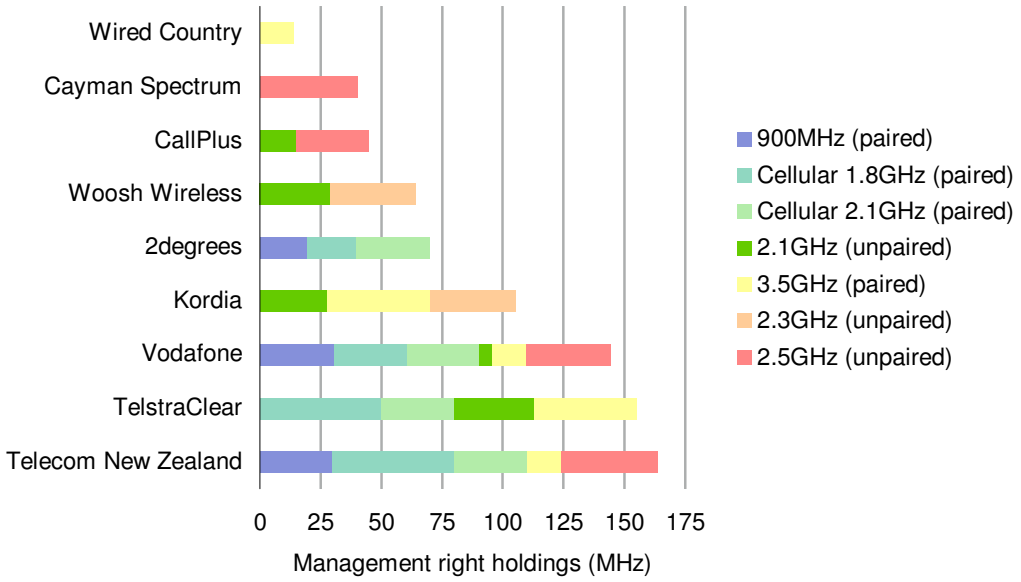


***Exhibit 2.2:*** *Existing allocation of broadband wireless spectrum [Source: Network Strategies]*

Telecom, Vodafone and 2degrees have utilised existing paired spectrum allocations in the 2.1GHz cellular band to provide broadband wireless access. More recently UMTS standards have supported 3G systems in the 900MHz band and this has been adopted by both Telecom and Vodafone.

Note that some of the existing holdings are not currently utilised. This does not of course imply that they will remain unutilised in the future. However it does imply that unused broadband wireless spectrum is currently available for purchase via spectrum trading. If it is not the case that particular applications require spectrum in the 700MHz band then alternatives exist which may potentially be acquired at lower cost than the premium digital dividend spectrum. Such alternatives may be appropriate for emergency services (discussed further in Section 2.5).

The MED commissioned a report[30] in 2010 to assess the applicability of overseas studies of the economic benefit of allocating digital dividend spectrum to other uses. Universally these studies predicted substantial net economic gains would accrue should the spectrum be allocated for mobile broadband services. The estimated gains far outweighed the gains from use of the spectrum for broadcasting purposes. The MED report concluded that the methodologies employed in these studies were appropriate to the New Zealand market and scaled overseas benchmark results by GDP to estimate New Zealand net economic benefits in the range of NZD1.1–2.4 billion.

## 2.5 Using the digital dividend for emergency services

Emergency service organisations in New Zealand and elsewhere have indicated an interest in obtaining spectrum for the dedicated use by Public Protection and Disaster Relief (PPDR) services. There have been suggestions that a portion of the digital dividend spectrum be set aside for this purpose.

We note that to date there is little evidence of global – or regional – harmonisation of PPDR services in the 700MHz band. There would clearly be strong arguments in favour of New Zealand harmonising PPDR spectrum with that in Australia and elsewhere in the Asia-Pacific region, but as we see below this is unlikely to utilise the 700MHz band

*Australia*

While a number of emergency service organisations were seeking an allocation of spectrum from the 700MHz digital dividend band, more recent discussions between government and those organisations have been focussed on the 800MHz band. Such an allocation is seen as being more consistent with developments in the Asia-Pacific region,

30 Venture Consulting (2010) *A review of the applicability to NZ of international digital dividend cost and benefits* studies, report for MED, 29 June 2010. Available at http://www.rsm.govt.nz/cms/pdf-library/policy-and-planning/digital-futures-planning-for-digital-tv-and-new-uses/Review%20of%20Applicability%20of%20Overseas%20Studies%20on%20Costs%20and%20Benefits%20of%20Digital%20Dividend.pdf.

where 806–824MHz and 851–869MHz was designated as one of the options for PPDR services.

A Public Safety Mobile Broadband Steering Committee has been convened, and is due to report to government by the end of February 2012. The objective of the steering committee is to:

- report on the most effective and efficient way for Australia's public safety agencies to obtain a reliable and robust mobile broadband capability that meets operational requirements and the potential for allocation of radio-frequency in this regard
- work with the ACMA as part of its review of the 800MHz band, to identify a suitable amount of spectrum necessary to meet foreseeable operational needs.[31]

*United States*

The 2007 auction of 700MHz spectrum saw D Block – a single national licence for 2 × 5MHz, with conditions requiring a public/private partnership to create a public safety broadband network – attract only a single bid of USD472 million (NZD711 million), significantly short of the USD1.33 billion (NZD2 billion) reserve price. The block thus was unsold.

The FCC's objective for the D Block licensee was to create a public/private partnership for a nationwide interoperable broadband network for state and local public safety users, which would be shared with commercial users. The D Block licence would be awarded to the winning bidder only after it entered into an FCC-approved network sharing agreement with the public safety broadband licensee.

Reserve prices for all spectrum blocks were published prior to the auction and were based on the auction prices for Advanced Wireless Services in the 1710–1755MHz and 2110–2155MHz bands ('AWS-1'). For D Block, a discount of just under 25% was applied to the benchmark reserve price, to compensate for the rules and obligations imposed upon the

31 Attorney-General's Department (2011) *Public Safety Mobile Broadband Steering Committee Terms of Reference*, 1 July 2011.

D Block licensee. The FCC considered that these estimated values were conservative, due to the more desirable characteristics of the 700MHz band as compared with AWS-1.

In a subsequent investigation by the FCC[32], a number of factors were identified which created huge risk for the commercial operator, and ultimately deterred potential bidders:

- uncertainty over the technical specifications of the public safety broadband system and thus the level of funding requirements
- quality of service for the public safety network was considered to be much higher than that required for commercial use, which would increase costs
- the priority access regime for public safety users – whereby the commercial operator would have access to the network on a pre-emptible basis – diminished the commercial value of the network
- the network footprint would need to be extensive, in order to reach all public safety users
- revenues were uncertain as there was no requirement nor guarantee that public safety users would subscribe to the network
- the high risks involved if the successful bidder was unable to negotiate a satisfactory network sharing agreement with the public safety broadband licensee – due to the bid default penalties that could be imposed on the winning bidder, the public safety broadband licensee had far greater leverage in negotiation proceedings. There may also have been a perception that the needs of public safety would receive preferential treatment in arbitration proceedings.

Some four years after its failure to be sold at auction the future of D Block remains uncertain.

In June 2011 legislation aiming to resolve issues relating to public safety spectrum was approved by the Senate Commerce Committee and a bill will be put to the US Senate. A key element of the proposed *Public Safety Spectrum and Wireless Innovation Act* is the establishment of a non-profit Public Safety Broadband Corporation, which would be given the 700MHz D Block, and deploy and operate the network on behalf of public safety users.

32 Federal Communications Commission (2008) *D Block Investigation*, 25 April 2008.

In the meantime, the FCC had received petitions from a number of public safety organisations for waiver of the FCC's rules to allow the deployment of broadband networks in the 700MHz public safety spectrum allocation. Conditional waivers were granted, however to ensure a common technology platform for a national public safety network and to enable interoperability between the various organisations, the FCC has proposed various technical rules, and specified a common air interface – namely LTE. [33]

It should be noted that the FCC has also allocated the 4.9GHz band for public safety broadband services.

## 2.6 Conclusions

Although it appears that policy objectives for the allocation of digital dividend spectrum in New Zealand are yet to be finalised, it is clear that the outcome must work in the long-term interest of end-users. As such the MED is considering objectives that include economic and technical efficiency, rapid deployment, wide coverage and encouragement of competition. The MED has also indicated that social considerations may also be important, such as the potential use of digital dividend spectrum for emergency services and for extending rural mobile broadband services.

Given this importance of these social considerations, relying solely on market mechanisms may not produce an optimal outcome for New Zealand unless appropriate controls are implemented. In particular, outcomes driven only by the business decisions of operators may not be consistent with consumer and public interest. It will therefore be essential to undertake a detailed analysis of potential options for allocation using a total welfare standard which captures wider costs and benefits than a consumer standard alone.

A number of overseas jurisdictions have engaged in such detailed analysis, providing valuable information in this respect for New Zealand. Key findings include:

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33 Federal Communications Commission (2011) *Third Report and Order and Fourth Further Notice of Proposed Rulemaking*, FCC 11-6. 26 January 2011.

- regulatory intervention and safeguards are required to ensure service availability in rural areas – otherwise operators will focus on urban locations while rural areas will receive less access and coverage
- competition assessments are a key means of establishing the market implications of possible award outcomes
- mobile broadband is the highest value use for digital dividend spectrum, and alternative spectrum offerings should be explored for other applications
  - in New Zealand significant quantities of broadband wireless spectrum have already been allocated, providing options for applications that do not necessarily require the digital dividend spectrum, such as emergency services.

# 3 Options for packaging the spectrum

## 3.1 Background

Radiofrequency spectrum has traditionally been allocated in New Zealand in the form of management rights issued by the Crown. Management rights confer the ability to utilise a specified range of frequencies for a fixed period of time (usually 20 years). The holder of a spectrum management right enjoys a certainty of tenure similar to that of a property owner. For example a spectrum management right may be used as financial security (mortgaged).

Traditionally spectrum management rights have been issued with the following characteristics:

- complete technology neutrality
- nationwide allocation
- no 'use it or lose it' requirements.

*Technology neutrality*

All existing spectrum management rights have been issued with complete technology neutrality. There is no requirement to utilise any specific technology within the management right.

This policy has resulted in two major conflicts between:

- Broadcast Communications Limited (BCL) and Woosh Wireless in 2003

- BellSouth New Zealand and Telecom New Zealand in 1994.

The latter conflict re-occurred in 2008 when Telecom and Vodafone (which had purchased the BellSouth network) became embroiled in a dispute over the Telecom's XT network upgrade. Both disputes were settled out of court with the conflicted operators mutually agreeing to implement guard bands and radio frequency filters.

Although the number of disputes has been small it is significant to note that a number of nationwide network deployments[34] have become involved in an interference dispute.

*Nationwide allocation*

All existing spectrum management rights have been issued on an all of New Zealand basis.

*Spectrum utilisation*

There is no requirement to deploy a service within any timeframe once a management right has been acquired[35]. Therefore spectrum can be acquired and not used providing the buyer is prepared to pay the cost of capital. This enables operators to acquire excess spectrum to prevent competition.

## 3.2 Technological issues

There are two prospective modes of fourth generation (4G) technology currently available for deployment within the digital dividend band: Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD).

34 Using the metric of more than 100 sites to identify a nationwide network.

35 Some of the 2.5GHz spectrum management rights do have a review clause at five years into the 20 year management right, however there are no coverage goals specified.

FDD is the scheme used by most current (and previous) mobile technologies. It uses separate blocks of spectrum for the uplink (from mobile to base station) and the downlink (from the base station to the mobile). As the blocks are the same size, FDD is suited to symmetric traffic such as voice. FDD transmits continuously in each direction (unlike with TDD) and this requires separate transmitter and receiver equipment at each end of the link, increasing the cost over having shared transmitter and receiver equipment. The main benefits of FDD are that it provides an upgrade path for existing mobile operators, allows for easier integration with existing mobile (FDD) handsets and most existing spectrum is parcelled to suit FDD technologies.

TDD is a more recent scheme that uses a single block of spectrum. The uplink and the downlink are implemented using separate timeslots on that single block. Since the time slots do not have to be allocated equally between the uplink and downlink, TDD supports asymmetric traffic loads (such as broadband) more efficiently than FDD. It further increases spectrum efficiency by removing the need for a guard band between the uplink and downlink channels[36]. While equipment is more complex[37], as only one transmitter is active at a time some of the transmitter and receiver equipment can be combined which may reduce costs. Disadvantages of TDD are the interference issues between sites and with other frequency bands[38], requiring more complex network planning than FDD systems.

LTE supports both FDD and TDD modes of operation but future deployments are likely to be primarily FDD. WiMAX uses TDD, and is likely to support either FDD or TDD in the future[39].

