Reforming Canadian spectrum policy for 5G and beyond

TELUS

Abstract

Ensuring the effectiveness of Canada's spectrum policy is a matter of immense national importance. It requires significant, thoughtful reform to ensure that Canadians receive the greatest potential social and economic benefit from their spectrum resources and that Canada can thrive in a global, digital economy. International comparisons demonstrate that Canada's spectrum policy framework has produced poor socio-economic outcomes relative to other advanced economies. Successive Canadian governments have over-indexed on using spectrum policy to try and restructure the telecommunications market and deprioritized the fundamental purpose of the policy framework: awarding spectrum in the manner best suited to promote connectivity. Consequently, and despite recent steps in the right direction, the framework has released too little spectrum, too slowly, and at inflated prices, denying Canadians access to high-quality connectivity when it has never been more important for their well-being. This white paper makes 10 recommendations to reform Canada's spectrum policy, to ensure universal access for Canadians and allow Canada to achieve a global leadership position in 5G and future generations of wireless technologies. Evidence-based policy, transparency and accountability are all required to ensure that Canada's spectrum policy delivers the world-class connectivity that Canadians deserve. Canada is now in a moment of relative reprieve, with many of the most pressing spectrum policy decisions for 5G already taken and stakeholders best positioned to give frank, impartial assessments of the policy framework. While more must still be done in the context of 5G, this is nonetheless the single best opportunity for a fundamental review of spectrum policymaking in Canada.

It must not be missed.

Why read this report?

Reading this report will help you understand:

The importance of high-quality wireless networks and 5G for competitiveness, innovation, economic growth, jobs, environmental improvement and social progress;

The role of spectrum policy and auctions in supporting these outcomes;

How most advanced countries use spectrum policy to drive competitiveness and innovation through 5G and the emerging digital and data economy;

How Canada is lagging its global peers as a result of using spectrum auctions as a tool for market intervention rather than to maximize connectivity; and

How Canada must reform its spectrum policy to drive sustainable and inclusive growth through high-quality networks.

Executive summary

Spectrum is a critical resource in the digital economy; its allocation determines the quality, coverage and affordability of all wireless networks. Generally speaking, the more spectrum an operator has, the better the quality of service offered for a given number of users, and the cheaper it is to deploy high-quality networks. There is, however, only so much spectrum to go around and it is therefore necessary for governments to undertake the complex task of determining how to distribute it between companies. This is challenging; governments must balance the effects of spectrum distribution on network quality, coverage and affordability, and it is easy to over-index on one of these elements at the expense of the others. This paper examines Canada's spectrum policy and presents an agenda for reform.

The potential benefits of more effective spectrum policy for Canada are vast. Canada's wireless industry already contributes $47 billion annually to the Canadian economy, about 3% of Canada's GDP (Statistics Canada, 2022), and 5G is estimated to increase the economic impact of the wireless industry to more than $90 billion by 2026 (PwC, 2022). Canada's wireless industry already provides secure, well-paying jobs to 150,000 Canadians, with wages 20% higher than in other service industries (Statistics Canada, 2022), and 5G is expected to more than double employment in the wireless industry to 400,000 Canadians by 2026 (Accenture, 2021). Canada's wireless networks are enabling post-pandemic recovery and are foundational to Canada's global competitiveness, enabling Canadian companies to compete in the global innovation economy and having a dramatic impact on industries such as agriculture and transportation. Fixed and mobile wireless networks enable Canadians living in rural, remote and Indigenous communities to access employment opportunities, healthcare, education and public services. Furthermore, adoption of digital technologies which rely on quality networks are projected to be able to reduce Canada's GHG emissions by up to 20% (Farrpoint, 2022; GeSi, 2021; WEF, 2021).

Although spectrum policy will determine whether these potential benefits from wireless services are realized, control of spectrum is not a panacea. This is the mistake made in Canada. Unusually, the government in Canada directly controls spectrum policy. As a result, successive governments have attempted to use spectrum to engineer market structure and thereby lower retail prices as a political priority. Beginning in 2008, the government undertook a massive experiment, providing artificially generous terms for smaller operators at the expense of all other objectives, despite limited supporting evidence. The need for continuous intervention to maintain such operators, despite significant costs to other goals, demonstrates that this was a mistake. After 14 years, there are no new competitors that the government considers self-sustaining, but there is demonstrable harm to coverage, quality and, ironically, affordability.

Many policy decisions concerning the quantity and timing of spectrum awards have made Canada's networks more expensive and, for 5G, lower quality (see Table 1). Key spectrum for 5G was auctioned too late, beginning four years after comparable jurisdictions and 38th in the world (Analysys Mason 2021). Canada was going to be first in the world, but delayed seven years to find means to preserve a potential entrant that has now left the mobile market (ISED 2014). Furthermore, with the government reserving large quantities of available spectrum for smaller competitors, little spectrum has been made available for 5G and, according to international standards, no operator will reach truly efficient channel sizes until after a second auction in 2023. Worse, unlike competing jurisdictions, the necessary spectrum will only become usable in 2025 in urban areas and as late as 2027 in rural areas, due to Canada's decision not to proactively clear legacy users. This is to say nothing of the fragmentation and dilution of spectrum holdings: Canada has the fourth least concentrated holdings of the 145 countries assessed by the GSMA (GSMA 2020).

Canadian spectrum is the most expensive in the world by a significant margin, crowding out investment in networks. High prices in Canada are due to the government continuing to guarantee spectrum to the 14-year-old regional entrants, thereby exacerbating spectrum shortages. Between 2008 and 2020, Canada's national operators paid 400% of the average OECD price for spectrum. Worse still, in 2021, those operators with the best record of deploying networks, the national operators, paid by far the highest prices in the world: three times the record-breaking US prices and 15 times the likes of the UK, France and Germany (see Table 1). This crowds out investment in networks, particularly in less profitable rural areas, and makes the most popular networks more expensive. To put this in perspective, if US operators had paid the same for spectrum per person as Canada's national operators,

they would have spent $300 billion, rather than $80 billion, and Canada's major operators have paid more to the government for spectrum ($29.3 billion) than they have invested to build world-leading networks over the past decade ($25 billion) (Crandall, 2021). This inevitably inflates prices. **By slowing investment and innovation, Canada's spectrum policy is a drag on the country's ability to compete globally, costing Canadians vast economic, social, and environmental benefits and undermining our future prosperity relative to other nations.**

Despite generous terms at the expense of Canadians, surviving entrants argue they need continuous further support to exist. Having received as much as $4.2 billion each in public subsidy since 2008 through set-aside spectrum, newer operators have been permitted to leave almost all the spectrum in rural areas unused to further sweeten the deal. **The result is far worse rural service than would otherwise exist and less resilient networks in the event of a network outage.** Some operators have even been allowed to use spectrum to speculate, sitting on subsidized spectrum and reselling it for hundreds of millions of dollars in profit to national operators, that put it to use, years later. Despite over a decade of government support at almost any cost, all the entrants have either now left the market or are associated with multi-billion cable companies, which would require no public subsidy if a real business case for competing existed, with some of the most successful still attempting to leave the market. Yet, even when recognizing that these profit-making companies exist only as a result of public subsidy, the government continuously indulges them, throwing good spectrum after bad.

Spectrum policy must be focused on producing benefits for Canadians, not enriching companies. Most fundamentally, the problems with Canada's spectrum policy stem from the fact that formulating spectrum policy to continuously and extensively preference a subset of operators is not competition, and certainly won't promote connectivity. **At root, Canada needs clear and appropriate spectrum objectives, with more data, more transparency and more accountability to link policy with outcomes.** This is in no way controversial. The need for evidence-based policymaking and transparency has been expressed by the government's own expert reports, the Auditor General and the IFSD. The danger of political decision-making with respect to spectrum policy was highlighted as early as 2001 by the OECD. Now, with mid-band policy determined, Canada must seize the chance for reform.

Country	First mid-band auction/ assignment for 5G[1]	All mid-band cleared for use	Spectrum at open auction (2021)[2]	Open average CAD/MHz/ pop in mid-band	Pro-competitive measures (2021)	First high-band auction[3]	# of national operators
South Korea	2018	2018	250 MHz	$0.29	Caps	2018	3
Italy	2018	2019	320 MHz	$0.56	Caps	2018	4
Australia	2018	2020	200 MHz	$0.46	Caps	2021	3
Japan	2018	2020	N/A	$0.00	Grant	2019	3
United Kingdom	2018	2022	390 MHz	$0.17	Caps	TBD	4
Germany	2019	2019	300 MHz	$0.24	Caps	2021	3
France	2020	2020	320 MHz	$0.24	Caps	TBD	4
United States	2020	2023	375 MHz	$0.97	Caps/bidding credits	2019	3
Canada	2021	2027	64 MHz	$3.27	Set-aside	2024	3

Table 1: Canada's outlier spectrum policy

1. Link to report: https://www.pwc.com/ca/en/communications/publications/5g-the-digital-economy-and-canadas-global-competitiveness.pdf. Assignment here refers to auctions in all countries save for Japan. In Japan, the government directly assigned licenses.
2. See: https://www.analysysmason.com/contentassets/3142cca88f924253be79605a6703503a/analysys_mason_5g_spectrum_canada_nov2021_rdnt0.pdf
3. Link to report: https://www.pwc.com/ca/en/communications/publications/5g-the-digital-economy-and-canadas-global-competitiveness.pdf

Ten recommendations for spectrum policy reform

There are 10 changes that a survey of the international empirical, academic, and policy literature suggests Canada should implement. Most critically:

1. **Go back to first principles** - Maximize the economic, social, and environmental benefits for Canadians from their spectrum resource. Canadian spectrum policy must be about Canadians and not about protecting companies. The government must return to first principles, adopting a laser-focus on the speed and efficiency with which spectrum is deployed to provide high-quality services to as many Canadians as possible without allowing spectrum to become a means of foreclosure.
2. **Spectrum policy must be evidence-based policy** - Canada's spectrum policy has been allowed to neglect its fundamental purposes because of the absence of any meaningful and transparent assessment of the government's policies, either before or after they are implemented. Canadian decision makers must be explicit about the objectives of spectrum policy and how they are balanced within any proposal, including an independent assessment of likely policy impacts akin to those undertaken by the Office of Economic Analysis of the US Federal Communications Commission. After a policy is implemented, sufficient public data, transparency, and accountability must be ensured such that independent bodies, commissioned by the government, can measure whether policies have been effective and thereby better ensure the desired policy outcomes moving forward.

