Investment Timeframes and Spectrum Licensing

Licensees look to minimize their spectrum risks
Summary

Catalyst

Regulators around the world are looking for ways to maintain flexibility in radiocommunications licensing while giving investors some certainty about spectrum tenure. One of the issues raised in this context is the duration of licenses. All things being equal, a longer license provides more certainty. However, there are many other factors that affect the investment risk associated with a radiocommunications license.

In this report, we examine a series of case studies of issuance and reissuance of radiocommunications licenses to understand what creates investment risk, what mitigates it, and how license duration affects risk. We also look at newer approaches to spectrum tenure such as indefinite terms and unlicensed spectrum.

These case studies will be of interest to regulators and operators who are working on radiocommunications reform and trying to understand the mechanisms of investment risk in a radiocommunications context. These will include established operators looking at long-term investments, but also new entrants who are taking risks with innovation and wish to minimize the sunk costs of a radiocommunications license.

This report was commissioned by Swinburne University as part of an Australian Research Council funded Discovery Project designed to explore new ways of conceptualizing and undertaking spectrum management. See Appendix for further details.

Ovum view

The Australian government is currently considering a proposal to establish a single radiocommunications license category and extend the maximum duration of its radiocommunications licenses to 20 years. There are also proposals to set out a clearer statement of expectations about renewal of those licenses. In addition, the regulator would also be able to make “spectrum authorizations,” providing unlicensed access to certain parts of the spectrum. The purpose of this proposal is to increase certainty for licensees who are making large, long-term investments in the associated radiocommunications infrastructure. These proposals are in line with other jurisdictions that have longer maximum license durations and clearer processes for renewal, such as the UK and New Zealand.

Ideally, it would always be possible to align the duration of a radiocommunications license to the life of the associated assets and services. In fact, there is weak evidence of a correlation between license terms and the actual durability of a service offering. Spectrum is often repurposed within the term of a license, and licenses are often used for the same purpose after a license is renewed.

In practice, the importance of license duration is mitigated by other factors. Presumption of renewal, rights of first or last refusal, or even presumption of a fair hearing eases licensee risk. There is also evidence of licensees taking their own steps to manage risk. For example, a portfolio of spectrum licenses can be assembled and alternative technology platforms can be sought. Increasing certainty is not the only way to manage risk. Increasing flexibility has the same effect.
Licensees with large, long-term investments will nevertheless always prefer a longer license duration to a shorter one, all other things being equal. On the other hand, the case studies also suggest that license expiry gives regulators an opportunity to reassign underutilized spectrum to more productive uses.

Also, the ability of licensees to determine the durability of their services in advance is not unlimited. When spectrum is globally harmonized, and technologies are globally standardized and have well-understood roadmaps (mobile telephony, fixed links, and satellite are examples), foresight is easier. In cases of an innovative technology or for services of only domestic scale, it is questionable whether any licensee could anticipate the technical and commercial risks. In the latter case, reforms to radiocommunications licensing that provide for more efficient entry and exit will reduce risk more than extending duration of licenses.

One approach that has been adopted in the UK has been to create “indefinite” licenses. These licenses have a minimum duration, but may be rescinded after that time with a minimum of five years’ notice. This arrangement has flexibility at both ends of the license period: at the beginning, when the regulator can set the fixed minimum term, and at the end when the regulator can recover spectrum with five-year notice. Traditional fixed-term licenses can provide the former, but not the latter option, so indefinite licensing has advantages for a regulator that seeks to maximize investor confidence but also wishes to retain some discretion to recover spectrum at a future time.

Key messages

- **Operating lives of most established telecommunications assets are stable.** They show no signs of significant change over the last two decades, though some of the new technologies (Internet of Things and better satellites) that are emerging have different lifecycles.

- **No strong correlation between license duration and operating lives.** We find little evidence that the operating life of assets or the durability of service demand drives the duration of radiocommunications licenses. However, operating life clearly affects the probability of renewal as regulators seek to encourage investment.

- **Licensees' forecasting is patchy.** Licensees’ record of predicting the commercial life of their investments is inconsistent. There are also cases of licensees failing to launch planned network and technologies. Their record is better in internationally harmonized bands such as mobile telephony and satellite, where technology roadmaps are clearer.

- **Risk associated with licensing is multivariate.** The duration of a radiocommunications license is one source of risk, but it can be mitigated by renewal conditions and by maintaining technical and commercial alternatives.

- **Different technologies face different licensing risk.** Technologies with mass appeal such as mobile services that are predictable in their technology trajectory will generally achieve radiocommunications renewal, provided the licensee is meeting demand at scale.

- **Traditional licensing approaches do not suit some innovators and new technologies.** The emergence of new approaches to spectrum management, such as indefinite terms and unlicensed spectrum, can reduce risk for certain kinds of investors, innovators, and technologies.
Recommendations

Recommendations for radiocommunications licensees

All things being equal, licensees should prefer a longer duration for a radiocommunications license if they are making long-term, sunk investment. This is particularly so for technologies like satellite, fixed links, and mobile telephony that have established spectrum, standardized technologies, and committed technology roadmaps that make long-term planning easier. Licensees should also pay attention to the terms of renewal, but can improve their chances of renewal by continuous development of the associated service. Risk can also be mitigated by building up a portfolio of radiocommunications licenses and seeking technological alternatives for service delivery.

For innovative companies seeking spectrum access, long-term licenses are less attractive. Rather, they seek spectrum that can be entered and exited efficiently. These companies should consider increasingly common unlicensed spectrum, or spectrum parks, and should encourage regulators to set aside spectrum for this purpose.

Recommendations for regulators

Regulators are trying to establish a balance between promoting investment and promoting efficient use of spectrum. Their responsibility for efficiency means they can never completely outsource management of the spectrum to licensees. Ultimately, regulators must retain the ability to recover spectrum. However, there is scope to strengthen spectrum tenure for established technologies that have clear need for long-term use of spectrum. Regulators should consider all of the variables: not just the duration of licenses, but the terms of renewal and the scope for licensees to acquire licenses in alternative spectrum. The fact that licensees have used these factors to “manage around” finite license periods shows that these can substitute for one another.