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36 Although a guard band is not required, TDD does require a guard period between the transmission and receiving time slots, which will reduce the effective efficiency of the band.

37 Embrace (2002), Time division duplex – flexible and efficient for millimetre broadband access systems, International Workshop on broadband fixed wireless access. Available at http://www.telenor.no/fou/prosjekter/embrace/Workshop/ole2.pdf.

38 Airspan (2007) *Coexistence of TDD and FDD wireless access systems in the 3.5GHz band*, white paper.

39 LTE manufacturers are developing TDD versions of LTE to make use of existing unpaired and thus otherwise unusable spectrum; WiMAX manufacturers are developing FDD versions of WiMAX to make use of the current mobile spectrum allocations and thus allow it to compete better with LTE.

## 3.3 International harmonisation

One of the considerations for packaging the spectrum is to maximise harmonisation with other countries and regions. Global or regional harmonisation has a number of advantages:[40]

- economies of scale for both handsets and network equipment
- better interoperability of terminals and equipment globally or within the region (in particular, facilitating subscriber roaming)
- higher chances of technology success and widespread adoption.

Many mobile spectrum bands have not been globally harmonised, particularly between ITU-R Region 1 (Europe, Africa and the Middle East) and Region 2 (the Americas). This lack of harmonisation has created incompatible technologies and caused roaming difficulties since the inception of mobile services. Examples of bands not globally harmonised include:

- 900MHz for GSM in Europe and 800MHz (850MHz) in North America
- 1800MHz for DCS (later GSM1800) in Europe and 1900MHz for PCS (later GSM1900) in North America
- 2.1GHz for UMTS in Europe
- the digital dividend spectrum (Exhibit 3.1).

40 Arya, V.K. (2007) *Where WiMAX Fits – Mobile WiMAX at Various Bands*, conference paper at the International Conference on WiMAX – Technology for Mobile Broadband & Mobile VoIP Services, 10 January 2007, available at http://www.assocham.org/events/recent/event_136/_v.k.arya.ppt.

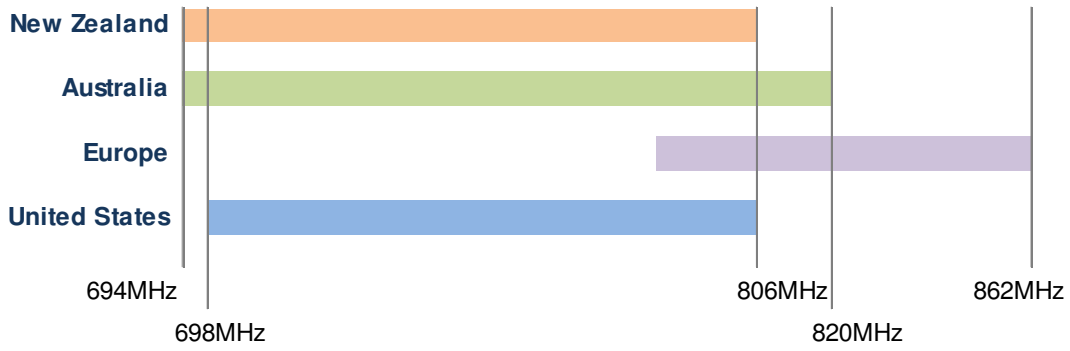


***Exhibit 3.1:*** *Digital dividend spectrum bands in selected countries [Source: MED, ACMA]*

Given that global harmonisation for the digital dividend clearly is not possible, the next best option would be to implement some level of regional harmonisation. In terms of ITU Region 3 (Asia-Pacific and parts of the Middle East), the Asia-Pacific Telecommunity Wireless Group (AWG) has established two harmonised arrangements: one for paired and the other for unpaired configurations, providing options for either FDD or TDD technology (Exhibit 3.3).

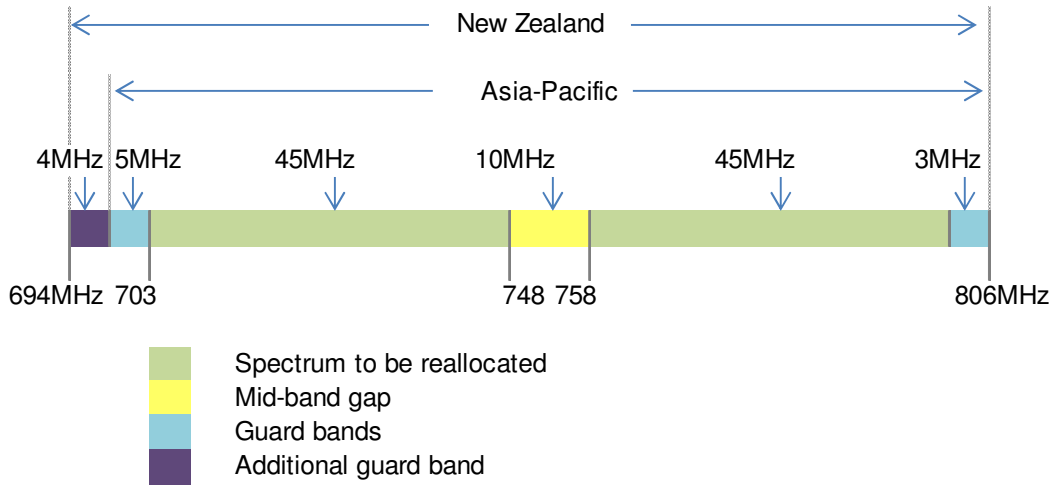


***Exhibit 3.2:*** *Harmonised Asia-Pacific digital dividend FDD band plan [Source: APT AWG]*

At this time few countries within the Asia-Pacific region have announced implementation plans for the reallocation of the digital dividend spectrum. In most of the region analogue switchover will be considerably later than in Europe and North America, and thus any decisions regarding the reallocation of the spectrum are likely to be some years away. For example, ASEAN member states have agreed to a phased switchover over the period 2015 to 2020.

Japan became the first Asian nation to undertake switchover, with all prefectures (except those affected by the March 2011 earthquake and tsunami) switching over to digital-only broadcasts on 24 July 2011. The three remaining prefectures will undergo switchover in March 2012. It is anticipated that the reallocation of the 700MHz band will commence in 2015.[41]

## 3.4 How are other countries packaging digital dividend spectrum?

The digital dividend spectrum has been packaged differently in various countries – clearly individual circumstances and market conditions would influence the structure of the licence offering.

Below is a profile of the digital dividend across a range of countries. While we note that the lack of global harmonisation means that the digital dividend band differs across these countries, the packaging and licence conditions provide useful insights into various approaches for optimising the long term benefits for end-users, including promoting competition, setting coverage targets and encouraging rural deployment.

41 Ministry of Internal Affairs and Communications (2010) *Action plan for frequency reorganization toward realizing wireless broadband*, Working Group on Discussion of Frequencies needed to realize Wireless Broadband Services report, 30 November 2010.

*Australia*

In May 2011 the Australian Communications and Media Authority (ACMA) released draft recommendations for spectrum allocation of both the 700MHz and 2.5GHz bands[42]. Following a consultation process (that concluded in July 2011) the ACMA will be preparing final versions of its recommendations to the minister under Section 153E of the *Radiocommunications Act 1992*. The final recommendations have not yet been publicly released.

In its draft recommendations, the ACMA proposed that the frequency boundaries for the digital dividend spectrum align with the AWG's harmonised band arrangements for FDD, namely two 45MHz blocks at 703–748MHz and 758–803MHz (Exhibit 3.3).

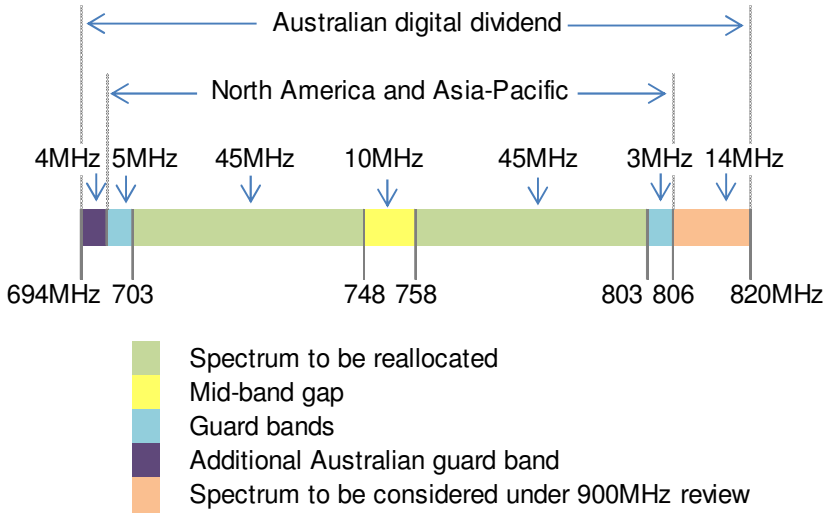


***Exhibit 3.3:*** *Proposed 700MHz band reallocation, Australia [Source: ACMA]*

The ACMA does not propose to allocate the following blocks within the current spectrum reallocation process:

- mid-band gap (748–758MHz)

42 Australian Communication and Media Authority (2011) *Draft spectrum reallocation recommendations for the 700 MHz digital dividend and 2.5 GHz bands*, information paper, May 2011.

- guard bands (694–703MHz and 803–806MHz)
- extension band (806–820MHz).

The ACMA noted that implementation of the AWG paired band plan allows for an additional guard band at the lower frequency boundary, which will further reduce the risk of interference with broadcasting services. The extension band is likely to be allocated separately from the digital dividend at some future time, and may be included in the 900MHz (820–960MHz) band plan review. No information on the ACMA's plans for the 700MHz mid-band gap is available.

The ACMA proposes a national allocation of the digital dividend spectrum, excluding the Mid West Radio Quiet Zone (RQZ)[43], as this is perceived to "facilitate the most efficient allocation and use of the spectrum"[44] given the likely demand for bidders for spectrum.

> …it is most likely that LTE mobile services will be deployed in the reallocated 700 MHz band.
>
> The higher efficiency of LTE networks means that it is likely that carriers will roll out the technology wherever they have existing base-station sites in remote and rural areas, delivering better services to areas that already have mobile coverage. Submissions to the discussion paper from members of the telecommunications industry expressed their intention to deliver LTE FDD broadband services across Australia. Carriers have indicated they intend to replicate the coverage of current networks and roll out additional coverage where people work, live or travel.
>
> Given stakeholder preferences for a national allocation, the lower amount of spectrum available in this band (compared to 2.5 GHz) and the optimal bandwidth of 2 × 20 MHz for

43 The RQZ is an area of Western Australia with very low levels of radiofrequency energy due to low population and remoteness, and is the location for the use and development of radioastronomy technologies. There is an embargo on the issuing of new apparatus licences in the RQZ, and spectrum licences will also be subject to licence conditions designed to prevent interference to radioastronomy services within the RQZ.

44 *Ibid*, p9.

> LTE, there are no strong arguments in favour of offering lower amounts of spectrum in regional and remote areas, or excising these areas from the reallocation process.[45]

The ACMA proposed a reallocation period from 2 November 2011 until 31 December 2014. Under section 153B(4) of the *Radiocommunications Act 1992* the reallocation period must begin within 28 days of the minister's declaration of the spectrum reallocation and must run for at least two years. In addition, the ACMA must allocate at least one licence prior to the reallocation deadline (proposed to be 31 December 2013), otherwise the minister's declaration will be taken as revoked. Note that the minister has 180 days to consider a recommendation from the ACMA and decide whether to make a spectrum reallocation declaration.

If the Minister declares the 700MHz and 2.5GHz bands for reallocation, the ACMA intends to conduct an auction for both bands at the same time. The auction is proposed for late 2012, however ACMA noted that an unforeseen delay to one band will not delay the auction for the other band.[46] At this stage, a band plan has not yet been released.

The ACMA estimates that 930MHz of spectrum suitable for mobile broadband will be required by 2014 to meet the anticipated demand. The reallocation of the 700MHz and 2.5GHz spectrum bands will partially address the additional demand, however there will still be a spectrum shortfall of 130-150MHz, and an additional 150MHz by 2020.[47]

The ACMA's projected spectrum demand is considerably lower than that of the ITU[48], which estimated a potential shortfall in Australia of 900MHz by 2014 and up to 1340MHz by 2020. The ACMA believes that this ITU forecast is unnecessary and unsustainable, and notes that it would be difficult to make this amount of spectrum available given that it is heavily utilised. Key differences in the assumptions include:

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45 *Ibid*, p8.

46 Giles Tanner (2011), *Digital dividend update*, ACMA presentation at RadComms2011 conference, 26–27 May 2011.

47 Australian Communications and Media Authority (2011) *Towards 2020 – Future spectrum requirements for mobile broadband*, May 2011.