To allow Canada to keep pace with international leaders in spectrum management and policy, it is further recommended that Canadian policymakers emulate and surpass other international best practices:

3. **Beat the global benchmarks** - Be the first OECD jurisdiction to make enough spectrum available to major operators for new services to efficiently meet International Telecommunications Union (ITU) recommended channel sizes, raise quality, lower costs, and prevent artificial shortages inflating auction revenues and retail prices.
4. **Focus on Canada's future** - Rapidly release and clear spectrum so that auction winners can use the spectrum to deploy new technologies in a timely manner, in line with competing jurisdictions.
5. **Defragment diluted holdings:** Prioritize the timely defragmentation of Canada's spectrum bands to accrue the largest benefit from efficient spectrum use over the longest possible time.
6. **Prioritize rural, remote and Indigenous Canadians** - Adopt strategies seen in other OECD countries to facilitate rural, remote, and Indigenous infrastructure investment through auctions, combining both positive and negative incentives.
7. **Set aside 'set-asides'** - End the possibility of providing set-asides for established operators which, while imposing costs on Canadians through the highest spectrum prices in the world and leaving them with the 4th least concentrated spectrum holdings, has failed to increase competition.
8. **Ensure speculators 'break even at best'** - Create rules to ensure companies that have purchased subsidized spectrum through a set-aside or other measure intended to increase competition cannot use it for profit by:
   - Continuing to ensure that deployment conditions are as aggressive and ambitions as is practicable for the spectrum is question to ensure squatting and flipping are unprofitable;
   - Conditioning resale on meeting initial deployment conditions, in both principle and practice; and
   - Blocking transfers of set-aside spectrum until deployment conditions are met.
9. **Make sure spectrum holders 'use it or lose it'** - Impose and enforce effective "use it or lose it" conditions, revoking licences in areas where companies purchase spectrum but do not meet robust deployment conditions and, once a full licence term has passed, use an expanded access licensing framework to make spectrum available to those willing to put it to use.
10. **Encourage operators to 'use it or share it'** - Even when operators comply with deployment requirements, design a 'use it or share it' regime that ensures operators share unused spectrum in the initial licence terms following the first deployment milestone where this will not affect their operations.

1. Introduction

Canadians don't have to tune their mobile phones to a particular 'channel' like an old radio or television, but this tuning process still takes place. On the inside, mobile phones are 'tuning in' to a particular channel to send and receive signals from a network provider. Each channel consists of a group of frequencies on the electromagnetic spectrum. Generally speaking, the larger the chunk of continuous frequencies used by one operator, the wider the channel, the better the quality of service offered for a given number of users, and the cheaper it is to deploy high-quality networks, increasing coverage in areas where the financial case may not otherwise exist. The more channels the better, and the greater the mix of channels between low, mid and high frequencies a network provider uses, the better the balance between coverage and speed.

There is, however, only so much spectrum to go around before different operators' signals start to interfere with one another and there is often too little of a particular type of frequency to satisfy all the possible users and uses. It is therefore necessary for governments the world over to undertake a complex but immensely important balancing act to determine who should get to use what spectrum, where and for what uses. This is a significant policy challenge; governments must formulate policies which balance the effects of spectrum on network quality, network coverage and affordability, and it is easy to over-index on one of these at the expense of the others. This paper examines Canadian spectrum policy considering international best practices, identifies how Canada could obtain greater benefits and sets an agenda for spectrum policy reform.

As a result of its spectrum policies, Canada is falling behind its international competitors. The policy choices responsible for this, which determine the shape of technological development within the Canadian economy, are now set to have significant detrimental effects on the livelihoods and lifestyles of Canadians for years. Each element of Canadian spectrum policy, from priority setting, decision making, mechanism design and implementation, is serving Canada poorly. In this context, determining the priorities of Canada's wireless spectrum policy can no longer remain the sole purview of technically minded civil servants, nor can the implementation of such technical policy continue without adequate independent policy review. Wireless communication is an integral part of the Canadian economy (Innovation Science and Economic Development Canada, 2021a). Access to spectrum allows firms to build wireless networks, which in the 21st century, are essential for economic prosperity. Ensuring evidence-based spectrum policy that works for all Canadians is therefore a matter of urgent national concern.

Canada's spectrum policy framework was designed "to maximize the economic and social benefits that Canadians derive from the use of the radio frequency spectrum resource" (Industry Canada, 2007). However, in recent years, policymakers have consistently adopted policies contrary to this goal, introducing significant obstacles to the efficient use of spectrum, allowing it to sit fallow and failing to keep up with peer jurisdictions. Three consultations launched in 2021 and 2022 by Industry, Science and Economic Development Canada (ISED), which focused on recovering

spectrum squandered as a result of existing policy and presented alternatives to counterproductive 'pro-competitive' measures applied throughout the last decade, demonstrate tacit acknowledgement of this point by the government.

Canada is facing an enormous digital transformation, but Canada's spectrum policy is at odds with the government's vision of a Canada with an advanced digital sector, world-leading industries and an inclusive economy. Canada is aware that the data-driven and digital economies, which are gaining momentum, require significant policy changes. For example, Canada is revisiting the Broadcasting Act in light of the platform economy, significantly updating its privacy policies for the digital economy and introducing legislation to govern the use of new AI technologies. Yet spectrum policy, the key piece of the policy arsenal that enables all wireless technologies and makes the digital economy possible, has not been meaningfully revisited since the release of the iPhone in 2007. That is an eternity in the context of such rapid technological transformation. The importance of wireless technologies is accelerating dramatically as 5G is deployed around the world and connectivity has become even more critical during the COVID-19 pandemic (Innovation Science and Economic Development Canada, 2021a). Canada's digital charter, released by the government in 2019, lists 'universal access' as the first of 10 principles that will lay the foundations for a 'made-in-Canada' digital approach (Innovation Science and Economic Development Canada, 2021a). To achieve this, Canada needs to refresh its spectrum policy. If this does not happen, the 'made-in-Canada' approach will entail being left behind by global peers and competitors.

While the government's Access Licencing consultation focused on changes to spectrum policy to increase connectivity in rural and remote areas, the consultation did not go far enough. Nor do the improved policies within the recent 3800Mhz auction framework. The recognition of the inadequacy of existing approaches is welcome, and some of the proposed changes will make a difference, but they cannot meaningfully address the multifaceted problems with Canadian spectrum policy. At root, there is a misalignment between the government's stated goals and the impacts of its spectrum policy, with no means of realignment save for the one-off exercise of ministerial discretion incapable of providing the requisite certainty for industry.

This white paper identifies **six key dimensions of spectrum policy** and shows that Canada is an outlier in each (see *Figure 1*). The inescapable conclusion is that Canada's spectrum policy does not play the enabling role required of it by a digital economy and society. Given the importance of 5G for all areas of socio-economic development, the significance of this failure cannot be overstated. Canada is stumbling just when industrial-grade wireless connectivity becomes a reality. While the data on Canada's relative performance to its peers presented herein is undoubtedly worrying (see *Figure 1*), this paper also identifies **10 key policy recommendations** that will ensure Canada recovers in the race for world-leading next-generation networks.

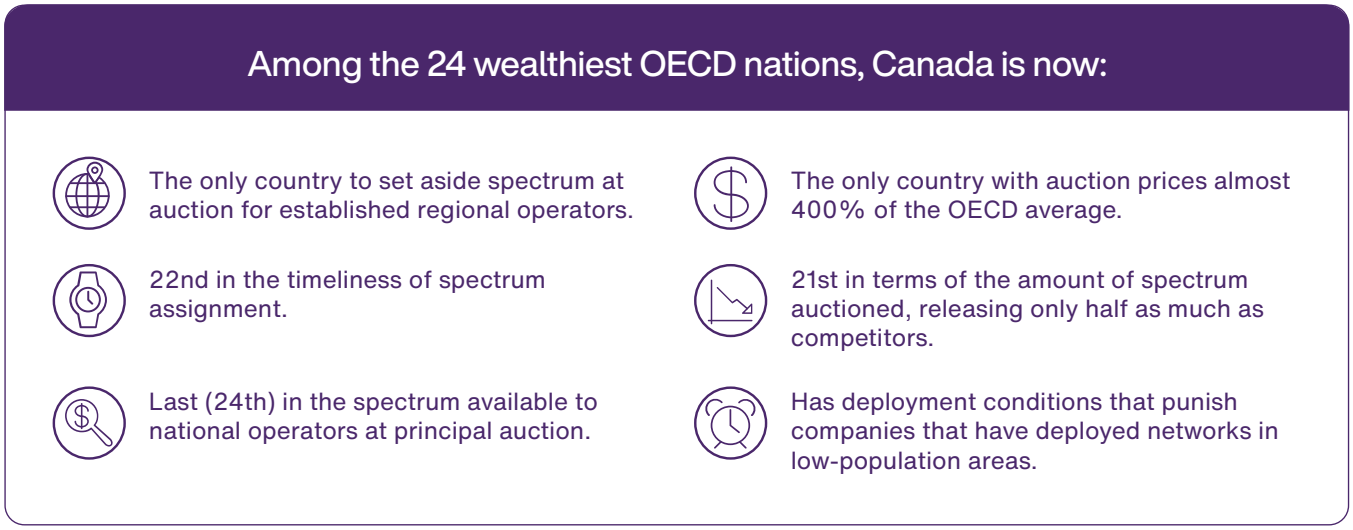

Figure 1: Comparing Canada's spectrum policy against our peers

2. Policy and economic context

Telecommunications are increasingly liberating Canadians from the tyranny of geography. Next-generation 5G networks and industrial-grade wireless connectivity represent an immense opportunity for increased competitiveness, economic growth, social inclusion and environmental sustainability in communities across the country. Wireless internet creates opportunities to combat inequality, facilitating economic activity in smaller, rural and more remote communities. These technologies are radically improving the competitiveness of peer jurisdictions and will do so in Canada with the right policy environment. The realities of the Canadian wireless market and its interaction with government regulation are complex and the benefits of future telecommunications technologies are in no way guaranteed.

Canadian operators are world leading. In terms of quality, speed, reliability and coverage, Canadian operators are frequently recognized by international observers for their global leadership, with TELUS offering the best network in North America (Ookla, 2022). In the context of 4G, Canada excelled. Quality LTE wireless services reached 99.5% of Canadians (Statistics Canada, 2022), Canada exchanged fastest wireless network in the world with South Korea over the course of the technological generation (Opensignal, 2020a, 2020b), a country 1/100th of the size, and ranked the highest in mobile wireless value compared to other G7 countries and Australia (Dippon and Clamon, 2020). Although there were regular disagreements between various stakeholders on the cost and affordability of consumer wireless services, by any measure Canadians have benefited from intense infrastructure-based competition and high-performing 4G networks that are the envy of the world. If rural Canada were assessed independent of Canada, in 2019 it would have had the 12th best performing networks in the world (Opensignal, 2019), and in 2020 would have had the fastest download speeds among the G7+Australia, with the exception of Japan and urban Canada (Opensignal, 2020c).