It is important to remember that licensee and regulator risk is not necessarily mitigated by certainty. It is possible to set out processes to handle license expiry, sometimes before a license is even issued. This creates certainty, but it also makes it harder to respond to industry and technological change at the end of a long license period. It was precisely these considerations in 2005 that led UK regulator Ofcom to adopt the practice of indefinite licenses.

Consideration should also be given to licensees with different, non-traditional needs. Innovation is inherently risky, but the risks faced by licensees using spectrum to launch innovative services can be mitigated by spectrum arrangements such as unlicensed spectrum and spectrum parks that provide for efficient entry and exit.

Risk management is key to radiocommunications licensing

Multiple sources of risk in radiocommunications investment

Over the last two decades, there has been considerable effort made to update radiocommunications licensing to accommodate new technologies. The rise of a mass market for mobile cellular communications was the primary driver of this change. More recently, the rise of the Internet of Things
(IoT) and the growing interest in unlicensed access to spectrum have added new complexities to radiocommunications management.

For radiocommunications managers, a key consideration has been to help spectrum users with the risk management associated with their large (and not so large) investments in physical layer radiocommunications infrastructure. The purpose of this report is to look at radiocommunications licensing and regulation from that perspective. Multibillion-dollar investments in national infrastructures require certainty about spectrum tenure, and the duration of radiocommunications licenses has been one way to achieve that certainty. The picture, however, is more complicated than that.

First, “tenure” involves two things: the period of the license and arrangements for reassignment at the end of that period. The latter may extend right up to presumption of renewal, or it may offer softer conditions such as implicit guarantees that tenure will not be terminated without good cause and adequate warning. Reassignment conditions may be even more important than the license period if the licensee is initially uncertain about their business model. They may prefer a cheaper, shorter license period with a presumption of renewal, for example. Recent interest in unlicensed spectrum is designed to address this demand.

Second, there are multiple types of timescale that are relevant since different parts of a network may have different outlooks; compare the operating life of a cellular tower infrastructure with that of a machine-to-machine (M2M) node, for example.

Third, certainty is not the only way to reduce risk. Flexibility can help too. For example, a licensee can assemble a portfolio of spectrum licenses to provide alternatives in the event that a license is not renewed.

Finally, not every radiocommunications investment is risky solely because it is large and long term. At the other end of the range, innovative companies are launching new, smaller-scale technologies. These technologies are more speculative and their prospects more uncertain than the typical large mobile network, and they may require different licensing approaches to minimize risk.

**Operating life for assets has been stable**

“Networks,” as such, do not have an operating life. Rather, different network assets have their own operating life. We have not found evidence that the useful or accounting lives of these assets have changed in ways that are both significant and systematic over the last two decades. Conveniently, New Zealand published depreciation rates for 1993–2005 and for 2006 and after, enabling a direct comparison in Table 1.

| Table 1: New Zealand depreciation lives for telecommunications equipment (years) |
|---------------------------------|-----------------|-----------------|
| **Asset**                        | **1993–2005**   | **2006 and later** |
| Antennas and networking equipment | 10.0            | 9.5             |
| Masts and towers                 | 18.2            | 16.7            |
| Cabling, land-based (inc. fiber)  | 18.2            | 11.8            |
| Cabling, submarine (inc. fiber)   | 18.2            | 16.7            |
| Ducts, in-ground conduits, manholes | 33.3           | 33.3            |
| Fiber-optic repeaters            | 10.0            | 9.5             |
| Main distribution frames         | 10.0            | 9.5             |
| Repeaters, line and network termination | 6.5           | 5.7             |
| Satellite dishes and network equipment | 10.0           | 9.5             |
These depreciation rates have been applied over a period exceeding two decades, yet the variations are minor, though there is a slight tendency for the depreciation lives to fall. The only significant change was for land-based cable, for reasons that are unclear. This suggests strongly that useful lives of network elements have been fairly stable. The US Internal Revenue Service (IRS) also publishes depreciation lives of certain classes of telecommunications equipment annually. A comparison of 1996 and 2016 shows no changes at all, as seen in Table 2.

### Table 2: US depreciation lives for telecommunications equipment (years)

<table>
<thead>
<tr>
<th>Asset</th>
<th>1996</th>
<th>2016</th>
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<tbody>
<tr>
<td>Telephone central office equipment</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Computer-based telephone central office switch equipment</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Telecoms distribution plant (physical infrastructure)</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>High-frequency radio and microwave systems</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Cable and long-line systems (includes related infrastructure)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Satellite ground segment</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Satellite space segment</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>CATV – headend, subscriber connection, and distribution systems</td>
<td>7</td>
<td>7</td>
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</tbody>
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Source: US IRS

Asset lives are stable, but determining these lives with precision is difficult, and there are variations in telecommunications depreciation lives between taxation jurisdictions. This is partly because different jurisdictions categorize equipment differently, but also because rates are often set for administrative convenience. For example, Hong Kong applies a flat 10% depreciation rate (corresponding to a 10-year life with straight-line depreciation) as part of a streamlined taxation system.

Also, newer technologies have emerged that have different lifespans to older ones. For example, CubeSats are designed to be built and launched at lower cost, and typically with shorter lifespans, than traditional communications satellites. Smartphones and M2M nodes are replaced more often than some older kinds of radiocommunications equipment. The trend then is that newer technologies often have shorter lifespans than older, more established ones. This in turn reflects deeper technology trends, such as a faster pace of technology development and falling technology costs that make faster turnover of equipment commercially desirable and feasible.

Based on observations of useful life of known network assets, we can categorize different assets in terms of operating life. Typical operating lives for different network assets are listed in Table 3. A few appear in more than one category because their lifespans cover a wider range, or because some categories include more than one kind of asset.

### Table 3: Indicative investment timeframes for telecommunications infrastructure

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Up to 2 years</th>
<th>2–5 years</th>
<th>5–15 years</th>
<th>15+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: US IRS</td>
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The factors that determine these lives range from simple wear-and-tear in the case of physical infrastructure, to technological obsolescence in the case of software-based assets. The lifecycle of software is significantly shorter than the lifecycle of physical infrastructure. To the extent that software substitutes for physical infrastructure, useful lives will reduce. This is reflected in Table 3, where the 15+ year category is dominated by physical elements.