48 ITU (2006) *Estimated spectrum bandwidth requirements for the future development of IMT-2000 and IMT-Advanced*, report ITU-R M.2078.

- the ACMA analysis assumed increases in spectral efficiency (to 15bits/Hz) and infrastructure (smaller cells)
- ITU estimates do not assume migration from one technology to another.[49]

Other than the 700MHz and 2.5GHz bands, the ACMA has identified a number of potential candidate bands for mobile broadband (Exhibit 3.4).

| *Frequency range* | *Duplex method* | *Available bandwidth* | *Current use* |
|---|---|---|---|
| 450–470MHz | FDD | 20MHz | Land mobile |
| 815–825MHz and 860–870MHz | FDD | 20MHz (2 x 10MHz) | Fixed / Mobile |
| 1427.9–1462.9MHz and 1475.9–1510.9MHz | FDD | 70MHz (2 x 35MHz) | Fixed / Mobile / Broadcast satellite |
| 1518–1559MHz and 1610–1660.5MHz | FDD | DL: 41MHz UL: 50.5MHz | Mobile satellite service |
| 1668–1675MHz | TDD | 7MHz | Mobile satellite service |
| 1675–1710MHz | TDD | 35MHz | Meteorological satellite service |
| 1980–2010MHz and 2170–2200MHz | FDD | 60MHz (2 x 30MHz) | Mobile satellite service |
| 2483.5–2500MHz | TDD | 16.5MHz | Mobile satellite service |
| 3300–3400MHz | TDD / FDD | 100MHz | Radiolocation |
| 3400–3425MHz | TDD / FDD | 25MHz | Fixed / Radiolocation |
| 3492.5–3542.5MHz | TDD / FDD | 50MHz | Fixed / Radiolocation |
| 3575–3600MHz | TDD / FDD | 25MHz | Fixed / Radiolocation |
| 3600–3800MHz | TDD / FDD | 200MHz | Fixed / Fixed satellite service |
| 3800–4200MHz | TDD / FDD | 400MHz | Fixed / Fixed satellite service |

***Exhibit 3.4:*** *Bands identified by ITU-R, 3GPP and IEEE standards bodies for possible IMT services [Source: ACMA]*

The ACMA is also considering various bands above 4.2GHz for future mobile broadband applications, with the primary benefit perceived to be in support of the deployment of

49 *Ibid*, p32.

femtocell-like infrastructure with the potential of increasing spectral efficiency by offloading capacity from macro network environments to personal networks.[50]

A public consultation process regarding spectrum options for mobile broadband – including the use of the identified candidate bands – concluded in July 2011.

The market share information of the three mobile operators in Australia is provided below (Exhibit 3.6).

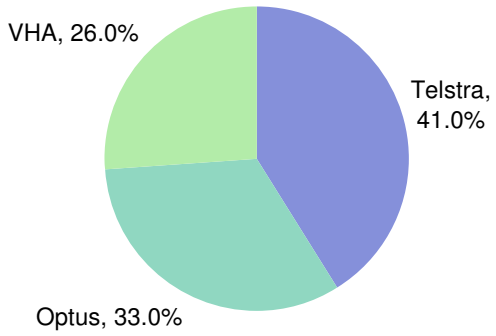


***Exhibit 3.5:*** *Australian mobile operator market share, June 2010 [Source: ACMA]*

*Canada*

In November 2010, Industry Canada (the spectrum management authority) released a consultation paper[51] discussing a framework for the release of 700MHz (698–806MHz, as

50 *Ibid*, p52.

51 Industry Canada (2010) *Consultation on a policy and technical framework for the 700 MHz band and aspects related to commercial mobile spectrum*, 30 November 2010.

in the United States) spectrum for commercial mobile services. The spectrum will be auctioned by late 2012.[52]

The consultation paper discussed four options for the band plan:

- harmonisation with the US band plan
- US band plan with slight adjustments – 8 and 10MHz channel blocks in the lower 700MHz band
- US band plan with slight adjustments – a mix of 3MHz and 5MHz channel blocks in the lower 700MHz band
- harmonise with the APT AWG band plan (Section 3.3).

Industry Canada noted that the US band plan is inefficient in terms of spectrum utilisation:

> In the United States, portions of the Lower 700 MHz band have been auctioned while broadcasting undertakings using 6 MHz channel widths were still in operation in other parts of the band. As a result, the Lower 700 MHz band (and, to some extent, the Upper 700 MHz band) was structured around a 6 MHz channel grid. Although the 6 MHz channel grid ensured compatibility with the previous broadcasting use of the band, the new broadband mobile technologies being deployed in this band are based on 5 MHz channel widths. …Over the entire 700 MHz band, as much as 12 MHz of spectrum would not be used effectively by new broadband technologies.[53]

No decision on the band plan has yet been announced, however stakeholders indicated a preference for the US band plan.

In terms of geographic area for the licences, Industry Canada has defined four categories of "service areas":

- Tier 1 – national

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52 Industry Canada (2010) *Minister Clement updates Canadians on Canada's Digital Strategy*, news release, 22 November 2010.

53 Industry Canada (2010) *Consultation on a policy and technical framework for the 700 MHz band and aspects related to commercial mobile spectrum*, 30 November 2010.

- Tier 2 – 14 service areas, eight with provincial/territorial boundaries and six across the two provinces of Ontario and Quebec
- Tier 3 – 59 smaller regional areas
- Tier 4 – 172 localised service areas.

The size of the licence service areas for 700MHz has not yet been announced, however Tiers 1 and 2 are typically used for mobile services, while Tiers 3 and 4 are used for fixed line licence areas.

The Canadian mobile market has three strong national players (Rogers Wireless, Bell Group and TELUS), a new entrant (Wind Telecom, backed by the Egyptian operator Orascom Telecom) and a number of strong regional players (including MTS Allstream and SaskTel Mobility) which may not necessarily seek national coverage (Exhibit 3.6). It is therefore likely that licences will be based on sub-national service areas.

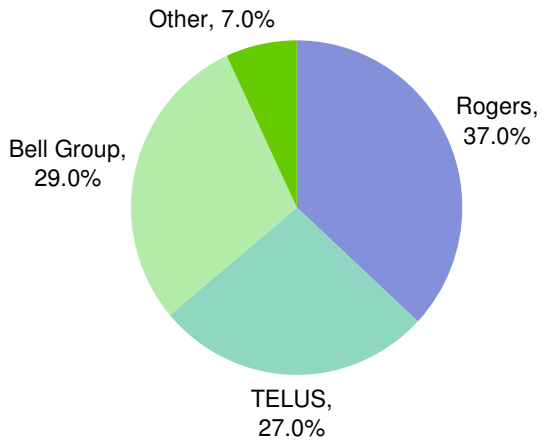


***Exhibit 3.6:*** *Canadian mobile operator market share, 2010 [Source: Canadian Radio-television and Telecommun-ications Commission]*

No decision has yet been announced regarding initiatives to encourage competition. In the 2007 Advanced Wireless Services (AWS) auction, some spectrum was set aside for new entrants.

Industry Canada is also examining whether any initiatives to promote deployment of broadband services in rural areas should be implemented within the licence conditions. It is noted that almost all Canadians have access to broadband services – 98% of the population is within a coverage area for 1.5Mbit/s broadband – either fixed or mobile (HSPA+) – and 97% of the population is within a mobile broadband coverage area.[54]

*France*

The French spectrum manager, ARCEP, is currently seeking bids from interested parties for 800MHz (digital dividend) and 2.6GHz spectrum licences. Bids close on 15 September 2011 for the 2.6GHz band, and 15 December 2011 for the 800MHz band. Licences are for a 20-year period.

The digital dividend band plan in France differs from that in the other European countries we have examined. Within the 800MHz band, four blocks are on offer – two 2 × 10MHz and two 2 × 5MHz – using FDD (Exhibit 3.7).[55] Bidders may submit an offer for lots of one or two blocks, up to a maximum of 2 × 15MHz. If a bidder is submitting an offer for a lot of two blocks, then offers for the single blocks must also be submitted.

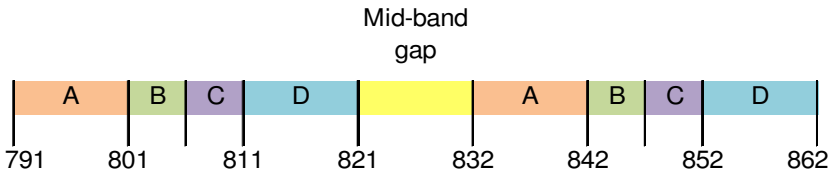


***Exhibit 3.7:*** *Band plan for 800MHz, France [Source: ARCEP]*

Reserve prices for each block and allowable block pairs have been set (Exhibit 3.8). Note also that bidders with commitments to host MVNOs will receive a higher rating when their bids are being assessed.

54 Canadian Radio-Television and Telecommunications Commission (2011) *Communications monitoring report*, July 2011.

55 ARCEP (2011) *Décision proposant au ministre chargé des communications électroniques les modalités et les conditions d'attribution d'autorisations d'utilisation de fréquences dans la bande 800 MHz en France métropolitaine pour établir et exploiter un réseau radioélectrique mobile ouvert au public*, May 2011.

| *Lot* | *Reserve price (EUR, millions)* | *Reserve price (NZD, millions)* |
|---|---|---|
| A | 400 | 684 |
| B | 300 | 513 |
| C | 300 | 513 |
| D | 800 | 1 368 |
| B + C | 600 | 1 026 |
| A + B | 700 | 1 197 |
| A + C | 700 | 1 197 |
| B + D | 1100 | 1 880 |
| C + D | 1100 | 1 880 |

***Exhibit 3.8:***
*Reserve prices for each block in the spectrum auction for 800MHz, France [Source: ARCEP]*

Coverage and rollout obligations will apply to all winning bidders. Coverage is defined as access to a high speed mobile connection with a theoretical downlink maximum of 60Mbit/s if the licensee has at least 10MHz of paired spectrum, and at least 30Mbit/s if the licensee has at least 2 × 5MHz. Access to high speed mobile must also be available all day, at a minimum of 95% of outdoor connection attempts. Twelve years after the issuance of the licence, coverage must be available to 98% of the population, and after 15 years, coverage of 99.6% of the population, as well as coverage of highways, main roads and road sections with traffic of at least 5000 vehicles per day. Furthermore, a minimum of 90% of the population in each French department[56]

ARCEP has also specified a list of priority areas for deployment. Five years after licence issue, coverage must be available to 40% of the population within those priority areas, and after ten years, coverage is required of 90% of that population.

If a licensee holds a lot of two blocks, then there is an obligation for granting reasonable requests for roaming in the priority deployment areas.

56 There are 101 French departments, or administrative divisions, including five overseas departments. The 800MHz spectrum licences apply only to metropolitan France (that is, France excluding the overseas departments).

*Germany*

The first European auction of digital dividend spectrum was held in Germany and concluded in May 2010. As well as the 800MHz band, the auction also offered rights to the 1800MHz, 2.0GHz and 2.6GHz bands, with expiry at the end of 2025 (15 years).

Within the 800MHz band, six lots of 2 × 5MHz were offered, with the three successful bidders – the mobile operators Deutsche Telekom, Vodafone and Telefónica O2 – each awarded two lots (Exhibit 3.9). A fourth operator – E-Plus, a subsidiary of the Dutch incumbent operator KPN – failed to win any 800MHz spectrum, although it did win lots in the other spectrum bands.

| *Block* | *Licensee* | *Winning bid (EUR, millions)* | *Winning bid (NZD, millions)* |
|---|---|---|---|
| A | Telefónica O2 | 616.6 | 1 140.8 |
| B | Telefónica O2 | 595.8 | 1 102.3 |
| C | Deutsche Telekom | 570.8 | 1 056.1 |
| D | Deutsche Telekom | 582.9 | 1 078.4 |
| E | Vodafone | 583.0 | 1 078.6 |
| F | Vodafone | 627.3 | 1 160.6 |

***Exhibit 3.9:*** *Results of the German auction for the 800MHz band [Source: Federal Network Agency]*

The 800MHz band was also subject to a spectrum cap, whereby bidding rights were restricted to a maximum of 2 × 20MHz, and that existing spectrum holdings in the 900MHz band counted towards this limit.[57] Effectively, this meant that Vodafone and Deutsche Telekom could only bid for two lots, O2 and E-Plus could bid for three lots and new entrants could bid for four lots.