These outcomes disguise the fact that Canada's telecommunications industry operates in a relatively challenging environment. Canada's operators have a heightened sensitivity to policy, due to the higher costs of production that they unavoidably face. The high factors of production result from: geographic factors such as population distribution, with Canada having 1/9th of the population of the similarly sized US per square kilometre; more extreme weather conditions; significantly lower economies of scale due to fewer numbers of subscribers and lower revenues; less countervailing buyer-power when negotiating with international consumer and network equipment oligopolies; and a fluctuating exchange rate relative to the US dollar (Dippon, 2022).

Factors of production	United States	Canada	Canada to US cost effect
Population	329.5 million	38 million	**9 times smaller** subscriber base
Population density	36.02 people / sq km	4.24 people / sq km	**8 times larger** area per subscriber
Economies of scale	364 million wireless subscribers	32 million wireless subscribers	**11 times fewer** subscribers
Bargaining leverage	Revenue of $224M CAD for top three carriers (2020)	Revenue of $23M CAD for top three carriers (2020)	**10 times smaller** total wireless revenue
Climate	Average temperature of 11.5°C	Average temperature of 3.6°C	**7.9°C colder**
Exchange rate	No currency exchange needed	Must exchange CAD for USD for purchasing equipment	Exchange rate fluctuations increase risk, **impose additional costs**

Figure 2: Comparing the Operating Environment of US and Canadian Network Operators (NERA 2022)

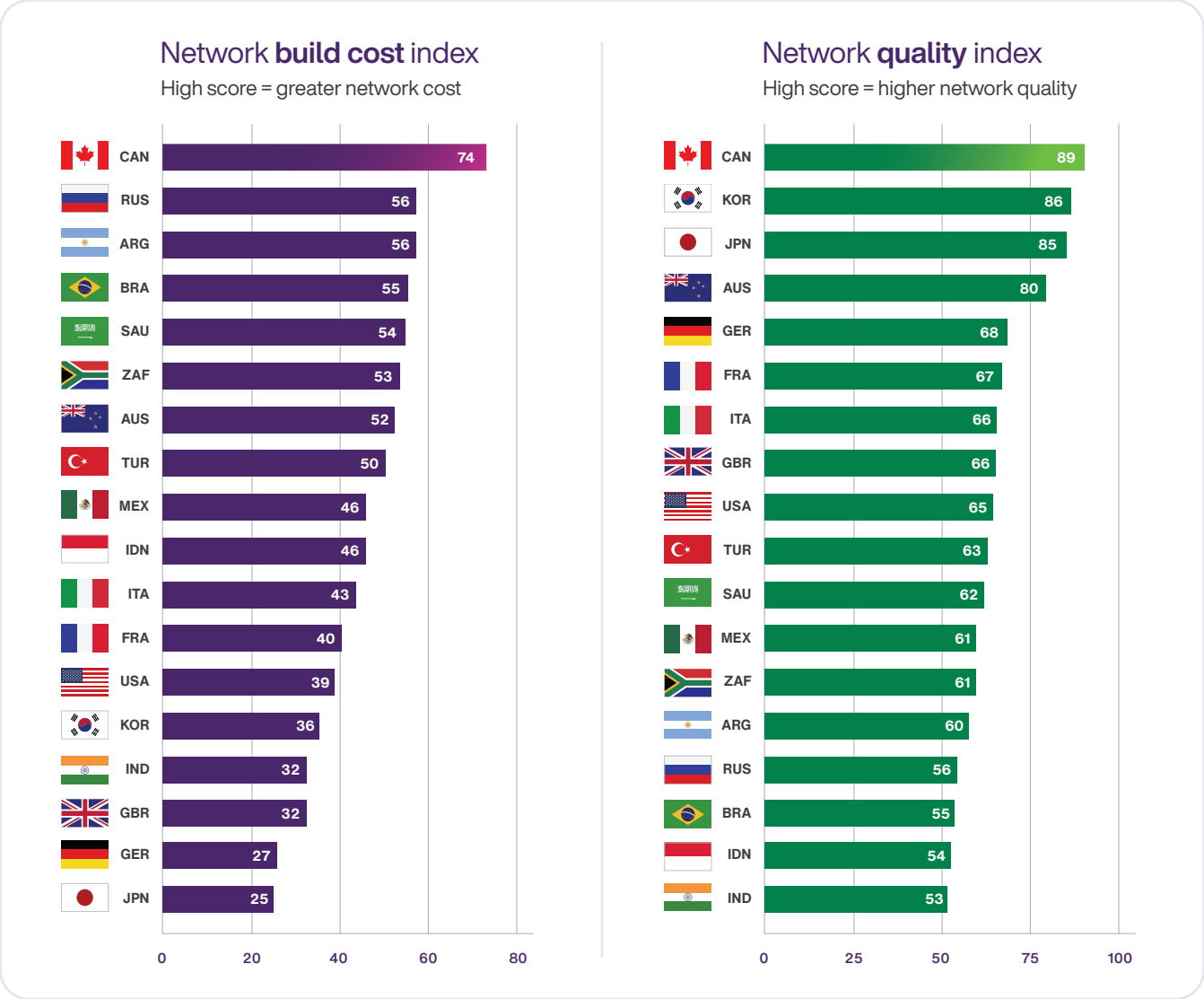

Figure 3: Network build cost index and network quality index (PwC 2021)

Despite this, Canadian policy is out of step with forward-looking international comparators and policies, which merely acted as a drag on 4G deployment, are now a serious problem for the rollout of 5G. Despite a commitment to 'innovation-led growth' (Innovation Science and Economic Development Canada, 2021a), Canada is falling behind. A series of policy choices for more than a decade have accumulated to a breaking point. In just the last few years, Canada has fallen in global rankings from second in the speed of its 4G networks to 14th in the speed of its 5G networks (Opensignal, 2021).

Even though spectrum is a critical resource for wireless service providers (Innovation Science and Economic Development Canada, 2021a), Canada's spectrum policy is not designed to confront the challenges we face. It is now significantly hindering our ability to compete with our peers as a leading wireless and digital technology jurisdiction. Canada was the 38th country to begin the process of allocating key spectrum frequencies for 5G (GSMA ,2020) and did so four years after the first allocations abroad (Analysys Mason, 2021). It will have allocated less spectrum than almost all other comparable nations by 2023 (Analysys Mason, 2021) and at prices far in excess of the OECD average (Analysys Mason, 2021; Koutroumpis, 2020). Worse still, there will be a significant lag before much of the auctioned spectrum becomes usable in Canada. Other countries, such as the US, have found ways to reduce this lag to a far greater extent (Institute of Fiscal Studies and Democracy, 2021). The critical mid-band spectrum, which will allow Canadian operators to reach international specifications for 5G networks, will not become usable in many rural areas for a full decade after other countries began the process. The

spectrum frameworks of Canada's competitors have evidently been much more effective, and nothing in the Government's recent consultations stands to effectively address any of these issues (See e.g. Innovation Science and Economic Development Canada, 2021a).

Every advanced country is now in a global race to bring next-generation network technologies to industry and connectivity to all citizens. Leading countries such as South Korea, Japan and the US understand that fast, reliable networks are necessary to compete on the global stage and facilitate leadership in sectors requiring digital technologies and the processing of vast amounts of data.

As discussed in more detail below, to keep pace, Canada must release more spectrum, faster and at a lower cost. It must revise its licencing conditions to better connect rural Canadians, improve oversight of policymaking and adopt a stronger system, which is more transparent, accountable and independent in line with other developed countries. A comprehensive review of spectrum policy, root and stem is required.

3. What is spectrum?

In the context of telecommunications, 'spectrum' refers to a subset of frequencies on the electromagnetic spectrum – the medium through which wireless technologies send information. The wireless communication of data depends on the allocation of particular 'bands' (sections) within the spectrum for particular uses and users. Just as having two different radio stations and police dispatch broadcasting on 88.1 FM in Toronto would create interference, spectrum bands often need to be used exclusively. For this reason, governments are required to allocate spectrum bands for specific purposes, such as commercial radio or the police, and then businesses, such as individual radio stations. Systems to allocate spectrum for different purposes operate at both domestic levels, in Canada through Innovation, Science and Economic Development Canada (ISED), and at the international level, through forums such as the International Telecommunication Union (ITU), the UN special agency. These bodies allocate spectrum for purposes, such as television, Wi-Fi, the military, satellites, meteorological observation and commercial mobile networks.

Challenges for policymakers arise because spectrum is scarce. Useful bands of spectrum are finite and different bands have different uses. Bands vary in the amount of information they can carry, the distances over which they can travel and how effectively they penetrate, for example, buildings and trees. Differences in range mean that exclusivity is required over a variety of sizes of area. Consider, for example, the range of a Wi-Fi router versus a mobile phone tower, or the differences in the amount of information communicated by mobile phone towers and FM radio. Scarcity, coupled with varying amounts of geographical range, makes allocating spectrum a difficult issue of policy. The issue is never truly settled. As technology changes, so do the useful parts of the spectrum, as do the socially optimal uses of the spectrum already allocated. For example, the switch to digital television meant that large amounts of spectrum previously used for television could be reallocated to mobile networks (the 600MHz and 700MHz bands). Even when spectrum has been allocated for a particular purpose, there is still the question of which entities will be awarded the limited spectrum available in that band to put it to the intended use.

Modern mobile telecommunications require large amounts of spectrum. There are only limited frequency bands that can be used for data-intensive, modern network technologies, which exacerbates the issue of scarcity. Generally speaking, the more spectrum a mobile network provider has, the better the quality of service it can offer, and the cheaper it is to deploy high-quality networks. Furthermore, to be used most efficiently, spectrum needs to be awarded contiguously, covering sequential spectrum bands. This means that, if its social and economic value is to be maximized, scarce spectrum must be divided up into large blocks for each operator. Mobile operators also need a combination of bands at different frequencies. Lower frequencies are optimal for covering large areas and effectively penetrating buildings, but they cannot transmit large amounts of data quickly, while higher frequencies are better for transmitting large amounts of data in a given time, but can only cover smaller areas and are less effective for indoor use. In summary, useful spectrum is scarce, needs to be given to operators in large contiguous blocks and each operator needs large blocks in different frequency ranges to provide quality services.

To make things more complicated, when new technologies such as 5G emerge, the frequencies that are most useful change. As a result, the process of allocating spectrum to commercial mobile networks and awarding it to specific operators must

happen repeatedly. Spectrum policy determines how this process of allocation and award occurs and thereby determines if, when and how the necessary spectrum for new technologies becomes available to mobile operators. It thus also determines how new technologies, such as 5G, develop in a jurisdiction. As noted, 5G presents for the first time 'industrial-grade' wireless connectivity. How it is deployed will therefore significantly impact Canada's capacity for economic activity and international competitiveness, making Canada's spectrum policy of immense importance.

4. How does spectrum allocation for mobile networks work?

There are two steps to mobile operators being given the ability to use a particular band of spectrum in a particular area: allocation and award. Spectrum must first be allocated by a government for use by commercial mobile networks (or, more recently, 'flexible use') in an area rather than, for example, the military, television or meteorological study. Once spectrum is allocated to commercial mobile networks, it can then be awarded by state agencies to specific mobile operators. This is usually achieved by granting an exclusive licence to use a section of a spectrum band within a particular area, ranging from national to hyper-local in scope.