Given that wireless investments are typically sunk for the operating life of an asset, it would appear that investors will need a license for spectrum that extends at least for that period to maximize their return on investment. The best way to determine the reality of this relationship is to look at examples of radiocommunications licensing of long-term investments, and see whether fixed license terms really do disrupt long-term investment.

### Investment incentives affected by many kinds of licensing

#### Submarine landing rights

Radiocommunications licenses are only one kind of licensing that affects investment, and wireless investors are not the only ones who face such risk. Apart from carrier licenses, landing licenses are important for submarine cable, for example. Submarine cable has a life in excess of 15 years in many cases and would therefore be sensitive to a landing license being revoked. Other kinds of investment are also dependent on regulator intervention in other ways. For example, returns on DSLAM investment depend significantly on ULLS access rights and pricing; though not strictly licensing, these regulatory rights are a significant contributor to investment recovery.

Submarine cable landing rights are managed differently in different jurisdictions. Many jurisdictions offer an indefinite license. Among those that do not, two contrasting cases are the US (which issues 25-year landing rights) and Canada (which issues 10-year rights), with rights renewable on application in both cases. The former is greater than the typical life of a submarine system, the latter somewhat less.

However, there is no evidence that this has caused any problems for investment. In recent months the Crosslake cable across Lake Ontario, connecting Canada and the US, has been announced, suggesting confidence in the capacity to recover investment over what will probably be a 20-year life.
This confidence is well placed, however, because there is no example of Canada failing to renew landing rights for an operating submarine cable.

Investment confidence depends on more than just the duration of a license. As noted earlier, it also depends on renewal terms. It can also depend on the availability of alternatives to the license. But if there are no renewal terms, then the license period becomes crucial. And this can either suppress or accelerate investment, depending on the nature of the license.

**Carrier immunities**

Another analogy that illustrates the acceleration of investment is the rollout of pay-TV cable networks in Australia in the 1994–1997 period. Telstra and Optus both rolled out cable networks in urban areas across Australia, using a significant amount of overhead cabling. As the rollout wore on, complaints from residents about overhead cable and the resultant loss of visual amenity gained significant momentum, but the carriers were empowered to override local planning laws through their federally authorized carrier immunities. The national government faced significant political pressure to eliminate these immunities.

The decision taken was not to withdraw the immunities immediately, since this would be a significant change to the investment environment. However, it was made clear that the immunities would be curtailed in July 1997, when a new regulatory regime was due to come into force.

The effect was to create a fixed-term “license” to override local planning laws and reduce rollout expense. Cable networks are long-term investments, but Telstra and Optus’ carrier licenses were not in question. There was no suggestion that the networks would not operate long enough to achieve a payback (there were other reasons why payback was not achieved, principally overspending on content), but there was limited time to make the investment at a lower cost. The result was the largest single burst of communications investment in Australia’s history up to that point, underlining the capacity of regulation and licensing to direct investment in unanticipated ways.

**Case studies of radiocommunications investment**

**Satellite services in the C band, 2015**

International cable licensing and the other kinds of authorizations discussed above are only analogies of spectrum licensing. One of the closest radiocommunications examples to these analogies is satellite. Like international cable, satellite is a large, long-term investment – sometimes in the USD100m range – that requires a long-term license to remain operational. Once launched, satellites are locked into their spectrum allocation, and useful lives have steadily increased as satellite reliability and on-board fuel efficiency have improved. Average life for a sensing satellite, for example, grew from 3.3 years for satellites launched in the 1970s to 8.6 years for satellites launched in the 1990s. There will be further increases as the longer-lived satellites launched since 2000 continue to push up average life.

There are other technical features associated with these licenses, particularly in the C band. Nearly all C-band satellites have their downlinks in the 3.7–4.2GHz range and their uplinks in the 5.925–6.425GHz range. C band is also more resistant to rain fade than Ku and Ka bands, which is important in the tropical regions in Asia, the Americas, and Africa. The C band is particularly effective for broadcast services because regional coverage is easier at these relatively low frequencies. Many
satellites in the C band have regional coverage that spans the boundaries of jurisdictions, meaning that radiocommunications licenses must be obtained from a number of regulators simultaneously. Global harmonization of satellite spectrum is therefore crucial.

It is not difficult to find examples of satellite operators emphasizing the importance of spectrum tenure. In a submission to the Culture, Media, and Sport Committee of the House of Commons in June 2011, Inmarsat stated that “these kinds of investment and technology development can only be made if there is suitable assurance that spectrum will be available during the lifetime of the satellite. Satellite registrations to obtain international recognition through the International Telecommunication Union (ITU) have a lead time of up to seven years before the satellite is placed into service. Today’s sophisticated communications satellites have lifespans up to fifteen years or longer. Once launched, satellites cannot be ‘retuned’ or modified to operate using other spectrum assignments. A threat to the availability of the appropriate spectrum means that substantial investments simply cannot be made. Regulatory certainty is an important element for high upfront business planning in the satellite sector.”

Similarly, in a submission to the Australian Communications and Media Authority in 2009, Intelsat told the regulator that the investment horizon for large satellite earth stations was over 10 years, and that spectrum planning needed to reflect this timeframe.

It might be concluded that satellite operators would be keen to see extensions of license periods. Satellite radiocommunications licenses are usually of a traditional kind: technology-specific and for a fixed period, ranging from around 5 years to 15 years. These licenses can be well below the actual life of satellite space and ground assets, but license duration is not raised as a significant issue by satellite operators. Rather, the main issues raised by satellite operators are international harmonization of spectrum allocations and preventing the reallocation of satellite spectrum to other uses. These are seen as having the potential to disrupt existing investments and to stop new investments. At the ITU World Radiocommunications Conference in 2015, the block between 3.4GHz and 3.6GHz was internationally recognized as future spectrum for mobile telephony, particularly 5G. However, the block between 3.7GHz and 4.2GHz was confirmed for long-term satellite use after a long and intense campaign by satellite operators.