Separate coverage obligations were imposed for the different spectrum bands:

57 Federal Network Agency (2009) *Decisions of the President's Chamber of the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway of 12 October 2009 on combining the award of spectrum in the bands 790 to 862 MHz, 1710 to 1725 MHz and 1805 to 1820 MHz with proceedings to award spectrum in the bands 1.8 GHz, 2 GHz and 2.6 GHz for wireless access for the provision of telecommunications services (Decision of the President's Chamber of 7 April 2008, reference: BK1-07/003 on the order for and choice of award proceedings and on the determinations and rules) and on the determinations and rules for conduct of the proceedings to award spectrum in the bands 800 MHz, 1.8 GHz, 2 GHz and 2.6 GHz for wireless access for the provision of telecommunications services (auction rules); Decisions taken under sections 55(9), 61 subsections (1), (2), (4) and (5), 132 subsections (1) and (3) TKG*, 12 October 2009.

- 1.8GHz, 2.0GHz and 2.6GHz – minimum coverage of 25% of the population by 1 January 2014 and at least 50% of the population by 1 January 2016
- 800MHz – in every federal state coverage as from 1 January 2016 of at least 90% of the population in towns and districts specified by the individual federal states, as well as 50% of the national population.

A rollout strategy for 800MHz coverage was also specified via designated priority stages:

- priority stage 1 – towns and districts specified by the federal states with population of not more than 5000
- priority stage 2 – towns and districts specified by the federal states with population of between 5000 and 20 000
- priority stage 3 – towns and districts specified by the federal states with population of between 20 000 and 50 000
- priority stage 4 – towns and districts specified by the federal states with population of more than 50 000.

Rollout within a priority stage can only begin once rollout in the preceding priority stage has covered 90% of the specified population (priority stage 1 is the first to be addressed by the rollout schedule). Annual progress reports on the rollout are required by the Federal Network Agency.

Exhibit 3.10 illustrates market shares of the four mobile operators in Germany. Note that the unsuccessful bidder in the 2010 auction was not the smallest operator by market share.

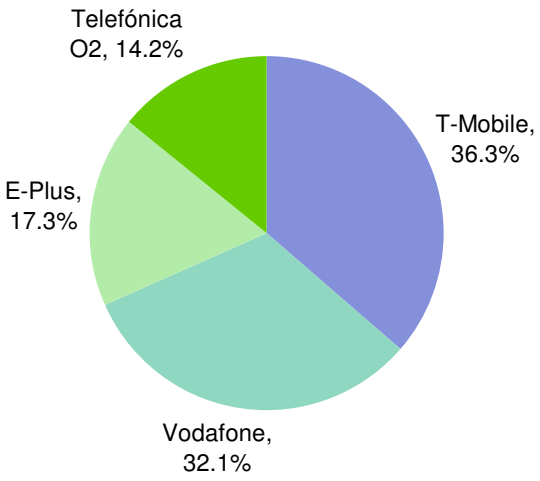


***Exhibit 3.10:*** *German mobile operator market share, September 2009 [Source: Federal Network Agency]*

*Ireland*

The Irish regulator (ComReg) will be conducting an auction for 800MHz, 900MHz and 1800MHz, which is expected to be held by February 2012. Conditions for the licensees are specified in ComReg's recently released draft decision.[58]

It is proposed that the 800MHz (791–821MHz and 832–862MHz) band will be assigned in FDD duplex mode and offered as six lots of 2 × 5MHz.

There will be two "temporal lots", or time slices, for the auction, the first running from 1 February 2013 to 12 July 2015 and the second from 13 July 2015 to 12 July 2030. This will enable alignment of licence expiry dates. Reserve prices and annual spectrum usage fees (SUFs) have been proposed (Exhibit 3.11). Note that the SUFs will be adjusted by inflation.

58 Commission for Communications Regulation (2011) *Multi-band spectrum release: release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands*, Document No 11/60, 24 August 2011.

| | *EUR* | *NZD* |
|---|---|---|
| *Temporal lot 1* | | |
| Reserve price | 3.34 million | 5.82 million |
| Spectrum usage fee | 1.21 million | 2.11 million |
| *Temporal lot 2* | | |
| Reserve price | 8.48 million | 14.76 million |
| Spectrum usage fee | 1.21 million | 2.11 million |

***Exhibit 3.11:*** *Reserve prices and annual spectrum usage fees for 800MHz and 900MHz [Source: ComReg]*

Spectrum caps will be imposed on bidders, either as single entities or in combination with other bidders, namely:

- 2 × 20MHz of sub-1GHz spectrum
- 2 × 50MHz of total spectrum
- 2 × 10MHz of 900MHz spectrum in Temporal Lot 1 only.

Any unsold spectrum will not be assigned for at least two years after the auction. According to ComReg's consultants, DotEcon:

> This is to avoid providing a negative incentive to bidders to "wait and see", that is, strategically withhold demand during the auction in the hope of being allocated this spectrum on the same terms as those offered in the auction in a follow-up process.[59]

While licences will be technology- and service-neutral, ComReg proposes that licensees provide six months' notice of any intention to terminate the provision of services using one technology, and replacing with another technology.

ComReg decided against imposing minimum broadband speeds for licence holders:

> ComReg is of the view that imposing minimum broadband speeds could prevent operators from offering a low cost, low speed option and could therefore lead to a reduced choice for

59 DotEcon (2011) *Issues relating to the award of spectrum in multiple bands in Ireland*, report for ComReg, 24 August 2011.

consumers. This would particularly affect those consumers for whom speed is not a priority. Therefore, ComReg has not pursued this proposal any further.[60]

It is proposed that all licence holders must achieve minimum coverage targets of 70% of the population, of which at least half must be met using the 800MHz, 900MHz or 1800MHz bands. This is to be achieved within three years for an operator with an existing mobile network, or seven years for a new entrant (for whom there will also be an interim target of half the coverage threshold after three years). ComReg noted that the 70% threshold is equivalent to the five major cities in Ireland, plus every town with over 50 inhabited houses.

ComReg considered that the 70% threshold could represent a risk of rollback from the existing mobile coverage, however the likelihood of this occurring is believed to be low:

- coverage is an important differentiator within the market, and thus any attempt to reduce coverage of voice services is likely to create opportunities for competitors to win market share
- coverage obligations of the 3G licences (and the additional coverage actually achieved) drive the voice coverage levels.

Coverage via national roaming agreements is explicitly excluded from the coverage and rollout obligations.

Market shares of the four mobile operators are shown in Exhibit 3.12.

60 Commission for Communications Regulation (2011) *Multi-band spectrum release: release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands*, Document No 11/60, 24 August 2011.

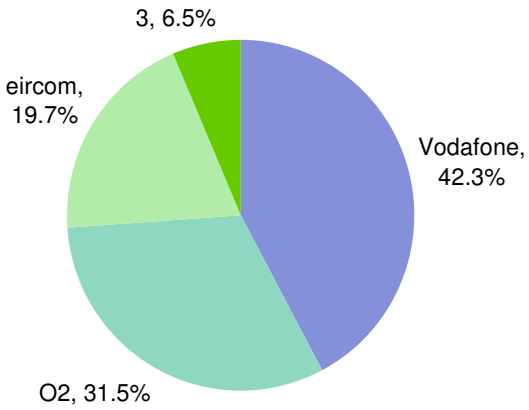


***Exhibit 3.12:*** *Irish mobile operator market share, March 2011 [Source: ComReg]*

*The Netherlands*

A spectrum auction for the 800MHz (791–862MHz, digital dividend), 900MHz and 1.8GHz bands is expected to be conducted by early 2012. The Dutch Ministry of Economic Affairs envisages that the joint auction will enable operators to obtain an optimal combination of mobile frequency bands.[61]

The Ministry also seeks to encourage new mobile entrants[62], and is thus planning to reserve 2 × 10MHz (two lots of 2 × 5MHz) of the digital dividend band for newcomers. The only applicants anticipated by the Ministry[63] are Ziggo 4 (a joint venture between the Dutch cable operator Ziggo and UPC, which is aiming to offer LTE services in 2012) and Tele2 (majority owned by the Swedish operator Tele2); both companies already hold 2.6MHz

61 Ministry of Economic Affairs, Agriculture and Innovation (2010) *Strategische nota mobiele communicatie*, December 2010.

62 There are currently three mobile network operators in the Netherlands: KPN (the incumbent operator), Vodafone and T-Mobile.

63 Ministry of Economic Affairs, Agriculture and Innovation (2010) *Strategische nota mobiele communicatie en beschikbaar stellen 800 MHz band voor mobiel breedband*, 10 December 2010.

spectrum licences, awarded in the 2010 auction. While there will be no national rollout obligation for the newcomers, a coverage target is likely to be set – the original target of 15% after five years (3080km$^2$ / 5MHz[64]) may be increased to 40%.

Spectrum caps have not been proposed, as the Ministry believes that the market mechanism of the auction will achieve an efficient outcome. The spectrum must however be used to offer a commercial service.

Final terms and conditions of the spectrum licences are expected to be released soon.

Market share of the three mobile operators is presented below (Exhibit 3.13). Note that the other category includes other service providers and MVNOs.

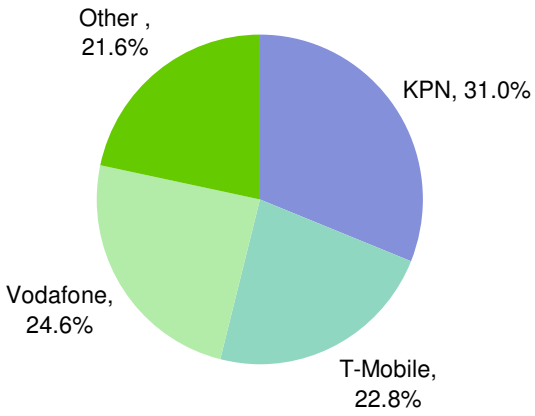


***Exhibit 3.13:*** *Dutch mobile operator market share, June 2010 [Source: Source: operator financial reports, OPTA]*

64 Ministry of Economic Affairs, Agriculture and Innovation (2011) *Regeling van de Minister van Economische Zaken, Landbouw en Innovatie van , nr. WJZ/10146523, tot vaststelling van de aanvraag- en veilingprocedure voor vergunningen voor frequentieruimte in de 800, 900 en 1800 MHz-band ten behoove van mobiele communicatietoepassingen (Regeling aanvraag- en veilingprocedure vergunningen 800, 900 en 1800 MHz)*, draft regulation, 11 February 2011.

*Portugal*

Draft regulations[65] for the upcoming spectrum auction of 450MHz, 800MHz (digital dividend), 900MHz, 1800MHz, 2.1GHz and 2.6GHz are currently the subject of a consultation process being conducted by the Portuguese regulator (ANACOM). The consultation process will close on 26 August 2011, with the auction expected to be conducted later in the year.

These draft regulations propose various conditions that favour new entrants in most of the bands, including the digital dividend band:

- spectrum cap of 2 × 10MHz in the 800MHz band
- obligations for non-discrimination for access seekers, covering MVNOs, national roaming, infrastructure access and network sharing.

The 800MHz digital dividend band (791–862MHz) will be divided into six lots of 2 × 5MHz. Coverage obligations for the 800MHz band require that for each 5MHz lot, licensees must deploy mobile coverage to at most 80 parishes without mobile broadband coverage – these parishes will be selected by the licensees from a list of no more than 480 parishes provided by ANACOM. Data transmission speeds within those parishes must be set with reference to existing commercial offerings – ANACOM will revise the maximum transmission speed every two years.

The Portuguese market is largely dominated by two mobile operators, with a third operator holding a much smaller market share (Exhibit 3.14).

65 ANACOM (2011) *Draft auction regulation for the allocation of rights of use of frequencies in the 450 MHz, 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands*, July 2011.

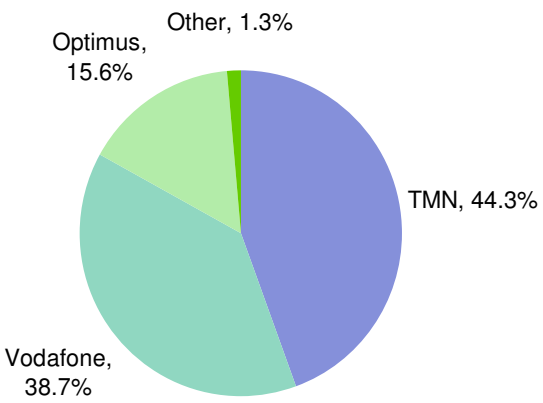


***Exhibit 3.14:*** *Portuguese mobile operator market share, March 2011 [Source: ANACOM]*

*Sweden*

Sweden was the second country in Europe – after Germany – to auction its digital dividend spectrum (791–862MHz). The spectrum was divided into six lots of 2 × 5MHz (paired), and there were three successful bidders, who each received two lots (Exhibit 3.15).[66]

66 PTS (2011) *Decision about licences to use radio transmitters in the 791–821/832–862 MHz frequency band*, 4 March 2011.

| *Block* | *Frequency* | *Licensee* | *Winning bid (SEK, millions)* | *Winning bid (NZD, millions)* |
|---|---|---|---|---|
| FDD1 | 791–796 and 832–837MHz | Hi3G Access AB | 165 | 27.5 |
| FDD2 | 796–801 and 837–842MHz | Hi3G Access AB | 266 | 44.3 |
| FDD3 | 801–806 and 842–847MHz | TeliaSonera Mobile Networks AB | 386 | 64.3 |
| FDD4 | 806–811 and 847–852MHz | TeliaSonera Mobile Networks AB | 468 | 78.0 |
| FDD5 | 811–816 and 852–857MHz | Net4Mobility HB | 420 | 70.0 |
| FDD6 | 816–821 and 857-862MHz | Net4Mobility HB | 349 | 58.2 |
| *Total* | | | *2 054* | *342.3* |

***Exhibit 3.15:*** *Results from the Swedish 800MHz auction, March 2011 [Source: PTS]*

The winning bidders were all connected with existing mobile operators (Exhibit 3.16) – the incumbent operator TeliaSonera, Net4Mobility (a joint venture between the Swedish operator Tele2 and the Norwegian incumbent Telenor aiming to provide LTE services in Sweden) and Hi3G (3G operator) – and will be using the spectrum for LTE networks. Another two bidders were unsuccessful.