Internationally, there are three broad mechanisms through which spectrum licences are awarded:

- **Auction:** globally, spectrum is often awarded via auction (Analysys Mason, 2021; Taylor and Middleton, 2020) and auctions are being used in Canada and all other OECD countries, save Japan, to award key 5G spectrum. Where they are undistorted by political concerns, auctions are the most efficient mechanism for awarding spectrum licences. Auctions are used because, rather than relying on the government to analyze the immense complexity of the market, they provide spectrum to operators, which based on their expert industry and market knowledge, believe they can generate the most value. The highest bidding prices are taken to reflect the highest expected returns, which in turn is deemed to identify the means of accruing the highest economic and social value possible from the spectrum without requiring the government to investigate or understand each business case in detail. While they are widely used, jurisdictions vary in terms of auction mechanism, the amount of spectrum auctioned, deployment obligations, spectrum caps (limits on spectrum holdings for individual operators) and whether spectrum is 'set aside' for a particular category of operator.
- **Beauty contest:** administrative awards or 'beauty contests' entail a more traditional tender system in which operators compete against one another on the basis of their business plans, and winners are simply chosen by the awarding authority. This is the approach used in Japan. Beauty contests can be problematic where a lack of sufficient information on the part of the awarding authority or political concerns distort the awards process, resulting in awards to operators that will use scarce spectrum less efficiently than the rejected candidates.
- **Direct award:** spectrum may be directly awarded to operators without competition. This is unusual in OECD countries, unless there is only very limited demand for the spectrum in question. In this case, spectrum is generally awarded on a first-come, first-served basis (see, for example, Innovation Science and Economic Development Canada, 2021a). Some direct awards do occur when there is significant demand for spectrum. This mechanism was used by some OECD countries such as New Zealand to accelerate spectrum awards in the face of the COVID-19 pandemic, which delayed the auction process. Canada did not use this mechanism in the face of COVID-19, simply opting to delay its equivalent auction.

Who awards spectrum licences?

Canada has used auctions to award spectrum licences since 1999. These auctions are organized by Innovation, Science and Economic Development Canada (ISED), a government department and the body also responsible for allocating spectrum for use by commercial mobile networks. This is an unusual institutional arrangement (World Bank, 2011). Most other comparable countries, including the US, the UK, Australia and all but two of the EU 27 (Spain and the Netherlands), separate high-level policymaking from detailed regulation and give an expert independent sectoral regulator, such as the CRTC, responsibility for determining the granular spectrum policies to achieve the government's objectives.

How long do the licences run?

The licences awarded recently for 5G in Canada now run for 20 years, which is the same as, for example, the UK, Australia and New Zealand, and include deployment conditions requiring that a percentage of the population receive coverage after a set period. These long licencing periods are necessary to create sufficient certainty for operators to invest in networks, but they also make it critical that licences come with adequate conditions to ensure valuable spectrum is used efficiently over an extended period of time. 'Deployment conditions' are intended to ensure that licence holders possess meaningful incentives to use the spectrum they are awarded to serve consumers rather than, for example, leaving it fallow before reselling it at a premium.

How do governments make sure spectrum is put to use?

An auction for a licence, unlike a beauty contest, removes the ability of the government to assess each operator's business plan to ensure that the planned use of the spectrum will meet policy goals. Deployment conditions are a key means of alleviating this weakness. Canada does include such conditions within licences sold at auction, but as will be seen, unlike other jurisdictions Canada's record with the design and enforcement of such conditions is poor. When combined with other elements of the Canadian regulatory regime, this has resulted in significant amounts of scarce spectrum being unused and vast areas with poor service. This is particularly the case in rural Canada, with severe implications for the social and economic well-being of rural Canadians and Indigenous communities.

Can spectrum lead to market power?

Ex ante mechanisms to ensure that spectrum awards do not result in unduly concentrated markets are relatively common internationally. When spectrum is scarce, most countries use spectrum caps to ensure that one or a few operators are not awarded so much spectrum that competitors struggle to act as a competitive constraint, which would otherwise allow such operators to exert market power. Such measures are entirely proper. While a cap could make an auction less efficient by precluding the most efficient user or users from bidding on all the available spectrum, caps are sometimes necessary to ensure that winning bids are motivated by high-value usages of spectrum rather than the value of obtaining market power by limiting competition. Spectrum caps are now used almost universally to address this potential problem, but only where there is a realistic prospect of such a problem emerging.

Can spectrum policy be used to address competition problems?

As noted, most jurisdictions use auctions because they are the most efficient way of determining which businesses will put the limited spectrum to the best use. In Canada however, spectrum auctions are also structured not only to prevent the creation of market power ex ante, but also to intervene in the market, ex post, as a supplement to competition laws, merger control and regulation. The goal is to address a perceived link between affordability and the level of competiton. In some sense therefore, the Canadian government seeks to have its cake and eat it too, attempting to combine the efficiency of auctions with the ability of a beauty contest or direct award to ensure a certain distribution of spectrum. The use of spectrum in this way is controversial, but is a natural consequence of all other powers for intervention lying outside the direct political control of the minister with the Competition Bureau bound by the competition laws and the sectoral regulator, the CRTC, being independent.

Intervening in the structure of a market using spectrum is not in itself historically unique. In some jurisdictions, priority in the auction process has not always been given exclusively to maximizing the economic and social returns from the use of the spectrum itself (Sims, Youell and Womersley, 2015) and such jurisdictions have also adopted more interventionist auction policies in an attempt to actively shape the market.

One form of such intervention is a 'set-aside'. Set-asides involve excluding particular operators from bidding for a portion of the available spectrum. This spectrum is 'set aside' for other firms. This means there are effectively two auctions, one open auction and one for the set-aside spectrum, with one open auction concerning an artificially reduced amount of spectrum and the other entailing an artificially reduced amount of competition. Encouraging new entrants to the market in this way used to be relatively common to counter the deep pockets of incumbents, but the practice is increasingly

rare as empirical and econometric evidence suggest that it is net-counterproductive (Cave and Nicholls, 2017). Set-asides have been absent in all wealthy OECD countries during the current 5G auctions, except in Canada and Italy (Analysys Mason, 2021). In Italy, set-asides were used to facilitate a new entrant following a merger (Analysys Mason, 2021). Canada, on the other hand, is alone in reserving spectrum through set-asides and considering established regional telecommunications operators with their own deep pockets eligible to bid for it (Analysys Mason, 2021).

Rather than determining which businesses believe they can create the most value from the spectrum, Canadian spectrum auctions thereby award significant portions of the limited available spectrum at an artificially discounted rate to large regional firms to encourage the presence of additional operators in the market. As noted, the goal is to address a perceived link between affordability and the level of competition. The result of reserving large amounts of spectrum for this purpose is that the national operators bid on artificially reduced amounts of spectrum, resulting in Canada having the highest average spectrum prices in the world by a significant margin, even when including the discounted set-aside spectrum (Analysys Mason, 2021). Artificially inflated prices have the knock-on effect of reducing the capital available for national operators to build networks and, unless regional firms are incentivized through strong deployment conditions to use their subsidized spectrum to compete aggressively, can raise the eventual prices charged to consumers as high spectrum costs are passed through. As will be seen throughout Section 5, Canada has a toxic combination of set-asides for large regional firms, introducing massive inefficiency, without adequate measures to ensure the set-aside spectrum is used as intended, and with significant evidence that using spectrum in this way has not created competition as envisioned.

Can auctions be used to raise funds for the government?

Alongside attempts to use spectrum awards to increase competition, some governments outside the OECD use spectrum awards to generate revenue for the government. Attempting to maximize auction revenues is frequently identified as a false economy; it undermines the efficient allocation of spectrum with larger knock-on costs to the economy than the revenue generated (Ala-Fossi 2020, Song 2020, Jain and Neogi 2020, Marcus 2020). It is important to note that Canada does not attempt to maximize auction revenues because this false economy is recognized (Industry Canada, 2007). Nonetheless, Canada's policies mean the country faces many of the same problems that maximizing revenues creates as set-asides produce artificial scarcity for national operators, driving up spectrum costs and crowding out investment in networks and innovation. Indeed, in the 2021 3500MHz auction, Canada's prices were the highest in the world for a mid-band auction by a significant margin (Analysys Mason, 2021).

5. International best practices in spectrum policy

This white paper presents six key dimensions of spectrum policy for comparing Canada to peer jurisdictions. The clear conclusion is that Canada is consistently behind other OECD countries and failing to deliver on its stated policy objectives. We examine:

1. **Pro-competitive measures**
2. **Price**
3. **Timing**
4. **Quantity**
5. **Deployment obligations and recovery of fallow spectrum**
6. **Governance**

This analysis demonstrates that the current spectrum policy framework is costly to Canadians. It is not fit for purpose in the context of global competition for 5G deployment or for building competitive firms that rely on digital and data technologies. Canada's rules inhibit our businesses, place Canada at a competitive disadvantage and, even within Canada, fail to deliver on their stated goals. Furthermore, it identifies the root cause of this problem: inadequate levels of transparency and accountability, and a lack of effective assessment of the effectiveness of the chosen policies.

5.1 Pro-competitive measures

The most distinctive feature of Canada's spectrum policy is the continued use of set-asides for established regional operators. Canada is the only wealthy OECD country to use this policy (Analysys Mason, 2021). Between July 2008 and July 2019, only four of the 65 4G auctions across the OECD had a set-aside without a cap, and three of these four were in Canada, with the fourth in the Netherlands way back in 2012 (Dippon, 2019). The set-asides imposed in Canada were also 'extra large' (43% to 60%), while the rest of the OECD applied nine tiny set-asides (c.5 to 7% with two exceptions), eight of the nine with an accompanying cap (Dippon, 2019). In the 5G world, the comparison becomes even more stark. In the 64 auctions for 5G spectrum outside the mid-band in other countries to 2019, only two set-asides were applied, with two more planned (Dippon, 2019). Each of these set-asides came with spectrum caps, eligibility was restricted to market entrants and these were small set-asides of more traditional mobile bands as part of large multi-band auctions (Dippon, 2019). In the context of mid-band auctions, only Canada and Italy among wealthy OECD countries have imposed set-asides, and in Italy only for new entrants following a merger (Analysys Mason, 2021). In Canada, the set-aside was again extra large, with around 44% of the total available at auction set aside (Analysys Mason, 2021). Canada's outlier status with regards to its continuous use of set-asides is truly remarkable in quantity, size and the eligibility of established operators.