None of this energy is evident in the discussion over satellite radiocommunications license duration. The implication is that there is a high level of confidence that regulators wish to keep incumbent satellite services in operation. The reason seems to be that examples of the withdrawal or non-renewal of licenses of operating satellites (other than for interference issues associated with ancillary terrestrial systems) are not common. In other words, confidence that licenses will be renewed outweighs concerns about licenses’ duration. This reflects the fact that tenure is more than just the duration of license, it is also about the terms of renewal and whether there is an explicit or implicit assurance that renewal will be the default course of action.

The 2.3GHz band in Australia, 1994–2015

Another relevant case study is the history of the 2302–2400MHz band in Australia. This band was licensed in 1994 to supply pay-TV services via multipoint distribution system (MDS) technology. Today, it is used for TD-LTE services. Initially, radiocommunications licenses in the 2.3GHz band consisted of “apparatus” licenses. These kinds of licenses were limited by statute to a maximum of five years, were initially technology-specific, and were only tradeable with authorization from the regulator. They were originally allocated for a broad range of sound and video services, including subscription television services. Most of these licenses, along with others issued on the 2.0GHz band,
were acquired at auction by companies associated with Australis Media, operator of a satellite pay-TV service.

Considerable sums were invested in launching MDS pay-TV services. Estimates at the time were that per-subscriber capex was AUD600. By 1999 there were 130,000 subscribers, suggesting a capex of around AUD78m (USD59m). This approached the value of the MDS licenses auctioned, which totaled AUD91m (1994 dollars) plus annual fees paid.

Australis Media was liquidated in 1998. This had little to do with either capex or license fees. Rather, Australis Media overpaid for content. Its MDS licenses were acquired by pay-TV competitor Austar, which subsequently acquired almost all of the remaining MDS licenses. Austar also gained access to the single, shared pay-TV satellite platform that emerged from the negotiations, expanding its delivery options.

In March 1999, the then Australian Communications Authority (later merged with the broadcasting regulator to create the ACMA) released a discussion paper entitled “Future Uses of the Multipoint Distribution System (MDS) Bands.” The paper addressed the impending expiry of the MDS licenses in the context of emerging needs for spectrum, particularly demand for 3G spectrum at 2.1GHz.

The regulatory context had also changed. Statute had been amended to allow for “spectrum” licenses of up to 15 years that were technology-neutral and much more easily tradeable.

In its summary of comments, the regulator noted that MDS license holders “proposed that the current MDS licenses in the MDS B band should be renewed for a further period of five years. They indicated that they had spent a considerable amount on MDS and associated equipment and suggested that it was appropriate for the ACA to renew their licenses for a further period to allow a reasonable return on this investment. Two of the respondents supported the introduction of spectrum licensing in the band only if the incumbent licensees were able to convert existing apparatus licenses to spectrum licenses for an acceptable access charge. Another respondent, which favored apparatus licensing of the MDS band, appeared to support the renewal of MDS licenses for the MDS B band without proposing a renewal period.”

The existing MDS apparatus licensees in the 2.3GHz band were extended another two years, then converted to spectrum licenses with 15-year terms, in return for an agreed market-based fee. In contrast, licenses in the 2.0GHz band were extended for another 2 years, then terminated to make way for fixed links displaced by the allocation of the 2.1GHz band for 3G.

After conversion, Austar used its licenses for MDS until 2002 when it migrated all pay-TV subscribers to satellite to make way for wireless broadband services. An early foray was Austar’s proprietary Chello service (a PSTN uplink combined with a wireless downlink). Plans for WiMAX followed.

Austar was always primarily focused on the non-metropolitan markets for pay TV. In 2005, it arranged a spectrum swap with wireless broadband aspirant Unwired, turning over its metropolitan 2.3GHz licenses in exchange for a financial payment and for the 3.4GHz licenses held by Unwired in rural markets. Unwired subsequently operated a WiMAX network in Western Australia, was acquired by media player Seven Network, and was renamed Vividwireless, but expansion plans were disrupted with the success of HSPA networks launched by the three MNOs.

In 2011, Austar sold its non-metropolitan 2.3GHz and 3.4GHz licenses to the NBN Co (which uses TD-LTE to provide fixed wireless broadband). This acquisition was a risk for NBN Co at the time, because the 15-year licenses for these bands expired in mid-2015. However, it was less of a risk than it might have been before 2.3GHz was globally recognized as a band for TD-LTE. In 2012 the
government indeed decided that, because of their importance for wireless broadband, it would renew these licenses “in the public interest” in return for a market-based fee. This announcement was quickly followed by Optus’ acquisition of Vividwireless, along with its metropolitan licenses in the 2.3GHz band which are now used to provide cellular TD-LTE on Optus’ 4G network.

The 2.3GHz band has had a variety of uses since 1994: first terrestrial pay TV, then wireless broadband (Chello and WiMAX), followed by TD-LTE (in cellular and fixed wireless modes). One observation is that Austar was generally an unreliable judge of its own future spectrum use and the commercial life of its investments. In 1998, it argued it need another five-year license to recover its MDS investment. Yet within three years it was clearing its MDS customers in pursuit of a different opportunity. In the event, that opportunity never materialized because Austar moved too early, before WiMAX standardization brought global economies of scale to wireless broadband. Its plans were then overtaken by HSPA and LTE developments and by the emergence of a government-funded competitor in the form of the NBN Co.

In no case did any single use extend close to the full 15-year term of an Australian spectrum license. MDS pay TV extended around eight years, wireless broadband around nine years, and TD-LTE around five years (so far). On the other hand, these uses have all extended beyond the five-year term of an apparatus license.

The conclusion might seem to be that the five-year apparatus licenses issued in 1994 were too short, but in practice this seems not to have been so. Concern for customer service continuity led to a sympathetic treatment by the regulator, with the license being renewed in 1999 for two years and then, in most cases, converted to the more flexible 15-year spectrum license for a market-based fee. Although some of Austar’s 2.0GHz apparatus licenses were extinguished rather than converted, Austar simply migrated its MDS users to the remaining 2.3GHz spectrum or satellite. By 2002, it was migrating all of these users to satellite, having identified an opportunity for wireless broadband at 2.3GHz. The combination of a sympathetic regulator and access to technology alternatives for pay-TV delivery meant that Austar’s business was never under direct threat.