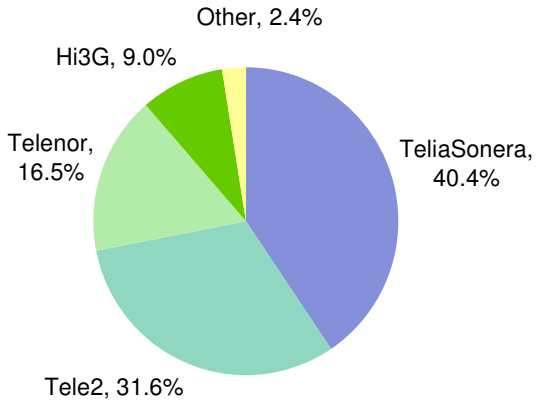


***Exhibit 3.16:*** *Swedish mobile operator market share, December 2010 [Source: PTS]*

The licence conditions specified that FDD technologies must be used.

There are also coverage and rollout requirements for the winning bidder of the FDD6 block, whereby all permanent homes and fixed places of business that do not have data services with a bit rate specified by the PTS (Swedish spectrum management authority) must be covered. Coverage is to be achieved according to PTS guidelines for appropriate and cost-effective rollout, with a maximum rollout cost of inflation-adjusted SEK300 million (NZD50 million), excluding value added tax. A minimum bit rate of 1Mbit/s is required. Rollout targets are also specified, with reference to a list of sites supplied by PTS each year:

- 25% of identified permanent homes and businesses by 31 December 2012
- 75% of identified permanent homes and businesses by 31 December 2013
- from 2014 onwards, all sites on the list by 31 December of that year, with PTS to supply the list each January.

For the most costly 250 locations, PTS may permit infrastructure using other bands, or alternative technologies, if such coverage is less costly than via the 800MHz digital dividend spectrum.

*Switzerland*

OFCOM (the telecoms regulator and spectrum management authority in Switzerland) plans to auction the digital dividend spectrum in Q1 2012.[67] The auction will encompass a number of spectrum bands:

- 800MHz (digital dividend, covering 791–862MHz) – 2 × 30MHz (FDD)
- 900MHz – 2 × 35MHz (FDD)
- 1800MHz – 2 × 75MHz (FDD)
- 2100MHz – 2 × 60MHz (FDD)
- 2100MHz – 20MHz (unpaired, TDD)
- 2100MHz – 15MHz (unpaired, TDD)
- 2600MHz – 2 × 70MHz (FDD)
- 2600MHz – 50MHz (unpaired, TDD).

Within the digital dividend band, six lots of 2 × 5MHz will be offered. The auction will be in two stages:

- **principal stage** – determines the number of generic lots to be awarded to each winning bidder, and the base prices for the generic lots (will comprise of multiple bidding rounds)
- **assignment stage** – a single bidding round that determines the specific frequencies to be awarded to each of the winning bidders and any additional prices that must be paid for being assigned specific frequencies.

To promote competition, spectrum caps will be imposed:

- total 2 × 25MHz over 800MHz and 900MHz; i.e. the frequencies acquired must not exceed 2 × 25MHz in total
- 2 × 20MHz for 900MHz
- total 2 × 30MHz over the 2.1GHz paired band
- total 2 × 35MHz over the 1.8GHz paired band

67 Federal Office of Communications (2011) *Invitation to tender for frequency blocks for the national provision of mobile telecommunication services in Switzerland*, edition of 19 July 2011.

- maximum 2 × 135MHz of the total available FDD spectrum.

The licence conditions for the digital dividend spectrum also include use-it-or-lose-it and coverage requirements:

- licensees must use the allocated frequencies as in Article 1 of the *Telecommunications Act* (TCA)[68] and to provide commercial telecommunications services over its own transmission and reception units
- licensees must ensure coverage of 50% of the population via their own infrastructure by 31 December 2018.

Failure to comply with the coverage obligation may result in the right to use the spectrum being withdrawn without compensation, unless the licensee can prove that the cause has been due to reasons outside of the licensee's control, and that a reasonable attempt has been made to meet its obligations.

Market shares for the Swiss mobile operators are shown in Exhibit 3.17.

68 Available at http://www.admin.ch/ch/e/rs/784_10/a1.html.

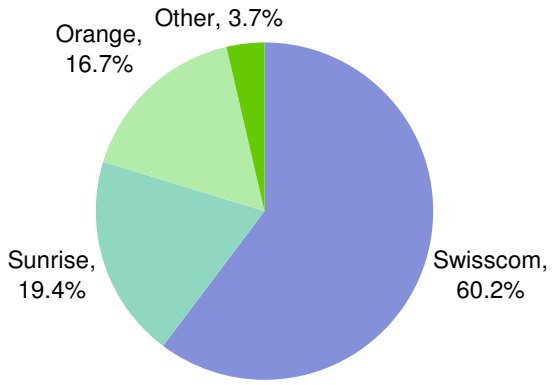


***Exhibit 3.17:*** *Swiss mobile operator market share, December 2009 [Source: OFCOM]*

*United Kingdom*

Ofcom presented its proposals[69] for allocating 250MHz of spectrum at 800MHz and 2.6GHz in March, and aims to conduct an auction early in 2012. The consultation process has now ended and a final decision is expected shortly.

Ofcom has proposed that spectrum floors be applied in order to ensure that operators have sufficient spectrum to provide high quality data services. As such Ofcom considers that the minimum holdings would be:

- 2 × 5MHz of sub-1GHz spectrum and 2 × 20MHz or more of 2.6GHz
- 2 × 5MHz of sub-1GHz spectrum and 2 × 15MHz or more of 1800MHz
- 2 × 10MHz of sub-1GHz spectrum and 2 × 15MHz or more of 2.6GHz
- 2 × 10MHz of sub-1GHz spectrum and 2 × 10MHz or more of 1800MHz
- 2 × 15MHz or more of sub-1 GHz spectrum.

69 Ofcom (2011), *Assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues*, 22 March 2011.

Very asymmetric holdings of spectrum are considered by Ofcom to be potential threats to competition in the longer term, and so two 'safeguard caps' have been proposed:

- a sub-1 GHz cap of 2 × 27.5MHz
- an overall mobile spectrum holdings cap of 2 × 105MHz.

The Ofcom proposals are driven by the desire to avoid a concentration of spectrum in the hands of only two or three operators which Ofcom considers 'would not reflect a socially optimal allocation of the spectrum, rather it would reflect likely lower competition'[70]. Accordingly the proposals are designed to ensure that at least four operators will have the opportunity to gain sufficient spectrum to deliver competitive national wholesale access services. We note that there are four mobile network operators in the United Kingdom, Orange and T-Mobile having merged in 2010 to form Everything Everywhere (Exhibit 3.18).

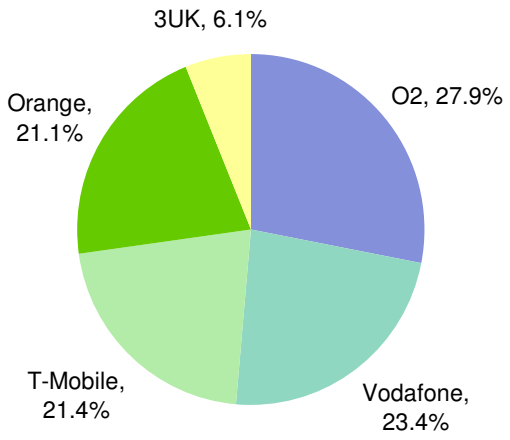


***Exhibit 3.18:***
*UK mobile operator market share, December 2009 [Source: Ofcom]*

70 *Ibid*, section 5.57.

Ofcom has also proposed the inclusion of a coverage obligation for one of the licences for the digital dividend spectrum. The requirement would be 95% population coverage with a minimum sustained downlink speed of 2Mbit/s with 90% indoor coverage confidence. This proposal was based on technical modelling undertaken by Ofcom which indicated that such coverage could be achieved with an LTE network of 9 000 sites using 2 × 5MHz of 800MHz carriers[71]. Note that this level of coverage is greater than that offered by the current 3G networks in the UK.

*United States*

Spectrum licences in the United States are assigned for a variety of area types, some of which are aggregations of smaller area types[72]:

- cellular market area (CMA) – 734 areas covering the country, plus Puerto Rico, US Virgin Islands, Guam, American Samoa and Northern Mariana Islands
- economic area (EA) – 176 areas covering the country, plus Guam and Northern Mariana Islands, Puerto Rico and US Virgin Islands, American Samoa, and Gulf of Mexico
- major economic area (MEA) – aggregation of EAs into 52 regions
- regional economic area (REAG) – aggregation of MEAs into 12 regions
- economic area grouping (EAG) – aggregation of EAs into 6 regions
- nationwide.

The US wireless market is characterised by a small number of nation-wide[73] mobile network operators – Verizon Wireless, AT&T, Sprint Nextel and T-Mobile – plus regional mobile network operators – such as Leap Wireless, MetroPCS and US Cellular – and over 90 small facilities-based providers that offer service in a single geographic area – for example Cincinnati Bell Wireless and Cellular South (Exhibit 3.19).

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71 *Ibid*, see Annex 8.

72 Federal Communications Commission (2011) *FCC areas*, available at http://transition.fcc.gov/oet/info/maps/areas/.

73 Note that these four mobile network operators are referred to as 'nation-wide' by the FCC although they do not cover the entire land area or population. Each operator has a network that covers over 87.5% of the United States population.

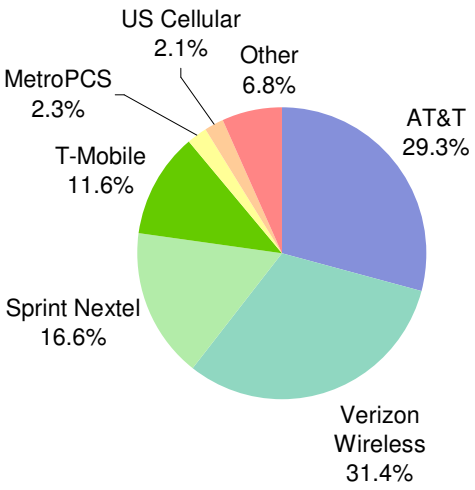


***Exhibit 3.19:***

*US mobile operator market share, December 2009 [Source: FCC]*

The 700MHz band plan in the United States is characterised by relatively small lot sizes, regional allocations and a mix of paired and unpaired spectrum (Exhibit 3.20). Small geographic areas require more co-ordination between licensees, increasing the number of roaming agreements, reducing economies of scale and is a less effective use of spectrum. However the smaller areas also provide flexibility to bidders enabling a better fit between the markets of interest and the licence area.

| *Block* | *Frequency range* | *Bandwidth* | *Pairing* | *Area type* | *Licences* |
|---|---|---|---|---|---|
| *Lower 700MHz band* | | | | | |
| A | 698–704 and 728–734MHz | 12MHz | 2 × 6MHz | EA | 176 |
| B | 704–710 and 734–740MHz | 12MHz | 2 × 6MHz | CMA | 734 |
| C | 710–716 and 740–746MHz | 12MHz | 2 × 6MHz | CMA | 734 |
| D | 716–722MHz | 6MHz | Unpaired | EAG | 6 |
| E | 722–728MHz | 6MHz | Unpaired | EA | 176 |
| *Upper 700MHz band* | | | | | |
| C | 746–757 and 776–787MHz | 22MHz | 2 × 11MHz | REAG | 12 |
| A | 757–758 and 787–788MHz | 2MHz | 2 × 1MHz | MEA | 52 |
| D | 758–763 and 788–793MHz | 10MHz | 2 × 5MHz | Nationwide | 1 |
| B | 775–776 and 805–806MHz | 2MHz | 2 × 1MHz | MEA | 52 |

Note: the shaded blocks were auctioned prior to Auction 73 in 2008. 763–775MHz and 793–805MHz are public safety.