The set-aside policy in Canada excludes the lagest operators from bidding on a proportion of the spectrum. As the eligible bidders for this set aside spectrum includes large established regional operators, the spectrum is effectively guaranteed to these firms who have far greater access to capital than, for example, community or Indigenous owned networks. The rationale is that introducing a fourth operator will intensify competition in mobile networks and thereby lower retail prices (Analysys Mason, 2021; Koutroumpis, 2020). The implicit expectation is that by continuing to set aside spectrum for large regional operators and thereby provide it at a subsidy by excluding competing bids, these companies will offer competitively priced services and even eventually begin to offer services nationally. This subsidy is substantial, with national operators paying an average of 3.5 times the prices paid by regional operators at the recent 3500MHz auction (Crandall, 2021). After 14 years of using set-asides in this way however, a fourth national carrier has not emerged and, in fact, the largest regional operator is attempting to merge with an established national operator, citing the need to keep up with investment in new infrastructure and technology (Shaw, 2021).

Higher spectrum prices in Canada are almost completely driven by set-asides, artificially reducing the amount of spectrum on which large operators can bid (Koutroumpis, 2020) and empirical research has demonstrated that spectrum costs account for as much as $100 on the bill of every customer of the national carriers each year (Crandall, 2021). Alongside raising retail prices, the artificially inflated cost of spectrum caused by set-asides crowds out other forms of investment, such as in networks and R&D, as operators exhaust large quantities of available capital to meet spectrum costs. In essence, set-asides provide huge discounts to regional operators on the spectrum they would otherwise purchase and awards them more

spectrum than they would otherwise purchase, while artificially reducing the amounts of spectrum large operators would otherwise purchase and massively inflating the prices they pay for the spectrum that they do purchase.

The conclusion one must draw is either that Canada has uniquely identified a means of addressing competition issues while raising billions in additional revenues for the public purse, or that every other jurisdiction has calculated that the costs in fact outweigh the benefits.

5.1.1 Set-asides, competition and efficiency

The fact that set-asides are net harmful is not new information. Econometric analysis has suggested that auction price concessions have limited effectiveness for encouraging competition (Madden, Bohlin, Tran, & Morey, 2013). As far back as 2006, academics were warning that set-asides allocate licences to low-value (i.e. inefficient) firms and that, if the resale market in licences/capacity is ineffective, this inefficiency can outweigh any positive effect from market entry (Hoppe, Jehiel and Moldovanu, 2006).

To increase the likelihood of set-aside spectrum being used by a fourth operator, the government prevents spectrum from being resold to national operators for an extended 'waiting period', guaranteeing the ineffectiveness of the resale market in the short and medium term. This is necessary to prevent set-aside spectrum being purchased with the intent to immediately resell it to a non-eligible operator, but also means that even an inefficient operator that purchases set-aside spectrum in good faith and discovers they are unable to put it to use is unable to resell the licence to more efficient operators until years later. If the government did not attempt to engineer the market through set-asides, spectrum would be less likely to be purchased by inefficient operators and, even if this were to happen, operators would be free to put spectrum they would otherwise waste back onto the market. A 2015 study found that in Canada, set-asides at the 2008 auction probably led to 'an efficiency loss on the order of $400-500 million' (Hyndman and Parmeter, 2015; Cave and Nicholls, 2017). Canada's continued use of this policy over a further 13 years has only inflated this figure.

It is worthwhile reflecting whether there is adequate evidence of proportionate benefits that justify these substantial costs to the Canadian economy. Certainly, if they exist, the size of the requisite benefits should mean that they can be identified but, if such benefits are evident, it is also curious that other jurisdictions do not adopt similar models and that Canada is the only country using set-asides in this way.

In Canada, the situation is worse than merely introducing inefficiency. Not only do set-asides award spectrum inefficiently, but regional operators have limited incentives to deploy their spectrum to the maximum extent possible. This results in fallow spectrum, particularly in rural Canada. This occurs because of roaming obligations (Industry Canada, 2007; Canadian Radio-Television and Telecommunications Commission, 2015) and Mobile Virtual Network Operator (MVNO) obligations (Canadian Radio-Television and Telecommunications Commission, 2021). Not only do regional operators receive their spectrum at a discount at auction, but under existing regulations, they are also able to then meet only their minimum deployment requirements by focusing on the most valuable areas – the urban areas – before piggybacking on the wider networks and spectrum of national operators. In effect, large regional firms are enabled by parallel regulation to offer high-quality services with wide footprints without making use of the spectrum they have received at a subsidy. This means these regional operators do not make efficient use of the spectrum they have been handed, leaving large portions of it fallow for decades, while the customers of these regional operators add traffic to the limited spectrum purchased by national operators (despite national operators having paid inflated prices for limited spectrum). As noted above, a necessary feature of the set-aside is that the spectrum cannot be resold in the short to medium term, meaning that the regional operators have neither the incentive to deploy the scarce spectrum, nor can they resell spectrum they have no intention of using until much later.

Wasting spectrum is a cardinal sin of government spectrum management and an immense failure of policy. Companies are willing to pay billions of dollars for spectrum licences far in excess of what would be required to provide some minimum quality of network, and this is not because they relish doing so. Spectrum is a necessary input for providing wireless services, but the quantity of spectrum directly determines the quality of services, the number of users who can receive that service and how efficiently network equipment can be deployed. Less spectrum means an inferior service, for fewer people, with a less efficient and more expensive deployment of network equipment. Implicit in the reference by Hoppe, Jehiel and Moldovanu (2006)

to the secondary market as a release-valve for the inefficiency created by set-asides is that large operators that already possess significant spectrum holdings are nonetheless willing to pay for further spectrum and put it to use. The waste of spectrum is therefore a terrible outcome for spectrum policy, but to force carriers that build networks using an artificially reduced amount of spectrum to accommodate the customers of companies wasting spectrum is to both cement and reward such wastage.

Given the demonstrable social and economic costs of set-asides and their blanket use in Canada, the government should be able to indicate the tangible benefits to Canadian consumers since set-asides were introduced over a decade ago. Implicit in the acceptance of expensive inefficiency to facilitate the entry of additional players is the idea that, at some point, these costs will be compensated by an improvement in competition, leading to lower prices or improved services. While it is not reasonable to expect a hard date be indicated by which point either this compensation is expected or the policy will be considered to have failed, after more than a decade this date has passed. Save for Eastlink and Videotron, every new entrant from the flagship 2008 AWS auction, the first to include a set-aside, has failed outright or been acquired by an incumbent (Bradshaw, 2016). The merger between Shaw, a well-positioned "new entrant" in the mobile space whose mobile business has received $1.5 billion in effective subsidy since 2008,[4] with a market leader, Rogers, merits official recognition of the failure of the set-aside policy in Canada.

Each of the remaining "new entrants" from the government's decade-old set-aside policy is now affiliated with a former cable monopoly. If they wished to deploy their networks, these well-capitalized companies would not need to rely on the subsidy from set-asides. If the business case existed for deploying competitive fourth networks across Canada, such companies could do so without issue. Given the level of subsidy, it is striking that this has not happened and that Shaw is seeking to leave the market to keep pace with the required infrastructure investments for 5G (Shaw, 2021). The business case, evidently, does not exist. What appears to be happening is that, rather than using set-asides to keep the door ajar for new entrants that will eventually become viable competitors, the government is propping up unviable fourth competitors through extensive subsidies, which have never and will never translate into concordant benefits for Canadians. This is to say nothing of the costs from inefficiency introduced to the market by the process. No other country does this. The picture is one of well-capitalized cable monopolies, mostly owned by billionaire families, being handed spectrum at a subsidy at the expense of Canadians who desperately need high-quality connectivity that such companies will not deliver, all while preventing large operators from offering that high-quality connectivity.

While a fourth carrier may seem a reasonable goal, blunt 'four is the magic number' policies are increasingly scarce (Czapracka, 2021; Davies, 2020; Rogers, 2021). For example, a merger in the Netherlands reducing the number of operators from four to three has recently been cleared without any remedies. Furthermore, 'four is the magic number' policies have been explicitly rejected by the Court of Justice of the European Union (Czapracka, 2021). Also of note is that, despite the majority of the G7 having only three national operators, only Canada uses set-asides continuously to prop-up established smaller players (Analysys Mason, 2021). Other jurisdictions are adopting alternative and more nuanced approaches that do not turn exclusively upon whether there are three operators or more and, even when the number of operators is a consideration, are willing to put heavy emphasis on benefits such as economies of scale, rather than merely counting the number of companies (Czapracka, 2021). All the available evidence suggests that these jurisdictions have overtaken Canada in the deployment of crucial spectrum for 5G.

5.1.2 Set-asides and spectrum profiteering

Alongside the trifecta of introducing market inefficiency, hamstringing deployment and a lack of evidence for proportionate benefits for the Canadian public in principle or in practice, set-asides as currently used in Canada also result in spectrum profiteering. This is the most egregious effect of this 'made-in-Canada' policy. Following substantial public subsidy at auction, and having left rural spectrum unused for years, regional operators are able to eventually resell set-aside spectrum to incumbent operators for significant profits and use subsidized spectrum as a valuable asset when being acquired. These profits come from the difference between the set-aside price paid at auction and the actual value of the spectrum if it had been sold in an open auction. National operators may even be willing

4. This is calculated from the difference between the setaside prices and open auction prices in Canadian spectrum auctions and public records on auction results from ISED.

to pay higher prices than in an earlier open auction if there is greater than expected scarcity or the spectrum increases in value over time (as equipment becomes capable of using additional spectrum more efficiently). Rather than a means to provide wireless network access to Canadians, for large regional operators with access to cheap capital spectrum thus can become another speculative investment, left unused until at least the end of the enforced waiting period when it can be resold.[5]

One example of this mechanism is a multi-billion-dollar cable company that has been given $4.3 billion in effective subsidies by the Canadian government through set-asides since 2008.[6] This subsidy reflects not only an immense cost saving, but a significant portion of the available spectrum made unavailable to larger operators that could have used it to deliver better services and deploy networks more efficiently. As such, there are clear costs to Canadians. In return, this operator has, for example, deployed only 8.8% of their rural spectrum in Eastern Ontario, covering only 76,084 of the 435,452 Canadians in the area and leaving 82.5% with no coverage.[7] In 2017, this same company resold subsidized spectrum received through set-aside for a self-reported $331 million in profit after leaving the spectrum unused for years (Quebecor, 2017; Innovation Science and Economic Development Canada, 2017a; Innovation Science and Economic Development Canada, 2017b). These transactions were approved by the government. Government policy allowed this firm to take a crucial public asset for the provision of critical services and turn it into an empty, unused, subsidy-fuelled object of speculation. The recent 3500MHz auction saw this same cable company acquire 50% of the set-aside spectrum in Canada, including in regions where they have no 4G presence (or no telecommunications presence at all). As a result of other government policies in this auction, the absence of an existing network in these areas will allow this company to cover as little as 5% of the population in an area by 2028, and they will be permitted to resell most of their subsidized spectrum for a huge profit after only five years (Innovation Science and Economic Development Canada, 2021b). This is to say nothing of the licences this company may acquire as a result of ongoing discussions concerning the merger of another regional operator and an incumbent, which would take the effective subsidy to $6.5 billion for a single company.