If we consider the counterfactual where Austar had been refused renewal, how would events have differed? Assuming that Austar would have still received a two-year extension to migrate its customers to a new platform, it would have moved its MDS customers to satellite one year earlier than it actually did. The regulator would have auctioned the spectrum and obtained an auction fee similar to the market-based fee it obtained from Austar. Austar would probably not have ended up holding that spectrum but it wouldn’t have needed to pay the market-based fee either. None of these differences would have been significantly injurious to either Austar or the public interest.

800/900MHz mobile licenses in Hong Kong, 2004

One case where the counterfactual actually arose occurred in Hong Kong in 2004. Hong Kong had a large number of 2G licensees at that time: six licensees held a total of eleven licenses across the 800/900MHz band and the 1800MHz band, all due to expire between July 2005 and January 2006. All were GSM or PCS1800 licenses, apart from a CDMA license held by Hutchison and a TDMA license held by CSL (both in the 800MHz band). Hutchison and CSL also held GSM/PCS licenses.

As the expiry approached, the issue arose of whether licensees would be offered a “right of first refusal” for the new 15-year licenses issued to replace them. In a consultation paper released in 2003, the Telecommunications Authority proposed to offer a right of refusal to all of the GSM/PCS licensees, but not the CDMA and TDMA licensees.
The reasons given were that both CDMA and TDMA networks were losing customers (in many cases, being transferred to the very same licensees’ GSM networks), and that the base station networks were being run down. CDMA subscribers fell from 280,000 in the year 2000 to around 40,000 in 2003, and base stations fell from 460 to 300. For TDMA, the figures were even more startling, as customers fell from 140,000 to around 30,000 and base stations fell from 400 to around 50 over the same period. This was in contrast to GSM/PCS networks that were growing and gaining customers.

The regulator concluded that Hutchison and CSL’s use of the spectrum was not efficient and, in contrast to their treatment of the GSM licensees, declined to offer a right of first refusal. This decision was confirmed in 2005.

The regulator was not concerned by the service disruption issue because it found that the two licensees had not been actively marketing their services in recent years, meaning that customers’ mobile handsets were relatively old. In addition, there was already significant migration off the CDMA and TDMA networks.

The condition of a sympathetic regulator did not exist in this case. However, commercial alternatives did exist, specifically Hutchison and CSL’s GSM/PCS networks. They continued their MNO businesses undisturbed on those frequencies.

Hutchison, in a later submission to the regulator in 2004, did not defend its use of the spectrum directly (arguing that difficulties arranging CDMA roaming and sourcing handsets accounted for low subscriber numbers). More interestingly, from an investment perspective, it also claimed that the loss of a renewal option would have a chilling effect on future investment. In its submission, Hutchison stated “if operators cannot anticipate the renewal of their licenses they will not make any investment that cannot be recovered within the term specified on the face of their licenses. Given the standard investment timeframes required to recoup investment, investment in new services is likely to cease after, say, seven years, where the license term is fifteen years.” This effectively establishes an eight-year payback period for incremental investment in a mobile network.

It is useful then to ask whether a “chilling effect” on investment emerged. In fact, the regulator successfully reissued all of the GSM and PCS licenses, for a fee that was set at a market-based rate with reference to international norms. This was not consistent with the presence of any “chilling effect.” Nor was any systematic slowdown in investment observed as those licenses aged.

Despite the regulator’s decision not to either renew or provide a first right of refusal to these licensees, the market for telecommunications investment seems to have continued undisturbed. This includes Hutchison and CSL themselves, who remain investors in the market. There are two possible reasons why. First, the licensees lost access to the spectrum for reasons that were well documented and well understood by other investors. Second, the growing global dominance of GSM, along with the emergence of clear upgrade paths to GSM’s successors 3G and HSPA, gave the investors increasing confidence that their spectrum would not be reallocated to alternative uses.

Mobile telephony and mobile data services are based on global standards, and the spectrum bands committed to these services are harmonized globally. This makes mobile telephony and mobile broadband spectrum different to spectrum set aside for more locally based technologies (like MDS, for example). Licensees can assume that a regulator will respect global agreements on spectrum harmonization. This means that MNOs often have confidence that other licensees do not. They cannot be sure that they will have their license renewed, but they can have confidence that alternative non-mobile users of spectrum will have a difficult time challenging their incumbency.
Another reason that mobile spectrum is different is that it supports a large number of consumer and business customers. A fixed link has one user, and non-renewal means one disgruntled ex-licensee. Non-renewal of a license for mobile spectrum means a disgruntled ex-licensee plus potentially millions of their customers. In this case, large sunk investments don’t only constrain licensees; they also constrain regulators. Hutchison and CSL in Hong Kong are an exception that proves the rule. As the regulator’s reasoning shows, had they maintained and grown their customer numbers it is very likely that they would have been offered the right to renew, just as their GSM competitors were.

The 850MHz band in Australia, 1993 to 2015

Another case in point is Telstra’s tenure of its 850MHz spectrum in Australia. This spectrum was initially allocated to Telstra in the 1980s under a technology-specific apparatus license, and used for the launch of Australia’s first mobile cellular network based on advanced mobile phone service (AMPS) technology in 1987. Thirty years later, Telstra retains use of this spectrum for HSPA services. On two occasions in this period, their license has expired, being handled very differently on each occasion.

On the first occasion, Telstra’s AMPS apparatus license renewal was not extended beyond 1999 after the government made a commitment to phase out AMPS in favor of the new GSM technology. This decision was announced in 1992, giving Telstra seven years to manage down its investment in AMPS (this period is close to Hutchison’s estimate of eight years as a payback period for mobile networks). This decision was partly to encourage bidders for new GSM licenses, and partly to create a level playing field between new entrants and Telstra which was also allocated a GSM license. The AMPS network had over 2 million customers at its peak in 1996, but Telstra had ample warning of the shutdown.