***Exhibit 3.20:*** *700MHz band plan for commercial services, United States [Source: FCC]*

In the upper 700MHz band, FDD technologies are mandated by the FCC. The FCC does not prescribe any duplexing mode of operation for the paired or unpaired spectrum in the lower 700MHz band. There are no guard bands provisioned between the paired and unpaired spectrum – interference issues are expected to be addressed by the licensees.

The ACMA noted that the US band plan:

> The US digital dividend (698–806MHz) aligns more closely [than the European digital dividend] with the frequency range that will be available in Australia. However, the ACMA considers that the plan implemented in the US is not an efficient use of spectrum because it contains interleaved small blocks of spectrum, requiring more guard bands than a single contiguous block and making handset design more complex. It would also be undesirable to unilaterally implement a modified version of the US plan, since this would effectively

> constitute a unique digital dividend plan, contrary to the objective of harmonising arrangements.[74]

In both the July 2011 auction ("Auction 92") and the 2008 auction ("Auction 73") of 700MHz spectrum, winning bidders could qualify for bidding credits, which aimed to provide additional support for small service providers and businesses providing services to tribal lands.

The size of the small and very small business bidding credit was dependent on the annual gross revenues of the applicant, its affiliates, its controlling interests and the affiliates of its controlling interest for the preceding three years:

- "small business" received a 15% discount on its winning bid – eligible applicants must have average annual gross revenues between USD15–40 million (NZD23–60 million)
- "very small business" received a 25% discount on its winning bid – eligible applicants must have average annual gross revenues no more than USD15 million (NZD23 million).[75]

The tribal land bidding credits were available for any winning bidder intending to use the licence for deploying services to federally-recognised tribal lands that were unserved by any telecommunications carrier or have a fixed line penetration of no more than 85%. The tribal land bidding credit was in addition to (and separate from) any other bidding credit for which the winning bidder was qualified, and was dependent on average gross revenues:

- 35% discount – if the eligible applicant had average gross revenues for the preceding three years of no more than USD3 million (NZD4.5 million)
- 25% discount – if the eligible applicant had average gross revenues for the preceding three years of no more than USD15 million (NZD23 million)
- 15% discount – if the eligible applicant had average gross revenues for the preceding three years of no more than USD40 million (NZD60 million).[76]

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74 Australian Communications and Media Authority (2010) *Spectrum reallocation in the 700 MHz digital dividend band*, discussion paper, October 2010.

75 Federal Communication Commission (2011) *Auction 92 700MHz band factsheet*, available at http://wireless.fcc.gov.

A significant proportion of winning bids in the 2008 700MHz auction were eligible for bidding credits (Exhibit 3.21).

| *Block* | *Area type* | *Number of winning bids with bidding credits* | *% of licences awarded within the block* |
|---|---|---|---|
| A | EA | 79 | 45% |
| B | CMA | 293 | 40% |
| C | REAG | 4 | 36% |
| D | Nationwide | 0 | 0% |
| E | EA | 2 | 1% |

***Exhibit 3.21:*** *Winning bids qualifying for bidding credits in 2008 700MHz auction [Source: FCC]*

## 3.5 Lessons for New Zealand

We have seen that there are very clear differences between countries – and even within the harmonised European region – with regards to the mechanisms applied within the licence and the auction conditions. Nonetheless, these mechanisms consist of a small number of fundamental tools:

- choice of band plan and lot sizes
- licence footprints
- spectrum caps
- coverage obligations
- rollout obligations
- quality of service obligations.

Choice of mechanism and the exact nature of its implementation are driven solely by local circumstances. For example sub-national licences for the digital dividend spectrum are only being considered or implemented in markets where there are regional mobile network operators (United States and Canada).

76 47 Code of Federal Regulations, section 1.2110(f).

The existing and future state of competition, including the number of operators, is also clearly a consideration when deciding on appropriate implementation options. In smaller markets we commonly observe three mobile operators as in New Zealand (Exhibit 3.22), while some of the larger markets have four.

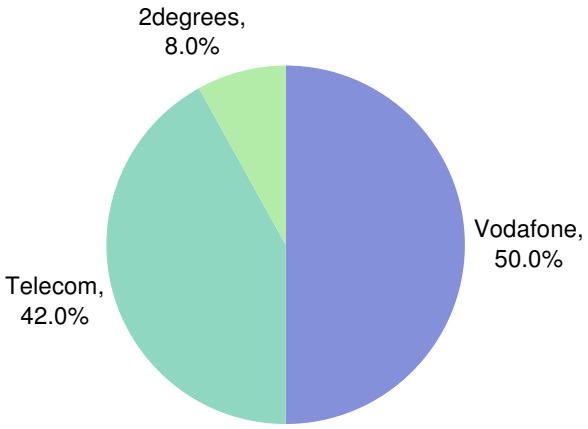


***Exhibit 3.22:*** *New Zealand mobile operator market share, June 2010 [Source: Commerce Commission]*

Spectrum management authorities seek to achieve desired policy goals by:

- identifying the characteristics of the local environment, in terms of competitive situation, market, demographics, geography and cultural
- evaluating the gap between the local environment and the policy goals, identifying barriers and enablers
- selecting – via an appropriate evaluation framework – the mechanisms that are best suited to achieving the policy goals given the local environment, and determining how those mechanisms are to be implemented.

It is clear that the actual implementation of any of the mechanisms – whether that be spectrum caps, coverage obligations, rollout obligations, or whatever – is being informed by characteristics, including the level of competition, market structure, market maturity,

demographic or geographic characteristics, that are unique to each country. What is appropriate in one country may not necessarily be the optimal solution to achieve New Zealand's policy goals.

It should also be noted that placing conditions or constraints on licences will affect the price bidders are willing to pay for those licences. Care needs to be taken that any proposed condition does not impede the achievement of the desired policy goal – or indeed has a detrimental effect on consumer welfare.

# 4 Issues for rural New Zealand

## 4.1 Overview

In New Zealand approximately 80% of the population lives within 0.5% of the land area, broadly corresponding to the top twenty urban population centres. Consequently as the mobile service footprint increases in rural regions, ever smaller subscriber numbers are covered. It is therefore most likely that the majority of the commercial value placed on nationwide spectrum management rights originates from the urban rather than the rural region. It is certainly the case that developing a viable business case for nationwide mobile broadband coverage would be challenging if spectrum availability is limited to bands above 2GHz. However wide contiguous channel bandwidths of sub 1MHz spectrum offer attractive possibilities for economic provision of ubiquitous rural coverage. We recently estimated in a study for the Australian Mobile Telecommunications Association (AMTA)[77] that if sites are deployed to provide maximum coverage (such as in rural areas) six times more sites would be required to provide coverage using 2.5GHz spectrum than using 700MHz spectrum.

The policy implications for bridging the urban-rural digital divide via the digital dividend spectrum are clear. From the GSMA:

> The digital dividend spectrum in the UHF range has very good propagation characteristics and is highly suitable for the roll-out of mobile broadband in rural and other difficult-to-reach areas. Allocating the digital dividend spectrum to mobile will mean that network

[77] Network Strategies (2010), *The future deployment of mobile broadband services: 2.5 GHz in Australia*, June 2010.

> operators require fewer base stations, meaning less capital investment is needed to bring broadband to all areas[78].

Policy-makers in many countries, recognising these special characteristics, are seizing the opportunity to ensure that the newly freed spectrum will assist in improving rural broadband coverage.

## 4.2 The RBI agreement

The objective of the Rural Broadband Initiative (RBI) is to improve broadband coverage in rural New Zealand so that 80% of 'Zone 4'[79] households and businesses may access broadband services, while 93% of Zone 4 schools are to be provided with a broadband connection. The project will be undertaken jointly by Telecom and Vodafone New Zealand with an NZD300 million subsidy from Government. Where Government funding has been used by Telecom and Vodafone New Zealand for infrastructure development, open access wholesale arrangements will apply. For example, subsidy-funded towers must be constructed to specified engineering design standards so as to facilitate co-location for other access seekers.

The RBI service is based on 3G (HSPA+) technology operating in the 900MHz band, providing peak speeds of 5Mbit/s (upstream) and 21Mbit/s (downstream). Nevertheless there are contractual provisions relating to 4G. For example, radio equipment on subsidy-funded towers is to be 'LTE ready' so that it may be upgraded to LTE[80]. In addition there are specified provisions in the RBI contracts for product reviews to:

> …establish a mechanism by which the Parties will periodically consider what, if any, changes it is reasonable to make to the Wholesale Service to maximise the benefit for End

78 GSMA (2010), *How to deliver broadband for all*, available at http://gsmworld.com/documents/DD_brochure_2010_FINAL.pdf.

79 These are rural areas not covered by the urban Ultra Fast Broadband initiative nor by Telecom's cabinetisation programme.

80 Ministry of Economic Development (2011), *Rural Broadband Agreement*, available at http://www.med.govt.nz/upload/76999/MED%20&%20Vodafone%20Rural%20Broadband%20Agreement%20(public%20version).pdf. See Appendix 1.

> Users in Zone 4 from the Infrastructure to improve the Wholesale Service to the service levels proposed by Vodafone in the [Telecom/Vodafone] Proposal …[81]

Each product review is to include details of deployment plans including LTE deployment plans. Furthermore the contract implies that if any change is proposed to the wholesale service once Vodafone has commercially deployed LTE at 700MHz on its network, then LTE must be used to support the change on sites that have not already been upgraded to HSPA+ (with new equipment)[82]. We note that the wording in the contract on this point may be open to interpretation, but our interpretation is that Vodafone has committed to LTE upgrades in rural areas under the terms of the RBI contract once commercial deployment has occurred.

## 4.3 Implications for rural New Zealand

The RBI will deliver broadband speeds of up to 5Mbit/s to rural communities in New Zealand. This level of service will naturally be inferior to that to be made available in urban areas via commercial offerings or the UFB, and the urban/rural digital divide may be exacerbated. We note that in its recent discussion paper on the digital dividend[83] MED stated that the digital dividend 'provides an opportunity to support the implementation of the Government's Rural Broadband Initiative, encouraging the provision of rural mobile broadband services offering speeds and data capacity over and above those already contracted[84].

It is certainly true that we can expect superior speeds from the newer technology. LTE is estimated to be able to support a theoretical peak rate of around 150Mbit/s assuming a 20MHz carrier in ideal conditions (Exhibit 4.1), although it can operate with a variety of carrier sizes from 1.4MHz to 20MHz.

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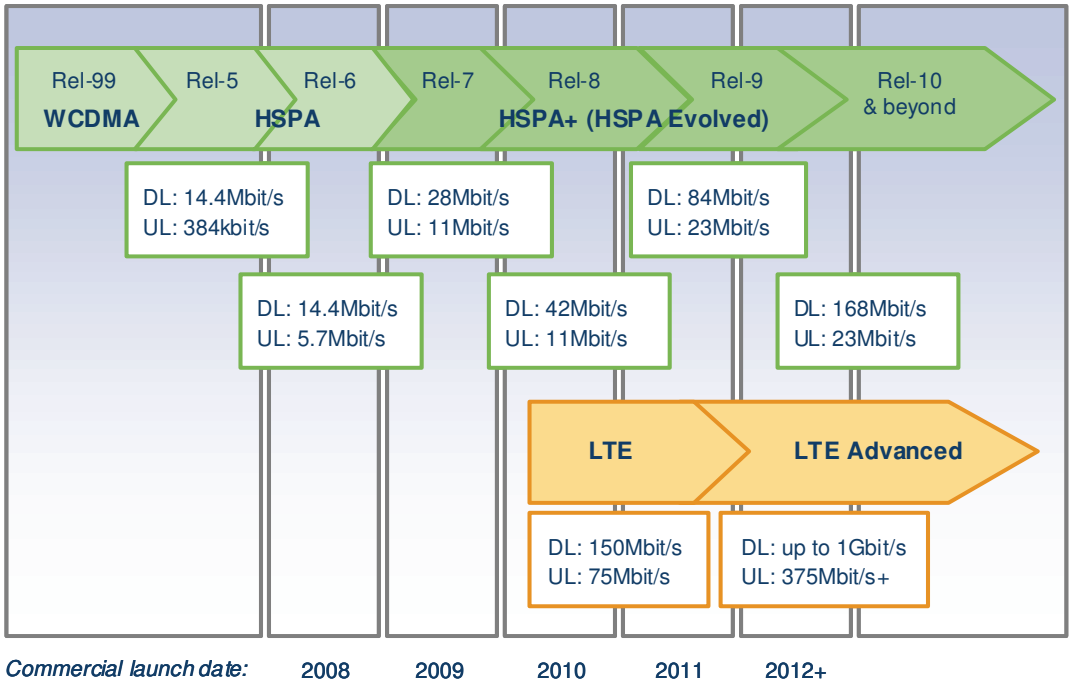
81 *Ibid*, Schedule 6, Section 4.1.3.