To reiterate, regional operators can engage in this behaviour without detriment to their service offerings from the perspective of Canadian consumers, but all Canadians suffer as a result. National operators are compelled to allow regional operators' customers to use their networks wherever the regional operator lacks their own network (and is therefore not using their spectrum) on the basis of either mandatory roaming or MVNO obligations. This means that all traffic outside urban cores is squeezed into the spectrum holdings of the national operators (purchased at inflated prices), while the frequencies controlled by the regional operators sit empty in the same areas awaiting resale. Whether a Canadian is a customer of a national operator or a regional operator, the degraded network experience from the over-concentrated traffic is the same. The absence of an effect on quality of service removes competitive incentives for regional operators to invest in rural networks, and at the same time, significantly reduces investment incentives for national operators that gain no competitive advantage from deploying networks widely. This makes rural deployment and the prevention of spectrum profiteering entirely dependent on the effectiveness of the government's deployment conditions, rather than competition (the problems with which are explained below. See Section 5.5). It should be emphasized that, under the existing policy framework, there is nothing wrong with this practice of purchasing a public asset at a subsidy and sitting on it before reselling it later for profit. Current policy, ostensibly designed to maximize the economic and social benefits from spectrum, permits and facilitates such unjust enrichment. This is why the policy must be changed, notwithstanding predictable objections and threats to withdraw from the market made by multi-billion-dollar companies that stand to profit by hundreds of millions of dollars from speculation under the existing system.

Spectrum profiteering represents not just an economic failure of government policy, but a moral failing. Propping up fourth carriers through public subsidy to allow them to make profits without concordant public benefit is objectionable in and of itself, but permitting

5. It should be noted that the deployment of network equipment to make use of spectrum that an operator intends to resell is impractical. The timeframes required to recoup the cost of equipment, coupled with the unlikelihood of reselling the equipment to other operators with differently configured networks, means that spectrum which is valued because of its resale potential is inevitably left unused until sold to operators that value it primarily to provide services.
6. See supra note 4
7. This is calculated from two public ISED databases: the 'Spectrum Licence Browser' (https://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/h_00010.html) and 'Spectrum License Site Data' (https://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/h_00012.html)

and incentivizing such companies to make hundreds of millions of dollars in profit as a reward for leaving spectrum fallow is an inimitable failure. Off the back of rural Canadians and Indigenous communities receiving poor or no service, companies that consistently attest that they operate only by virtue of government handout make eye-watering amounts of money. Indigenous communities, promised economic reconciliation by the government, have a significant resource over their territories wasted and potentially flipped for profit. Worst of all, the government has continued to use the very policy that facilitates this outcome, set-asides, despite having seen this occur: they approve the relevant spectrum transfers. This suggests either that the government does not care that they are handing manifestly unjust profits to billionaires at the expense of rural and Indigenous Canadians, or that they think this is an acceptable price to pay for the ostensible virtues of propping up fourth carriers through set-asides. Again, where and when these virtues will purportedly manifest is unclear. Whether these benefits will manifest or not, it is unclear that Canadians, and particularly rural and Indigenous Canadians, would agree with the calculation the government has made.

While the access licencing regime proposed by ISED in their 2021 consultation could address the use of spectrum for speculation in some circumstances, the bands under consideration in that document were awarded so long ago as to be irrelevant to the conversation concerning bands auctioned since 2008. Nonetheless, the access licencing regime could go some way to preventing profiteering if made part of a general retroactive attempt to compensate for the historic weaknesses in the set-aside policy in Canada (Innovation Science and Economic Development Canada, 2021a).[8] As things stand, the only real mechanism for preventing profiteering, if a government insists on using a set-aside policy, is to ensure that the necessary resale ban is robust and ensures deployment prior to any potential resale. While this has an obvious chilling effect on the secondary market and may result in wasted spectrum, this has to be accepted as a known cost from set-asides. The issue of fallow spectrum in Canada derives from a use of set-asides, but exacerbated by insufficiently stringent deployment conditions (see Section 5.5) coupled with too short a period of time when resale is prohibited.

5.1.3 The alternatives to set-asides

Spectrum set-asides are a counterproductive method of attempting to intensify or facilitate competition in Canada. A call for their abolition, however, does not necessarily entail the removal of all competitive measures, or even the government's fourth carrier policy. A further possibility is to use other, less distortive measures such as a spectrum cap.[9] Caps, which are observed often internationally, set a maximum amount of spectrum an operator can win at an auction. By doing so, they can ensure that no one operator, or no group of operators, acquire so much spectrum that none remains for further operators if the result will be the acquisition or maintenance of market power. Caps have been used in Canada in several auctions over the last decade (the PCS auction in 1995, the 700Mhz auction in 2014, and the 2500Mhz auction in 2015), and have been tacitly acknowledged to be superior to set-asides by ISED in the recently released 3800MHz auction framework, and can be used both in isolation and in combination with a set-aside. While they are preferable to the impacts of a pure set-aside, they can nonetheless introduce inefficiency and must be used properly if their negative impact is not to outweigh any benefit. It is therefore necessary, prior to the argument concerning the superiority of caps to set-asides, to consider when it is appropriate to use pro-competitive measures in Canada.

There are three broad ways that pro-competitive measures can be used to:

1. Prevent operators acquiring so much spectrum that the concentration of spectrum holdings creates market power through foreclosure;
2. Address market power already acquired by operators as a result of spectrum holdings; and
3. Address a market power problem or competition goal unrelated to spectrum holdings.

Operators that possess market power can expect monopolistic or oligopolistic profits and will lack the incentives to respond adequately to market incentives and put spectrum to use efficiently. Without some measure to address market power acquired or maintained through the concentration of spectrum holdings, the bids entered in an auction will not reveal the most efficient (proposed) user(s) of the spectrum. A reasonable question is which of these particular form

8. It should be noted that the proposals related to subordinate licencing can do nothing to address the issue of spectrum used for speculation as subordinate licences are unable to prevent the transfer of spectrum licences.

9. Although other alternative competitive measures such as bidding credits are a possibility, there has been no appetite expressed for their use in Canada and they will thus be left to one side for the sake of simplicity.

of potential market power problem are at issue when considering pro-competitive measures in Canada, if any, and whether they are appropriate to address through spectrum auctions.

The easiest starting point is to look at whether the market is competitive. If the market is competitive, then one can only be dealing with the first potential use of pro-competitive measures: to prevent the creation of market power. If market power does appear to exist, it must then be determined whether it is connected to spectrum holdings. As Canada has the fourth lowest concentrated spectrum holdings of the 145 GSMA monitored countries, it can be safely assumed that any market power problem which could possibly be identified in Canada is unlikely to be linked to spectrum concentration. As such, in Canada, the use of competitive measures can only realistically be concerned with either preventing operators from acquiring market power through foreclosure or addressing a market power issue unrelated to spectrum auctions.

5.1.3.1 Foreclosure

Whether the outcome of any particular spectrum auction in Canada could result in foreclosure and market power on the part of incumbents is an empirical question, the likes of which competition bureaus and merger authorities address frequently. Although ISED references foreclosure in the mm-Wave consultation, for example, their rationale simply reads 'ISED is of the view that larger service providers likely have the means and incentive to prevent other bidders, particularly smaller service providers, from acquiring spectrum licences in an open auction.' No evidence is provided, nor does ISED explain how it has reached this view. This is particularly notable in the mm-Wave auction, where huge amounts of spectrum are available and the use cases for the spectrum are not yet clear. The idea that there is a risk of foreclosure in these circumstances seems questionable.

As noted, a risk of market power resulting from an auction is an empirical question. Merger control rules in both the US and Canada use clear objective measures of whether a merger is likely to concentrate the market such that the result will be anti-competitive, such as the HHI index (Competition Bureau Canada 2011, (US) Department of Justice and Federal Communications Commission 1997). Even when these tests are satisfied, potential efficiencies which outweigh an anti-competitive effect are also taken into account.

The measures used are not arbitrary and are observed internationally. To impose pro-competitive measures to prevent the acquisition of market power through a spectrum auction, it is reasonable to assert that similar guidelines should be in place when discussing a risk of market power resulting from spectrum auctions, so that the judgment of any potential anticompetitive effect can be based on sound analysis and free from arbitrariness. Although Canada has a relatively low spectrum HHI index, an anti-competitive concentration of spectrum holdings could be alleged and it is therefore important to have such guidelines in place. Notably, the nature of any pro-competitive measure chosen on the basis of such analysis, such as the level of the cap, may be substantially different from those chosen in the absence of such measurement. A cap, for example, would be set at the level where spectrum concentration raises a competition concern, and no lower. Such a cap may also be substantially different from one designed to address an issue of market power unrelated to spectrum.

5.1.3.2 Non-spectrum competition issues

An alternative reason to use pro-competitive measures is to address a perceived issue with market competition unrelated to spectrum holdings, whether actual or potential. The goal with such measures is to engineer a particular market outcome from the auction, despite potential costs to the efficient use of spectrum and the goals of spectrum policy. Auctions in which there is no incentive to attempt foreclosure and no market power maintained through spectrum holdings are efficient as the bids will reflect the value placed on the spectrum by operators for providing services, with the highest bids reflecting the highest returns (or the greatest likelihood of returns) and therefore the highest possible economic and social benefit to Canadians. A pro-competitive measure such as a cap in this instance would prevent an operator acquiring spectrum above a certain quantity, even when they would use that spectrum most effectively to provide efficient services. Unlike using a pro-competitive measure to prevent inefficient bidding aimed at creating or maintaining market power, a measure seeking to indirectly engineer market structure in this way has costs for which policymakers must demonstrate Canadians will be realistically compensated.

A reasonable question is whether pro-competitive measures within one or several spectrum auctions are capable of addressing the competition issue in question or if it is not the appropriate tool. As noted, the efficacy

of attempting to introduce additional carriers such spectrum auctions has poor empirical evidence behind it. Furthermore, because of this lack of evidence, how to use pro-competitive measures to address through issues is therefore equally unclear. For example, it is not clear whether one should use a set-aside or cap in a manner likely to encourage many operators, or one, or whether the effective subsidy from the set-aside is a relevant consideration. This is quite apart from whether the alleged competition problem that policymakers are seeking to solve is itself sufficiently well-defined to invite consideration of a proposed chain of causation to an eventual positive outcome. The picture is one of muddy problems being addressed using inappropriate and exceptionally complex tools that can cause harm.