However, in its early days GSM was limited to a 35km range from the base station. In the densely populated European market this was a minor irritation. In the vast spaces outside metropolitan Australia, it was a significant technical problem. Rural customers who enjoyed AMPS coverage were often out of range of the new GSM networks. As 1997 and then 1998 progressed, this became a political problem for the government.

At this time, the government was still the majority shareholder in Telstra. Telstra therefore shared the government’s imperative to solve the problem. However, the government was also committed to receiving the maximum amount at auction for the old AMPS 850MHz spectrum, which was to be split into two lots of 2×10MHz and sold at auction in 1998 in advance of clearance. To make matters more difficult, one of the 850MHz lots was reserved for a new entrant, and Telstra could not bid on it. The solution came at auction when Telstra used its incumbent financial resources to outbid its rivals for the remaining 2×10MHz block at 850MHz, also acquiring significant amounts of the 1800MHz spectrum offered at the same time and paying over 50% of total auction proceeds. It shortly announced plans for a national CDMA network that did not suffer from the range limitations of GSM technology. AMPS was shut down slightly behind schedule, but the CDMA network successfully provided metropolitan and rural coverage until its 850MHz spectrum was refarmed to Telstra’s HSPA network after 2008.

Telstra’s 850MHz license expired again 15 years later, in 2013. In this instance, the transition was handled much more smoothly. Rather than operating an AMPS network officially declared obsolete, Telstra was operating the latest generation of HSPA network, but again providing coverage where no other operator did. Rather than send the license to auction, the government made an official
declaration that it was not in the public interest for the spectrum to be auctioned. Instead, the license was renewed for another 15 years for a market-based fee. This was intended to ensure service continuity and it also preserved Telstra’s investment.

This appears to be a case where the term of the license mattered. If the license had expired five years earlier, in 2008, consideration of the renewal conditions would have occurred in the twilight years of the CDMA network, which was being overtaken by 3G technologies. In such circumstances, renewal would have been less certain – as the AMPS and Hong Kong examples show. In reality, consideration took place when the spectrum was being used for a popular HSPA network in its technological prime.

But this also suggests that the issue is not so much “term” as “timing.” Telstra’s AMPS network, Hutchison’s CDMA network, and CSL’s TDMA network had all passed their technological prime when their radiocommunications licenses came up for consideration, and were therefore vulnerable to reallocation to other uses. It would have mattered little whether their licenses were for 5, 10, or 15 years; all that mattered was that the licenses were soon due to expire at around the same time that the technology was heading for obsolescence. In addition, in both countries regulators were keen to promote newer technologies with clearer upgrade paths, and both had operators willing to do so.

The 800/900MHz band in New Zealand, 2010

The case of New Zealand seems to offer a counterexample. In 2007, the New Zealand government decided to offer mobile incumbents Telecom New Zealand and Vodafone a right of renewal upon the 2011 expiry of their cellular licenses. Each held 2×25MHz in the 800/900MHz spectrum band, with Telecom New Zealand operating CDMA and Vodafone operating GSM.

New Zealand offers “spectrum management rights” of up to 20 years. In addition, in 2003 the New Zealand government agreed to a policy for the allocation of commercial spectrum rights at expiry. Subject to a case-by-case review, replacement rights were to be offered to existing rights holders five years before expiry to provide certainty for investment and to ensure a seamless transition from one term to another. If a rights holder did not accept the renewal offer, the rights would be auctioned. A renewal fee approximating the market value of the rights was charged to produce a fair return to the Crown.

Combined, these provisions provide significant guarantees of tenure and renewal that give large licensees considerable certainty that their interests will be considered. However, the policy does not require the government to offer exactly the same (or indeed any) renewal rights in every circumstance. For example, in 2005 the government decided not to offer renewal for 2.3GHz spectrum it considered to be underutilized.

In this case, the government was also keen to end the incumbents’ duopoly in the mobile market. After due consideration, the government decided in 2007 to offer renewal of only part of the 800/900MHz licenses, leaving room for a third entrant. The two incumbents were offered renewal on the condition that either:

- Telecom and Vodafone each sold 2×5MHz to a third party, having the remainder of their rights renewed, or
- 2×7.5MHz of each company’s management rights would not be renewed and the Crown would allocate them to a third party.
Both licensees negotiated sale of a 2×5MHz block to New Zealand’s third mobile carrier aspirant NZ Communications, later renamed 2degrees. This left the incumbents with 2×20MHz of high-quality 800/900MHz spectrum in addition to their other spectrum holdings.

In its consideration of renewal, the New Zealand Cabinet papers explicitly reference sunk investments and technological continuity: “a 20-year period, the maximum possible renewal period under the Radiocommunications Act 1989, is a reasonable timeframe, considering the investments that have been made by current right holders or that will potentially be made by any new entrant in deploying a cellular network. This timeframe would also be consistent with the likely future use of these bands for the evolution of advanced cellular technologies.” In addition, Cabinet noted that “auctioning all of the rights to be renewed in 2011 and 2012, on the other hand, would increase the risk of stranding investment, through the incumbents losing their spectrum at auction. There is also the risk of undue disruption of services during the transition from one period to another.”

Telecom’s CDMA network was explicitly referenced, foreshadowing Telecom’s later refarming of its 800MHz spectrum: “Telecom can only operate in the 800MHz band using its current technology [CDMA] because the 1.9GHz band in New Zealand is not configured for CDMA use. If Telecom chooses to adopt the UMTS (Universal Mobile Telecommunications System) path, then it can operate in both the 800MHz and 2.1GHz bands.”

In this case, the foreshadowed obsolescence of CDMA did not lead to a loss of renewal rights. A major difference between New Zealand and Hong Kong is that Telecom’s CDMA network was one of two large networks operating in the country, and that non-renewal would have severely disrupted the market by eliminating a key competitor and forcing a large customer migration. In contrast, the Hutchison and CSL networks in Hong Kong were increasingly of residual significance, from both a competition and a service perspective.

The 28GHz band in the UK, 2000–10

Auctions were held in the UK in 2000 for tradeable 15-year regional licenses for 28GHz broadband fixed wireless access (BFWA). The spectrum was divided between 14 regions, each with three spectrum blocks. The results were disappointing, with only a fraction of the licenses sold. The remaining 15-year licenses were subsequently sold in 2008. One nationwide license was subsequently created as well. This spectrum is currently mostly used for wireless backhaul links, though there is growing interest in using it for broadband access as well, potentially using 5G technology.