82 *Ibid*. See Section 2.1.3.

83 Ministry of Economic Development (2011), *Digital Dividend: opportunities for New Zealand*, August 2011.

84 *Ibid*, page 3.




Note: Speeds presented are theoretical peak speeds – actual speeds achieved by customers will be lower.

***Exhibit 4.1:*** *Evolution of mobile broadband [Source: Qualcomm, UMTS Forum]*

Note that actual rates achieved will be less than the theoretical maximum speeds (Exhibit 4.2). Actual rates depend on many factors, including distance to base station, base station loading, speed of the customer's device[85].

| *Channel bandwidth* | *Antenna technology* | *Realistic average subscriber rate* |
|---|---|---|
| 20MHz | 2 × 2 MIMO | 2000 – 12 500kbit/s |
| 10MHz | 2 × 2 MIMO | 2000 – 7500kbit/s |
| 5MHz | 2 × 2 MIMO | 500 – 4000kbit/s |

***Exhibit 4.2:*** *Realistic subscriber rates for LTE [Source: Motorola]*

From the operator's perspective it would also make economic sense, subject to the level of demand, to deploy 4G technology in the digital dividend spectrum band, with an optimal

85 Motorola (2009) *Realistic LTE performance: from peak rate to subscriber experience*, white paper.

20MHz carrier size which would achieve very high capacity. Furthermore, in the rural context where other spectrum bands are of far more limited value, allocation of large channel bandwidths may be justified on the basis of required coverage and performance. Such an allocation policy would also be consistent with the underlying objectives of the RBI.

This leads to the question of whether the rural consumer would best be served by a regional allocation of the digital dividend spectrum, rather than a nationwide allocation. Operators could then deploy networks on a regional basis and new competition may even emerge in some areas. Given that the RBI agreements are already in place, however, such an approach would most likely involve alignment of rural allocation areas with the RBI.

The potential advantages of non-national lots must be considered alongside the disadvantages. Management of the spectrum would become more complex. For example, arrangements may be required to minimise the risk of interference at the boundaries for operators using the same frequencies for different regions. Another important consideration is the additional complexity brought to the spectrum allocation process with the increase in the number of lots for sale, together with the appropriate valuation of such lots.

It is noteworthy that a small amount of low cost spectrum was previously made available in the 2.5GHz band as part of a managed service park (MSP) created by the MED for small operators to deploy innovative wireless broadband services. We understand that there have been instances of small companies launching broadband wireless access services in various parts of rural New Zealand using this spectrum. This may indicate that there is interest amongst smaller organisations in providing services to rural areas if suitable spectrum is made available.

It was recently reported[86] that the New Zealand Transport Agency had acquired managed part of the MSP spectrum rights (originally intended for wireless broadband) in Auckland, Wellington and Christchurch which it intends to use for traffic light cameras. Although such an application appears lawful it also seems inconsistent with the objectives of the MSP initiative.

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86 The Press (2011) *Transport Agency grabs radio spectrum*, 29 August 2011, available at http://www.stuff.co.nz/the-press/technology/5520889/Transport-Agency-grabs-radio-spectrum.

While auctions or spectrum trading are normally viewed as the appropriate tools to ensure spectrum is allocated to the highest value use, when competition for spectrum rights is low, or if the spectrum parcel has limited value (due to obligations on the licensee, or characteristics of the licence, such as a limited geographic footprint) it is possible that the end-user benefits or overarching policy objectives may not be achieved. Furthermore, if spectrum is to be a vehicle via which specific policy objectives are to be achieved, the terms and conditions of the licence should ensure that undesirable outcomes are not possible.

# 5 Alternative infrastructure models

As substantial capital investment will be required for the deployment of 4G networks, it is possible that infrastructure sharing may offer advantages to operators, service providers and consumers. For example, if it were possible to share some of the cost and investment risk, then the time required for network deployment may be reduced and the consumer may benefit with earlier availability of services at potentially lower cost.

## 5.1 Different forms of infrastructure sharing

National roaming is one form of sharing, enabling operators to increase their coverage via roaming on others' networks with no implications for asset ownership. This is particularly useful for new entrants, in order to increase geographical footprint quickly and without the need to deploy extensive infrastructure. For this to occur roaming agreements must be put in place, which are normally subject to regulatory scrutiny to ensure that such arrangements are not detrimental to competition.

Beyond this there are different potential levels of infrastructure sharing, each with different ownership, technical, market, competitive and regulatory implications.

*Site sharing or co-location*

A form of passive sharing, site sharing is already commonplace amongst competing mobile operators. Although located on the same site, operators install their own equipment. Thus in general separate assets are maintained and operators compete to provide coverage and services. Alternatively operators may engage in further passive sharing by extending their co-operation to mast or tower sharing on shared sites.

A key motivation for passive sharing is the desire to reduce costs. BEREC notes[87] that in Europe passive sharing already supports costs savings of 15–30% in total. Practical issues are another key driver of passive sharing, including the desire to minimise lengthy bureaucratic procedures or obstacles by offering to site share or co-locating on an existing site. Such issues have become more important in recent years with growing public concern about health and environmental issues associated with mobile infrastructure.

*Shared backhaul*

Where options for leasing sufficient backhaul capacity are limited, it may be commercially attractive for mobile operators to share the cost of building the required transmission networks. Such a strategy may be particularly attractive with respect to rural areas.

*Shared RAN*

A significant proportion of the capital investment required for 4G networks lies in the Radio Access Network (RAN). This has led to considerable debate about the circumstances in which active RAN sharing might be applicable or feasible. Full RAN sharing implies a single access network in which all equipment is shared including backhaul, with separation at the connection point to operators' core networks. Implementation of this level of sharing may be technically challenging in existing (2G/3G) networks, but is much more straightforward in greenfields deployments (for example, LTE networks) in which at the outset infrastructure may be optimised to support the required level of demand.

Advantages may include savings in both capital and operating expenditure. If it is possible to reduce the number of sites while maintaining coverage levels, this would also bring positive externalities for the environment.

87 Body for European Regulators (2011), *BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks*, June 2011. See page 7.

*Core network* Sharing at the core network may involve transmission ring sharing, or it may extend further than this to encompass sharing all parts of the core network (for example, value added systems). This would enable some operators to delay investment in these parts of the network. However the GSMA notes that operators tend to focus more on the RAN than the core network when considering sharing, as the benefits of sharing core network elements are less clear-cut[88].

Above we have noted the advantages of both passive and active sharing, however naturally there are disadvantages as well. Commercial and technical agreements must be put in place to support sharing arrangements between or amongst operators. The deeper the level of sharing the more detailed and complex these arrangements become. While on the one hand the aim of such arrangements might be to facilitate cost savings, on the other hand a detrimental impact on efficiency may result if ongoing consultation and agreement is required during network deployment and for any subsequent changes not specifically addressed in an initial agreement. One potential solution is to outsource management, operation and/or implementation of sharing to an independent company.

## 5.2 Regulatory context for infrastructure sharing

Regulatory treatment of infrastructure sharing differs. In some countries certain types of infrastructure sharing are mandated while in others there may be no obligations although sharing may be encouraged. From BEREC's survey of practices in this respect it is clear that there is no common regulatory treatment across Europe[89]:

- in Finland site or mast sharing may be imposed as an SMP remedy

88 GSMA (2010), *Mobile infrastructure sharing*, 2010.

89 Body for European Regulators (2011), *BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks*, June 2011. See page 15.

- in France passive infrastructure sharing has been obligatory since 2006 and from 2008 active sharing of 3G networks in very rural areas; frequencies may be shared in order to facilitate nationwide coverage[90]
- in the Netherlands site and mast sharing is mandated, and further sharing is permissible on the condition that competition is not impaired[91]
- in Portugal sharing is encouraged
- in Switzerland passive sharing is encouraged on a 'reasonable efforts' basis although not mandated, while core network sharing is not permissible.

## 5.3 Spectrum sharing

Active infrastructure sharing may (or may not) involve sharing spectrum – that is, the simultaneous use of a specific frequency band by different operators. The ITU notes that:

> In theory, all bands can be shared, using combinations of administrative means (setting geographic separation buffers and channelization plans) and technical solutions (SDR and cognitive radio, as well as smart antennas)[92].

In the context of LTE RAN sharing with shared spectrum can be technically challenging due to the need to allocate radio resources between operators. Another approach is to maintain independence of radio resources with RAN sharing through the use of dedicated spectrum. In this case the node is shared while the logical part of the network is kept separate[93].

According to BEREC in Europe no specific spectrum sharing agreements were in place in 2010, nor did any countries have provisions relating to this issue.

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90 ARCEP (2011), *Décision proposant au ministre chargé des communications électroniques les modalités et les conditions d'attribution d'autorisations d'utilisation de fréquences dans la bande 800 MHz en France métropolitaine pour établir et exploiter un réseau radioélectrique mobile ouvert au public*, Décision n° 2011-0600, 31 May 2011. See Section 4.

91 Ministry of Economic Affairs, Agriculture and Innovation (2010) *Strategische nota mobiele communicatie*, December 2010.

92 ITU (2008), *Trends in Telecommunications Reform, Six degrees of sharing,* November 2008.

93 For further discussion of shared and dedicated spectrum see ZTE (2010), *Network sharing accelerates LTE deployment*, available at http://wwwen.zte.com.cn/en/solutions/wireless/lte/fdd_lte/201012/t20101202_194990.html.

> Generally, in EU countries, every MNO [mobile network operator] must use its own frequencies to deploy the radio access network, and in this sense frequency sharing is not allowed (eg. ES [Spain]), or subject to limitations. In some countries, spectrum rights are linked to the obligation, for licence holders, to roll-out nationwide infrastructure: as network sharing is limited by licenses, spectrum sharing is limited in the same extent. In Sweden, for example, one of the conditions for licensing 3G spectrum until March 2011 was that no more than 70% of network infrastructure could be shared; in Denmark instead, the license owner is required to meet certain coverage obligations for the deployment of 2G and 3G network, having full control of the respective core network and Radio Access Network (RAN).[94]

Recently in Ireland the possibility of spectrum sharing has been raised in the context of the forthcoming spectrum auction. The Irish spectrum authority, ComReg, has noted that permission for spectrum sharing would depend on the impact on competition and as such regulatory scrutiny would be required[95]. Nevertheless ComReg has stated that if operators engage in sharing agreements prior to the auction then they would be permitted to bid jointly, provided that no individual bids are entered in addition to the joint bid. Furthermore there would be no amendment to spectrum caps for joint bids.

## 5.4 Examples of 4G sharing arrangements

*Canada*

The licence conditions for radiocommunications carriers in Canada include mandatory tower sharing and roaming requirements[96], which were introduced in 2008.

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94 Body for European Regulators (2011), *BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks*, June 2011. See pages 14 – 15.

95 Commission for Communications Regulation (2011) *Multi-band spectrum release: release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands*, Document No 11/60, 24 August 2011. See section 12.

96 Industry Canada (2008) *Conditions of licence for mandatory roaming and antenna tower and site sharing and to prohibit exclusive site arrangements*, CPC-2-0-17 Issue 1, November 2008.

The policy objectives for the tower sharing requirements were to:

- limit the social impacts of deployment of new towers
- facilitate entry of new players for the provision of wireless services.

In the case of mandatory roaming, the policy intent was to ensure that services would be provided at competitive prices to the largest proportion of the Canadian population.

The Minister has announced that a review of the tower sharing and roaming policy will be conducted by Industry Canada, to assess if the policy is working effectively.[97]

*Hong Kong*

In 2009 Hutchison and PCCW jointly acquired 30MHz of spectrum in the 2.6GHz band in Hong Kong, in order to deploy a single LTE network. While the infrastructure will be shared, the two operators will compete at the service level. Note that given the size of the Special Administrative Region (SAR) achieving widespread coverage is less of an issue than in many other jurisdictions. Hence we would expect the main thrust of competition to be at the product level.

The joint network deployment has already commenced, and a deal has recently been announced with equipment manufacturer Huawei for 2000 base stations to provide nationwide coverage[98].

*Kenya*

In Kenya the Government is considering a business model in which individual operators would not obtain spectrum in the 2.6GHz band suitable for 4G. The spectrum would be

97 Industry Canada (2010) *Minister Clement updates Canadians on Canada's Digital Strategy*, news release, 22 November 2010.