As will be discussed further in Section 5.6, the reason that spectrum is being used to address perceived competition issues unrelated to spectrum seems likely to be connected to the fact that, unlike in other jurisdictions, spectrum remains under political control in Canada, while the sectoral regulator is independent. As such, spectrum is being used to try and address a perceived competition issue, even if there is no relationship between the issue and spectrum holdings. What is happening is that the government is using the tools it has on hand, whether they are appropriate or not. As the evidence elsewhere suggests, this has not been effective. All the entrants encouraged by spectrum set-asides since 2008 have now either failed or are associated with a wealthy cable company, one of which is currently attempting to merge with an incumbent, and none of these companies attest that they can exist without continued government support. Entrants have needed mandatory roaming to be granted by the sectoral regulator to remain competitive and, in 2021, were deemed to still not be adequately providing competitive pressure, thereby requiring MVNO access as a further prop. Even then, a mandate to reduce prices by 25% for some of the most popular plans was imposed between 2020-2022. Evidently, this experiment through the spectrum auctions failed, and fails continuously, but the costs to Canadians, including those particularly attributable to set-asides, are known and significant. If the Canadian government continues to use pro-competitive measures in spectrum auctions in an attempt to guarantee a fourth or fifth competitor, despite the absence of any link between any problem and spectrum holdings, it remains unclear when and how compensation for the inefficiency created will materialize, and nor is it clear that the government has adequately assessed that this will ever happen.

5.1.4 Caps versus set-asides

In circumstances where pro-competitive measures are justified, each potential measure should not be considered equally harmful. In particular, there are distinct benefits to the use of caps over set-asides.

Unlike set-asides, spectrum caps do not create artificial scarcity in the auction and thereby drive up prices. Instead, they create artificial sufficiency. Exercised demand for spectrum is curtailed by the existence of the cap; only if the cap is large enough that buyers demand more than the spectrum available, despite the cap, will the auction raise above the reserve price. This is the case even in the context of the government's ill-advised fourth carrier policy. For example, with 450Mhz available and a cap of 100Mhz, four operators could reach the cap, but only with a fifth operator attempting to purchase more than 50Mhz would the auction price exceed the reserve price. A notable feature of this mechanism is that prices may be artificially suppressed. This is a positive result for the Canadian economy relative to set-asides; as will be explained below (see Section 5.2), high spectrum prices have distinct disadvantages for Canadians and competing jurisdictions charge far less for their spectrum in order to encourage network deployment.

An auction subject to a cap rather than a set-aside also results in all operators that bid paying the same price. This avoids the huge disparity between the inflated prices paid by operators in the open auction and the deflated price paid by those eligible for set-aside. This has the effect of undermining speculation, and speculation can thereby be addressed without needing to resort to strong deployment conditions. As will be discussed below, strong deployment conditions can prevent small operators from bidding. Caps are therefore useful if deployment conditions cannot be made sufficiently stringent to prevent speculation. Although speculators could purchase cheap spectrum at the auction, subject to a cap, and seek to resell it later at a higher open-market value, operators purchasing spectrum seem likely to later value the spectrum based on what they paid at auction, rather than the set-aside price. Furthermore, such operators may expect to get substitutable spectrum in future auctions at a lower price caused by a cap and will be unwilling to pay a far higher price. This is another reason that the predictability of policy is important. Nonetheless, caps do not totally abrogate the risk of speculation, particularly where new use cases may dramatically increase the value of purchased spectrum,

and thus caps as a substitute for set-asides still rely upon deployment conditions to undermine speculation, if to a lesser degree.

That caps are preferable to set-asides is seen in international practice. Of the 21 wealthiest countries using auctions for 5G, 18 use caps (Analysys Mason, 2022). Unlike set-asides, adopting caps would bring Canada in line with international best practice.[10] There are some promising signs from the government. With 450Mhz available overall, the cap of 100Mhz imposed by the Canadian government across both the 3500Mhz and 3800Mhz bands guarantees that four operators can reach the 100Mhz of spectrum required to deploy one 5G channel at maximum efficiency, with 50Mhz still remaining for a fifth operator. As such, with this cap, Canada can have at least five operators in each region without the significant price distortion and with a lower risk of speculation than with set-asides. Despite this, the government has also raised the possibility of a set-aside, or a combination of cap and set-aside, both in the consultation for this auction and for other auctions. Again, this undermines the certainty necessary for operators to bid rationally, even in those auctions where a cap is in fact used.

Nonetheless, even with the manifestly superior policy of a cap, the Canadian government is not necessarily in line with international best practice. The problem of whether the pro-competitive measure is being used to pursue an appropriate competition goal continues to loom large. As noted above, with a cap of 100Mhz and 450Mhz available across the mid-band, the government has effectively set up the auction in a way that guarantees at least five purchasers of spectrum in each region. How the government has arrived at the conclusion that this is necessary or productive is unclear. Certainly, no empirical evidence suggesting a link between the spectrum and market power has been provided. As such, there is no clarity as to whether this cap is expected to introduce inefficiency and, if so, how Canadians are going to be compensated. The justification is perhaps that 100Mhz is the maximum channel width recommended by the ITU and that a cap of 100Mhz thereby guarantees four players with this efficient channel size. However, if this is truly the most efficient quantity of spectrum to be held by each operator, there is no need for a cap in the first place as it would be reflected in bidding patterns. As such, either the cap is unnecessary, or this factor alone is inadequate justification for the choice of cap.

The critical problem is that, as with beauty contests, pro-competitive measures, whether cap or set-aside, at root require the government to identify and manufacture some ideal market structure, despite staggering information asymmetries. This is precisely the unpalatable exercise that the use of auctions seeks to avoid and, similarly, why merger control and competition policy often turn upon clear and objective tests. An auction whereby the government uses pro-competitive measures to decide who will win what spectrum, and where, is merely a beauty contest hidden from oversight by a pseudo-marketplace. When this exercise takes place in the absence of any requirement for objectives tests, empirical evidence or even a clear description of how the measures will meet policy goals so that efficacy can be measured, this is a recipe for poor policy. This is what has happened in Canada. Canada must abandon engineering the market through spectrum, measure how and when pro-competitive measures are used and, where they are necessary, use those measures that create the least amount of harm to efficiency and incentives.

10. Whether these caps are motivated by the risk of foreclosure or the desire for an effective set-aside is outside of the scope of this paper.

Canada must:

- **Go back to first principles** – Maximize the economic, social, and environmental benefits for Canadians from their spectrum resource. Canadian spectrum policy must be about Canadians and not about protecting companies. The government must return to first principles, adopting a laser-focus on the speed and efficiency with which spectrum is deployed to provide high-quality services to as many Canadians as possible without allowing spectrum to become a means of foreclosure.
- **Spectrum policy must be evidence-based policy** – Canada's spectrum policy has been allowed to neglect its fundamental purposes because of the absence of any meaningful and transparent assessment of the government's policies, either before or after they are implemented. Canadian decision makers must be explicit about the objectives of spectrum policy and how they are balanced within any proposal, including an independent assessment of likely policy impacts akin to those undertaken by the Office of Economic Analysis of the US Federal Communications Commission. After a policy is implemented, sufficient public data, transparency, and accountability must be ensured such that independent bodies, commissioned by the government, can measure whether policies have been effective and thereby better ensure the desired policy outcomes moving forward.
- **Set aside 'set-asides'** – End the possibility of providing set-asides for established operators which, while imposing costs on Canadians through the highest spectrum prices in the world and leaving them with the 4th least concentrated spectrum holdings, has failed to increase competition.
- **Ensure speculators 'break even at best'** – Create rules to ensure that companies that have purchased subsidized spectrum through a set-aside or other measure intended to increase competition cannot use it to profiteer, by:
  - Continuing to ensure that deployment conditions are as aggressive and ambitious as is practicable for the spectrum is question to ensure squatting and flipping is unprofitable;
  - Conditioning resale on meeting initial deployment conditions, in both principle and practice; and
  - Blocking transfers of set-aside spectrum until deployment conditions are met.

5.2 Spectrum prices

Government policies in Canada, which exacerbate spectrum scarcity, artificially inflate spectrum prices with negative knock-on effects for network investment and retail mobile wireless prices. Research has consistently demonstrated that spectrum prices in Canada are almost four times higher than the OECD average (Koutroumpis, 2020) and that higher spectrum prices in Canada are almost completely driven by the use of set-asides (Koutroumpis, 2020). Alongside set-asides, policy decisions which fail to maximize the spectrum available at auction, such as withholding spectrum or staggering its release, also contribute to inflated spectrum prices. In the recent 3500MHz auction, Canada's operators paid the highest prices in the entire world (Analysys Mason, 2021). National operators paid up to 15 times the amounts paid by their counterparts in the UK, France and Germany (Crandall, 2021) and 49 times the prices paid in Finland (Analysys Mason, 2021).

As a by-product of the government's approach, spectrum prices are being inflated contrary to best international practice and optimal auction design as presented in the academic literature (Bichler and Goeree, 2017; Klemperer, 2002). These high spectrum prices have downstream negative impacts, such as decreased network investment and inflated retail prices (Ala-Fossi, 2020; Jain and Neogi, 2020; Song, 2020). The issue is not that Canadian operators should preferably pay artificially deflated prices, but that current artificially high prices are a result of set-asides and have negative consequences.

Despite widespread agreement across the industry and government on the importance of affordable, retail wireless prices and the efficient deployment of networks across the country, current spectrum policy is at odds with both.

The extent of Canada's outlier status is demonstrated in figures 5, 6 and 7. The figures for Canadian operators presented in figures 3 and 5 do not take into account the spectrum purchased at the 3500MHz auction in 2021, which represent spectrum purchased at an even higher price in figure 5 and the further increase of spectrum assets per subscriber on operator balance sheets in figure 7.