The original licenses allocated in 2000 were due to expire in 2015. In 2012, Ofcom launched an inquiry in response to a request from two of the licensees, Urban WiMAX and Cable & Wireless, to convert these licenses to an indefinite term after 2015. In the UK, “indefinite” means that the license is issued for a fixed minimum term determined by the regulator, and that Ofcom must give five years’ notice of any subsequent withdrawal of the license.

In consultations, it emerged that both Urban WiMAX and Cable & Wireless had plans to utilize the spectrum for microwave access and backhaul infrastructure but were reluctant to invest because the licenses were due to expire only three years later. This was not sufficient time, they argued, to recover investment in infrastructure. In its 2012 consultation document, Ofcom noted the licensees’ argument that “given the estimated lifetime of such equipment, the investment can only be justified if there is security of use of the spectrum past the current expiry dates of the licenses. The current uncertainty over future access rights to this spectrum also creates risks over continuity of service for consumers
using services provided by BFWA licensees with consequent challenges for those licensees developing services in the band.” Given that the licenses had three years to run at the time, the implication is that the payback period for these microwave investments was greater than three years.

The alternative that Ofcom had to consider was whether to reactivate the spectrum instead. However, it agreed with the applicants that the impending expiry suppressed investment, and recognized that this precluded efficient use of the spectrum in the interim. It also reasoned that the tradeable nature of the licenses meant that the spectrum would find its way to its most efficient use without another auction. The regulator subsequently granted the licensees’ request to convert the licenses to indefinite licenses. It subsequently offered the same right to the other 28GHz licensees.

In this case, the licenses had remained relatively underutilized in the years immediately after 2000. Markets and technology for 28GHz fixed access were not mature at the time, which accounts for the poor showing at the original auction. As the decade progressed, interest in the 28GHz band grew and there were several license trades. In other words, the licensees’ troubles did not arise from the 15-year duration of the license alone. They also arose from the timing of the original auction and the late development of market and technological maturity in this band. At the same time, it is undeniable that the issuance of an indefinite license back in 2000 would have avoided these troubles. This reveals again the difficulty of disentangling the effect of license duration from the effect of the terms of renewal.

Another observation is that the original plans for this spectrum were often plans for WiMAX. In fact, these plans have not come to fruition. Urban WiMAX has subsequently abandoned its name, changing to Luminet, and wireless broadband is not a prominent element of its service offering. Arqiva, which holds the national 28GHz license, has announced plans to launch fixed wireless services based on 5G in this band. 28GHz is being developed as a globally harmonized 5G band for fixed wireless access, and the experiences cited in the case studies above suggest that this will improve Arqiva’s chances of a successful implementation.

Key observations

Several findings emerge from these case studies:

- **No strong correlation between license duration and operating lives.** We find little evidence that the operating life of assets or the durability of service demand drives the duration of radiocommunications licenses. Instead, we find examples of radiocommunications licenses passing from use to use over the lifetime of the license. Conversely, we observe single uses extending beyond the expiry of licenses as they are renewed.

- **Licensees’ forecasting is patchy.** Licensees’ record of predicting the commercial life of their investments is inconsistent. There are also cases of licensees failing to launch planned network and technologies. Their record is better in internationally harmonized bands such as mobile telephony and satellite where technology roadmaps are clearer.

- **Risk associated with licensing is multivariate.** The finite duration of a radiocommunications license is one source of risk, but it can be mitigated by flexible renewal conditions and by maintaining technical and commercial alternatives. This is easier for major spectrum users who will typically have a portfolio of spectrum licenses and technologies at their disposal, and who have large customer bases that make it easier to request renewal.
Different technologies face different licensing risk. Technologies with mass appeal such as mobile services that are predictable in their technology roadmap will generally achieve radiocommunications renewal, provided the licensee is meeting demand at scale. In contrast, less visible technologies like satellite have to fight harder for their allocations.

These findings apply specifically to the traditional world of radiocommunications licensing, with well-identified licensees and single uses for spectrum. At the same time, a different and more flexible approach to spectrum licensing is emerging, driven by new technologies such as the Internet of Things. Although the regulatory details are still under development, these new approaches offer opportunities for smaller-scale and innovative companies to utilize spectrum on a shared or unlicensed basis.

Unlicensed spectrum expands user options

New technologies drive new approaches to spectrum management

M2M and IoT services are likely to have implications for spectrum management in the coming years. M2M may tend to lock in some allocation of the spectrum. A large number of M2M devices around the world are currently equipped only for 2G. Some consumer electronics may be operational 10 years after they are purchased; smart meters are expected to work for 30 years. The effect will be an expected lifetime of M2M of between 10 and 30 years, and customers will expect 2G networks to remain active beyond this period. In markets where 2G is still operating, it will become harder for operators to switch off their 2G networks.

However, some regulators have proactively worked to make more spectrum available for M2M and IoT applications in different ways. In most cases, this has happened by enabling the use of TV white space (TVWS), often via a dynamic approach (i.e. a license-exempt basis). Until recently, radiocommunications management has almost entirely relied on license-based approaches, with licenses awarded through market-based mechanisms such as auctions. More flexible approaches are being considered by regulators to support innovative services. In particular, dynamic, shared, or unlicensed spectrum access will become a more popular approach. This applies both to low-band spectrum (i.e. TV white spaces), and to high-band spectrum which is seen as suitable for IoT development. A mix of both approaches is likely in the future.

Possible use cases for white space spectrum include metropolitan and campus networks, smart meters and utility grid networks, smart home and smart cars, broadband service to public transport, and emergency service networks.