98 TeleGeography (2011) *Huawei wins sole provider contract for Hutchison and PCCW joint LTE network*, 22 August 2011. See http://www.telegeography.com/products/commsupdate/articles/2011/08/22/huawei-wins-sole-provider-contract-for-hutchison-and-pccw-joint-lte-network/.

dedicated to a single open access 4G network which would be available for operators to lease capacity[99]. Although no details have been confirmed it appears that a Public Private Partnership model may be an option, as well as a build and operate tender. The rationale for this approach lies in the multiplicity of mobile operators in Kenya outstripping the availability of spectrum, together with previous unsatisfactory experiences with operators failing to satisfy licence obligations (mainly with respect to coverage). In addition Government has emphasised the need to improve availability of advanced mobile services in rural areas.

*Poland*

Poland has yet to auction digital dividend spectrum, together with spectrum at 2.6GHz. An auction is not anticipated until 2012 at the earliest. However two small operators, CenterNet Mobile and Mobyland are co-operating to deploy an LTE FDD network by refarming existing 2G spectrum holdings at 1800MHz. Commercial launch occurred in September 2010. As a third operator, Aero2, now owns both CenterNet Mobile and Mobyland, further rationalisation of resources and sharing is expected. Since Aero2 has spectrum holdings at 2.5GHz and is currently investing in LTE-TDD technology it is possible that a hybrid network may emerge.

*Sweden*

In 2009 Tele2 Sweden and Telenor Sweden announced[100] a joint venture, an infrastructure company called Net4Mobility, to deploy a 4G network in Sweden. The arrangement includes spectrum sharing in the 800MHz and 2.6GHz bands as well as joint network construction, with the aim of nationwide coverage by 2013. The partners claimed that the sharing arrangement would bring cost efficiencies, and that the sharing of spectrum would

99 TeleGeography (2010) *Government withholds 4G spectrum, calls for open access network*, 23 November 2010. See http://www.telegeography.com/products/commsupdate/articles/2010/11/23/government-withholds-4g-spectrum-calls-for-open-access-network/

100 See *Telenor and Tele2 to build joint 4G network in Sweden*, 14 April 2009, press release available at http://www.telenor.com/en/news-and-media/press-releases/2009.

enable the combined entity to improve its market position, leading to faster availability of mobile broadband services for consumers. Commercial launch occurred in November 2010.

*United States*

In July 2011 LightSquared, a mobile satellite company deploying a wholesale LTE network in the US using satellite and terrestrial infrastructure, announced a sharing agreement with Sprint[101]. The main advantage for LightSquared was stated as reductions in capital and operating expenses, with Sprint to deploy the radio access network in LightSquared's spectrum holdings using Sprint's existing sites and towers, while LightSquared maintains an independent core network.

To date LightSquared's plans have encountered obstacles, largely due to the fact that its spectrum holdings are in the 1500–1600MHz bands. These frequencies are adjacent to frequencies used for Global Positioning Systems (GPS), and considerable concern has been expressed by GPS operators about interference to GPS signals caused by the proximity of high-powered transmitters[102]. In June LightSquared proposed a compromise to the FCC in which it utilised only the lower 10MHz of its spectrum to launch services, delaying use of the higher 10MHz frequencies that potentially could cause radio interference[103], thereby giving time to GPS operators to install filters. LightSquared has also raised possibilities of altering its spectrum holdings via, for example, spectrum swaps.

101 See http://www.lightsquared.com/press-room/press-releases/sprint-nextel-and-lightsquared-announce-spectrum-hosting-and-network-services-agreement/.

102 See http://www.saveourgps.org/GPS_Threatened_with_Widespread_Interference.aspx.

103 http://ssv.cachefly.net/lightsquared/wp-content/uploads/2011/06/LS-Recommendation-and-Tech-Appendix-6-30-11-FINAL.pdf.

## 5.5 Implications for New Zealand

With only one exception, the overseas sharing examples that we have examined were all driven by commercial considerations as operators sought strategies for workable business cases, given available spectrum holdings.

Government policies on sharing differ considerably, with many confined to encouraging passive sharing or ensuring there are no obstacles to sharing. Many regulators state that sharing will be prohibited where a negative impact on competition is likely.

There are also examples of Governments requiring operators to share. In the case of France active sharing in very rural areas is compulsory and it appears that Government is encouraging frequency sharing where it would assist in achieving widespread mobile broadband coverage across the extensive rural regions. In the case of Kenya it was clear that specific local circumstances may lead to the Government adopting a far more interventionist course of action with respect to network and spectrum sharing for 4G deployment than in other countries.

In New Zealand mobile operators engage in passive sharing with roaming and co-location agreements already in place for existing networks. There is, however, no active infrastructure sharing, as operators seek service differentiation on the basis of coverage. For operators the removal of this differentiator could conceivably be commercially justified if the potential cost savings were an overriding consideration in the decision. Hence it is possible that for some operators there may be commercial drivers for different levels of sharing. Assuming that sharing occurs within a competitive market, this may bring benefits to the consumer if economies at the infrastructure level are passed on in the form of lower service prices, and there may be a shorter timeframe for network deployment than there would have been otherwise. It is doubtful however that any of these considerations would support a role for Government other than ensuring there are no impediments to sharing (in the absence of any concerns that it would be detrimental to competition).

It should also be noted that the manner in which the spectrum is packaged may affect the desirability of sharing. For example, relatively small lots of contiguous spectrum may not present economic opportunities for network deployment. Consequently operators may be compelled to seek spectrum sharing arrangements in order to improve efficiency.

One issue that is likely to be a concern for New Zealand policy-makers and the public is the environmental impact of 4G technologies. In particular a multiplicity of new sites and towers accompanying new network deployment would not be welcome. Naturally existing mobile operators will seek strategies to use existing sites, overlaying new infrastructure so that new and old networks co-exist. However a key issue in New Zealand for LTE deployment is the planning restrictions which limit the height of towers. In practical terms this implies that more towers would be necessary in the absence of space to extend existing facilities vertically. The problem is compounded with multiple operators physically unable to share towers. RAN sharing may improve this situation, but as noted in Section 5.3 dedicated frequencies may be required.

# 6 Conclusions

The Government recognises that the digital dividend spectrum offers opportunities 'to improve the provision, quality and use of wireless broadband within New Zealand'[104]. In allocating the spectrum Government has the following objectives:

- promotion of competition
- rapid deployment
- wide coverage
- economic and technical efficiency.

As we have seen from our survey of overseas digital dividend policy and regulatory proposals, many tools are available to achieve policy objectives.

*Promotion of competition*

Tools which facilitate multiple operators acquiring spectrum include specification of lot sizes, and setting spectrum caps. Very unbalanced holdings may be a threat to competition. Possible approaches are to impose limits on the amount of spectrum that can be acquired by a single operator either within band (restricting the number of lots that can be bid for), or in combination with other bands (encompassing either existing holdings or other bands being offered in a multi-band auction).

Reservation of spectrum for new entrants is uncommon. The only example we found was in the Netherlands where two lots of $2 \times 5$MHz were reserved for new entrants, however the identity of

104 Ministry of Economic Development (2011), *Digital Dividend: opportunities for New Zealand*, August 2011.

these new entrants was known and market entry was highly likely, given they had previously purchased 2.6GHz spectrum.

Yet another possible approach is to include an obligation to provide access to MVNOs or access seekers (such as in Portugal) or to give bidders with commitments to host MVNOs a higher rating when assessing bids (as in France).

*Rapid deployment and wide coverage*

Coverage and rollout obligations may be imposed to achieve these policy objectives, in addition to providing 'use it or lose it' requirements. In each of France, Germany and Sweden one spectrum lot had coverage obligations requiring that specified coverage targets be achieved within a specific timeframe. The underlying policy objective was to deliver broadband services to unserved or underserved areas, and lower prices were paid for these lots compared to lots with no such obligations. Certain geographic areas may be prioritised – for example, in Germany those areas with the lowest population are the areas that are to be covered first.

In most cases digital dividend footprints are national, although sub-national licences have been issued in markets where there are regional or local players not likely to seek national coverage (for example, the United States).

*Economic and technical efficiency*

Regional harmonisation will foster economies of scale for handsets and network equipment, better interoperability of terminals and equipment, and higher chances of technology success and widespread adoption.

Minimum spectrum holdings (spectrum floors) may be set to promote an efficient outcome, including ensuring a sufficiently high quality of service is technically possible. In some instances, spectrum managers have specified minimum service bandwidth.

To date MED has indicated that operators will decide on efficiency trade-offs as they bid for different quantities of spectrum, and that minimum spectrum requirements are a business decision[105].

A decision-making framework based on a total welfare standard may be useful to navigate through the options and ultimately to select the optimal tool-set and avoid undesirable outcomes. In New Zealand one approach would be to consider options for achieving each of the stated potential Government objectives of technical and economic efficiency, rapid deployment and wide coverage, and then to assess these on the basis of:

- the likely impact on competition
- the impact on end-users or consumers
- the impact on producers or operators
- the wider social impact.

So, for example, our research indicates that the most efficient lot size may be 2 × 20MHz. This would support highest speeds as well as the most economically efficient deployment. One option is to impose spectrum floors to ensure that large contiguous blocks of spectrum are sold. However in a market with three mobile operators this may lead to asymmetric holdings of the digital dividend spectrum, and potentially this may adversely affect competition. So in evaluating the potential impact on competition of such an option it will be necessary to assess:

- how many competitors may emerge
- how competitive intensity will be affected
- whether there is any scope left for new market entry
- if there is little scope for new market entry, whether competition would be adversely affected
- whether the arrangements will promote asymmetric or symmetric holdings amongst operators
- whether any form of network or spectrum sharing would be necessary or desirable.

105 See Ministry of Economic Development (2011), *Digital dividend discussion document workshop, Summary of questions and answers*, 8 September 2011.

We note that the MED is indeed considering implementing caps of 2 × 15MHz although allowing one operator to obtain 2 × 20MHz, subject to an overall sub-1GHz cap and a possible sell-down requirement to a new entrant if one emerges during the management right. This approach is unusual by comparison with overseas practices in that typically the policy objective for a larger allocation is associated with rural broadband provision (as it appears to be in the New Zealand case) and as such coverage obligations are attached to the licence. In the absence of coverage obligations achieving rural policy objectives through one larger bandwidth allocation may not be guaranteed.

Note that one issue that differentiates New Zealand from a number of other countries is that spectrum at higher frequencies has already been sold. So, in order to evaluate the competitive impact of different proposals regarding spectrum caps and/or floors it may also be necessary to consider operators' existing holdings, in conjunction with any new digital dividend spectrum they may acquire. This would also assist in determining whether an overall spectrum holding cap might encourage efficiency.

In assessing the impact on consumers of the proposed option key considerations are typically price, quality and availability of service. Clearly favourable outcomes from this perspective are inextricably linked with market competition. Thus if a monopolistic outcome may result then consumer interests will not be served. However, to take full advantage of the technical characteristics of the digital dividend spectrum it simply is not feasible possible to carve the spectrum into a plethora of small lots to accommodate numerous operators in the pursuit of competition. In any event in this case the spectrum would lose value from the operators' perspective, and presumably some commercial rationalisation would follow.

With respect to broad social value, in New Zealand this should perhaps be assessed by asking whether the proposed option will complement the RBI, which has as its aim improving broadband coverage in less commercially attractive rural areas. Arguably allocation of larger channel bandwidths to rural areas would be consistent with the aims of the RBI. The use of large channel digital dividend bandwidth in rural areas would achieve optimal performance levels while other bands are of much more limited value. However explicit coverage obligations typically are integral to ensuring rural policy aims are achieved.

It is clear that there are many considerations to be taken into account prior to settling on a final allocation strategy. Of paramount importance is the issue of whether the objective of economic and technically efficient allocation of the spectrum is consistent with the objective of improving market competition. Although analysis may be informed by overseas experience, the solution for New Zealand must be based on an examination of our own unique market conditions and decisions on our priorities.

# Annex A: Purchasing power parity rates

Conversion to a standard currency (NZD) used the 2010 purchasing power parity rates from the World Bank (Exhibit A.1).

| *Country* | *LCU:USD* |
|---|---|
| Australia | 1.5126 |
| Canada | 1.2216 |
| France | 0.8809 |
| Germany | 0.8136 |
| Hong Kong | 5.3455 |
| Ireland | 0.8646 |
| Italy | 0.8115 |
| Kenya | 37.5624 |
| Netherlands | 0.8383 |
| New Zealand | 1.5062 |
| Poland | 1.8735 |
| Portugal | 0.6340 |
| Sweden | 9.0369 |
| Switzerland | 1.5105 |
| United Kingdom | 0.6515 |
| United States | 1.0000 |

***Exhibit A.1:*** *Purchasing power parity rates, 2010 [Source: World Bank]*