The US has been one of the first countries to make TV white spaces available for other uses (particularly, unlicensed broadband wireless devices). This happened in 2010, when the FCC finalized its Second Memorandum Opinion and Order to amend and complement an initial ruling of 2008. Under these rules, both fixed and personal/portable devices can operate in the white spaces in the TV bands on an unlicensed basis. The primary method of preventing interference to TV and other services is the geolocation capability of the white spaces devices, combined with database access to identify vacant TV channels at specific locations. The databases are established and administered by
parties selected by the Commission. In 2015, the FCC adopted additional rules for unlicensed services in TV and 600MHz bands in an effort to maximize unlicensed white space devices’ access to spectrum while also protecting licensed users from harmful interference. At the same time, the FCC continued to protect TV services from harmful interference by adjusting power limits, specifying separation distances, and specifying antenna heights.

Channel availability for a white space device is determined based on the geolocation and database access method. White space devices that incorporate a geolocation capability shall determine their location and their geolocation uncertainty (in meters), with a confidence level of 95%. The party who registers a device in a database is responsible for the accuracy of the device’s geographic coordinates. Portable white space devices must update their location every 60 seconds while in operation mode.

Each fixed white space device must access a white space database over the internet to determine the available channels and the corresponding maximum permitted power prior to its initial service transmission. Operation is permitted only on channels and at power levels that are indicated in the database as being available for each white space device.

Similarly, in 2015 the UK’s Ofcom gave the green light to the industry to exploit the benefits of TV white spaces (the unused parts of spectrum in the 470–790MHz band). It had already authorized the use of short-range devices (SRDs) in the 870–876MHz and 914–921MHz bands by license exemption, so those that meet certain technical requirements will be exempted from the need to have a Wireless Telegraphy Act 2006 license. Ofcom has proposed a neutral set of rules that will apply to a range of SRDs, including:

- M2M (also referred to as IoT)
- in-car and "Car2Car" communication
- smart metering/smart grid
- alarm systems
- digital audio.

In December 2014, Ofcom also authorized high-duty cycle network relay points (NRPs) in the 870–873MHz band. NRPs are used to connect individual consumer devices to one another and to networks. Ofcom explicitly stated that in introducing licensing for NRPs it aims to assist the early development of emerging IoT and M2M uses. Non-exclusive licenses have been available since January 12, 2015. Ofcom has not limited the number of such licenses and will not place a cap on the number of NRPs that can be deployed in a network. Holders of these licenses will have to use an effective interference mitigation method, although Ofcom has not mandated any specific method.

Regulators are also experimenting with shared access by licensing different uses within the same spectrum allocation. In April 2015, the FCC established a new Citizens Broadband Radio Service for shared wireless broadband use in the 3.5GHz band. New rules were issued to govern the Citizens Broadband Radio Service to benefit businesses, consumers, and government users. A three-tiered spectrum authorization framework governs the Citizens Broadband Radio Service, while a dynamic spectrum access system manages the access and operations. The three tiers include Incumbent Access, Priority Access, and General Authorized Access.

The Incumbent Access users include authorized federal and fixed satellite service users that are currently operating in the 3.5GHz band. The Priority Access users are those with Priority Access Licenses (PALs), which will be assigned through bidding process. Each PAL is entitled to use a
10MHz non-renewable channel in a single census tract for a period of three years. In any given census tract, no more than seven PALs can be assigned, with no more than four PALs going to any single applicant. General Authorized Access users are permitted to utilize the remaining portions of the 3.5GHz band that are not assigned to higher-tier users.

Both unlicensed and shared spectrum are regulatory innovations based on new technological capabilities to manage location-specific access in almost real time using networked information. It is possible that this approach may become much more common in the future as regulators look to expand their portfolio of market-based allocation methods.

**Unlicensed spectrum expands options for spectrum access**

These regulatory innovations expand the options for spectrum access seekers (who are not necessarily licensees in this case). They are designed to accommodate a different kind of technology to traditional radiocommunications, one where the sheer number and diversity of nodes and use cases would make the issue of a single license unmanageable. This will certainly lower barriers to spectrum entry and exit for all users, including both new entrants and large mobile incumbents.

However, this ease of entry and exit does not necessarily correspond to short-term investment; when technologies succeed, they may have very long lives. As noted above, the useful life of a utility smart meter can be up to 30 years. Devices accessible and controllable through the network will not all last that long, but many will come close: the IoT node in a smart car, for example, will need to operate as long as the car does. Similarly, public transport authorities and emergency service agencies will seek useful lives in excess of 10 years in many cases. The sheer number of devices will make moving to a new spectrum band expensive.

This means that some of the risk management methods discussed above are ineffective. Alternative spectrum bands, for example, are of little use unless IoT devices can be easily retuned, making them more expensive.

While it is true that there is no license that can be withdrawn in unlicensed spectrum, users of this spectrum will wish to see guarantees that spectrum allocated as unlicensed or shared spectrum will remain allocated in that way. This is harder to do than setting the duration of a license. Unlicensed spectrum has been sourced opportunistically so far, but domestic allocations are being made in similar bands leading to a measure of global harmonization that will stabilize these allocations.

This kind of spectrum management therefore has a complex relationship to both risk and certainty that will require further regulatory refinement. There are several approaches to creating certainty that could be considered, but these are underdeveloped as IoT remains an emerging technology. It has been practice for certain spectrum allocations (e.g. broadcasting) to be made by statute, and this may be an option. Alternatively, long-term spectrum plans of regulators, given statutory backing, may be enough to give the 30-year commitment that is needed to secure investment. Further global harmonization of unlicensed bands would help create certainty and would also increase global economies of scale and lower costs.
Appendix

Methodology

This report is based on desk research across several country markets, and on interviews with several radiocommunications operators in those markets.

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Acknowledgement

The report was commissioned by Swinburne University as part of an Australian Research Council funded Discovery Project, “Spectrum After Scarcity: Rethinking Radiofrequency Management for a Connected Society” [DP 150100887]. The project is exploring new ways of conceptualizing and undertaking spectrum management, including case studies evaluating the allocation and reallocation of particular bands around the world. The Project also resulted in an issue of the international journal Telecommunications Policy on “Optimizing Spectrum Use,” edited by the Project’s chief investigator Jock Given (Swinburne University, Melbourne) and partner investigator Martin Cave (Imperial College London), published in June 2017 (vol. 41 issue 5–6).

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ISBN: 978-1-925761-02-3
https://doi.org/10.4225/50/5a554eaf2ecfd