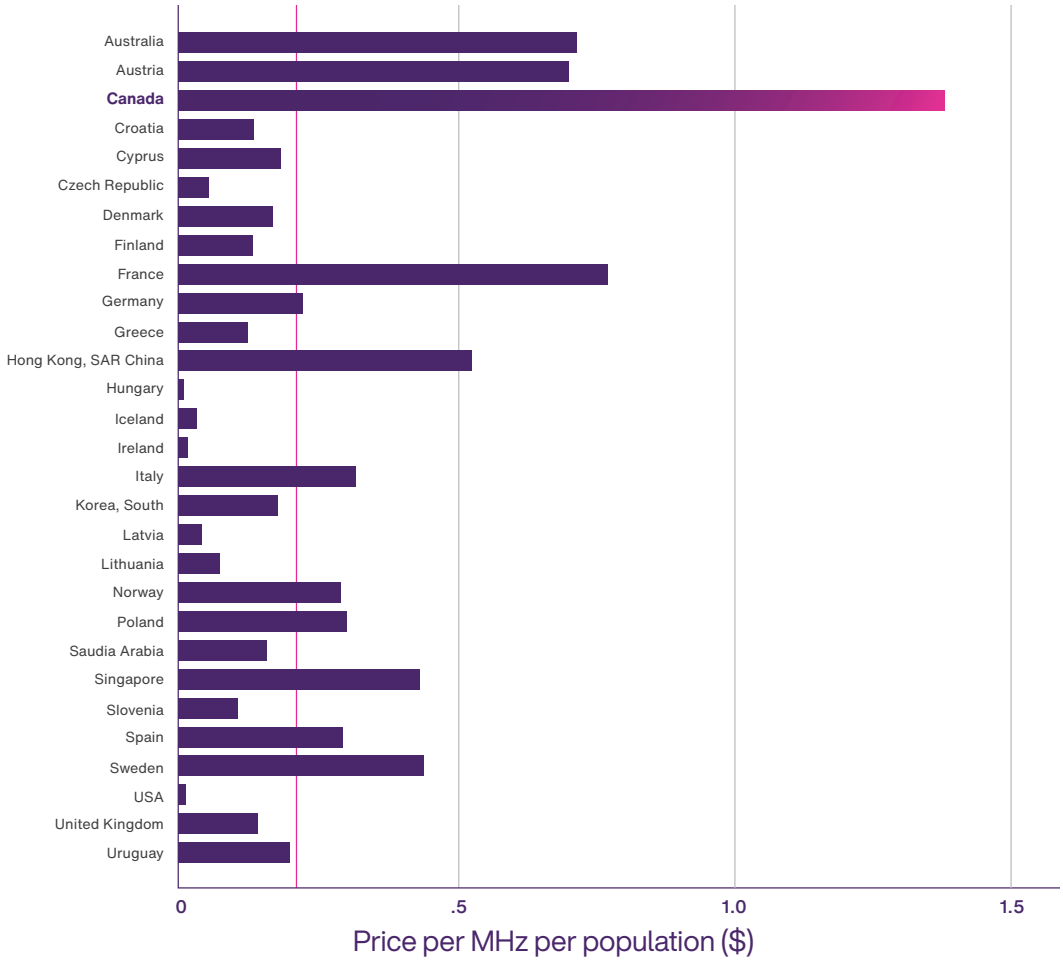

Figure 5: Spectrum prices paid per MHz per population between 2010-2020 (Koutrompuis, 2020)

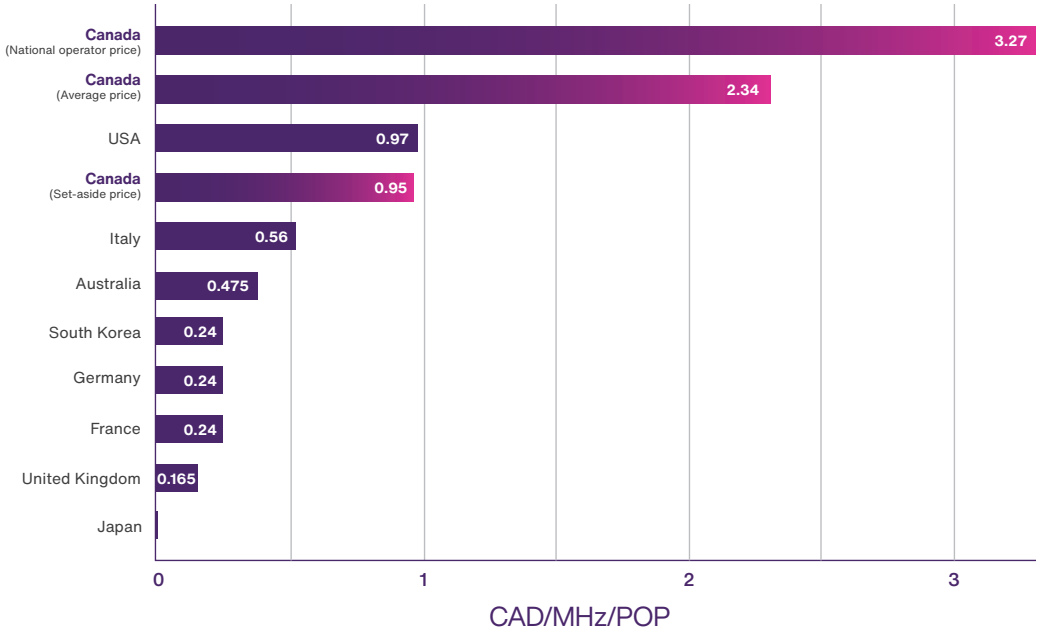

Figure 6: Average (weighted) prices paid for 3.4GHz-4.2GHz spectrum (USD/MHz/pop) (Source: Analysys Mason 2021)

Company (country)	Spectrum assets per subscriber (US $)
Bell Canada (Canada)	270
Rogers (Canada)	570
TELUS (Canada)	688
Weighted average (Canadian national carriers)	**514**
Deutsche Telekom (Europe)	146
Orange (France)	225
Orange (Spain)	91
Orange (Poland)	90
TIM (Italy)	77[3]
BT (United Kingdom)	125[4]
Weighted average (European carriers)	**133**

Figure 7: Total spectrum assets per subscriber of selected carriers, December 31, 2020 (Crandall, 2021)

Operator revenues must cover all costs. This means that inflated spectrum prices must be passed on to consumers or have a negative impact on network investment. As total pass-through would require unrealistic levels of price elasticity of demand even in monopoly and short-term effects on available capital will pertain even if gradual recovery is possible, the situation in Canada is likely a combination of both. The precise balance between the two is unknown, but the fewer spectrum costs recovered through higher consumer prices the more acute the impact on investment incentives.

That inflated spectrum prices undermine investment incentives is significant. Deploying modern networks is extremely capital intensive, none more than 5G networks. With 5G, high spectrum prices delay infrastructure investment that stand to benefit the entire economy, from energy to education to healthcare. The ways in which inflated spectrum prices undermine investment incentives are multi-faceted (Marsden, Ihle and Traber, 2019). First, inflated spectrum prices reduce profits on existing sunk assets and thereby lower expected returns on future investments. This means that, although operators may be forced to shoulder high spectrum costs to maximize returns on prior network investments, in the medium term the (expected) effect on profits will lead to reduced investment, market exit or consolidation (Rogerson, 1992). Second, high upfront payments, such as those for spectrum, can either be made using internal capital, reducing the available internal capital, or by external capital, which will be much more expensive (Myers and Majluf, 1984). If expected returns on investments are insufficient to cover a higher risk premium from external capital, the firm will no longer undertake these investments. Operators awarded spectrum at inflated prices have a significantly reduced amount of capital to deploy the networks to make use of the spectrum (Ala-Fossi, 2020; Jain and Neogi, 2020; Song, 2020). This not only delays rollout of the network infrastructure necessary, but undermines the business case for rural rollout (Castells and Bahia, 2019; Crandall, 2020). High spectrum prices can crowd out investment as higher risk or less profitable investments are abandoned. Third, within firms, internal capital will be focused on markets and services with higher expected profitability (Ihle and Traber, 2019). Although Canada's major operators are focused on the Canadian mobile market, operators' decisions to allocate capital to the Canadian mobile market versus other markets or services within their businesses are impacted by the effect of inflated spectrum prices on profitability. As spectrum prices inflate, 'de-escalation' or the 'reverse sunk-cost effect' (McAfee, Mialon and Mialon, 2010) can be expected. Again, this will mean capital being redirected away from mobile telecommunications investments in Canada. Furthermore, the Canadian mobile telecommunications market is particularly sensitive to these effects as major operators are restricted in how they can raise capital through equity, due to extensive ownership rules.

To the extent that they can be passed through, the estimates of the potential impact of high spectrum costs on retail prices are significant. Spectrum prices represent as much as $100 on the annual bill of every

Canadian (Crandall, 2021). If spectrum prices in Canada were equal to the international average, retail prices would be up to 12.5% lower in Canada (Crandall, 2021; Koutroumpis, 2020) and, on this basis, in 2020 the excess cost of spectrum in Canada when compared to Europe was equivalent to an additional annual tax of $1.76 billion on Canadian subscribers (Crandall, 2021). The cost of spectrum at the 3500MHz auction will add up to $580 million to this tax annually as 5G networks are deployed (Crandall, 2021). This means that spectrum costs represent an annual tax of up to $2.34 billion on Canadians that Europeans do not pay. This is an ongoing challenge in delivering affordable services for business and residential consumers.

The implications of high prices in mobile markets are well known. High prices have the effect of lowering adoption and demand for wireless services from consumers and can thereby cause a general drag on economic growth and government revenues. In addition, particularly vulnerable Canadians are excluded from participating in the modern economy as a result of inflated prices. Again, with 5G there is also the question of industrial applications. Slow adoption in the healthcare, industrial and automotive sectors places all of these sectors and the general Canadian economy at a disadvantage. Higher prices and the resulting slower adoption of 5G therefore has a much wider adverse effect on the economy than high, mass-market retail prices in the context of 4G.

There is broad recognition that artificially inflating spectrum prices is poor spectrum policy. Many countries actively adopt policies which lower upfront costs for operators. Countries such as Austria and Germany have allowed payments for spectrum to be deferred and grant discounts to promote rural deployment of mobile infrastructure, clearly prioritizing infrastructure over revenues. Sweden has allowed operators to keep auction proceeds for the purpose of providing coverage to designated areas. Most telling of all is that Canadian operators paid $8.9 billion for spectrum in the recent 5G auction, but it is projected that, just by adopting similar spectrum policies to South Korea in 5G auctions, Canada can add $40 billion to GDP over 20 years (GSMA, 2020).

Together, these considerations mean that the Canadian government must adopt policies which maximize the available spectrum at auction insofar as is possible. This entails releasing as much spectrum as possible for mobile or flexible use, as quickly as possible. Most critically, it requires that the government cease using set-asides, which create artificial scarcity in the open auction and, where pro-competitive measures are necessary, use spectrum caps, which do not share the same inflationary effect.

5.3 Timeliness

5.3.1 Auction timing

The 3.4-4.2 GHz band is key for 5G as it combines good coverage and high speeds; however, by the time Canada held its first auction for this band in June 2021, it was the 38th country to do so (GSMA, 2020). By this time, many countries had held their second auction in this band and others had auctioned so much spectrum at their initial auction that they had no need to hold another (see *Figure 7*). Canada has another auction to go in 2023 before it catches up to these countries.

Initially, Canada planned to be the first country in the world to auction this spectrum as early as 2017 (ISED, 2014). However, the government prioritized finding a means to accommodate the fixed-wireless providers already in the band. Perhaps unsurprisingly, this included an attempt to keep whole a fixed wireless provider that was also a potential competitor in the wireless market (that has now left that market).

Of the 24 OECD countries covered by an Analysys Mason study, by May 15, 2021, 18 countries had assigned spectrum on a long-term basis, three had assigned spectrum on a short-term basis and a further three, including Canada, had assigned no spectrum. At the end of June 2021 when Canada was awarding its

Canada must:

Set aside ‘set-asides’ – End the policy of providing set-asides for established operators, which while imposing costs on Canadians through the highest spectrum prices in the world, has demonstrably failed to increase competition.

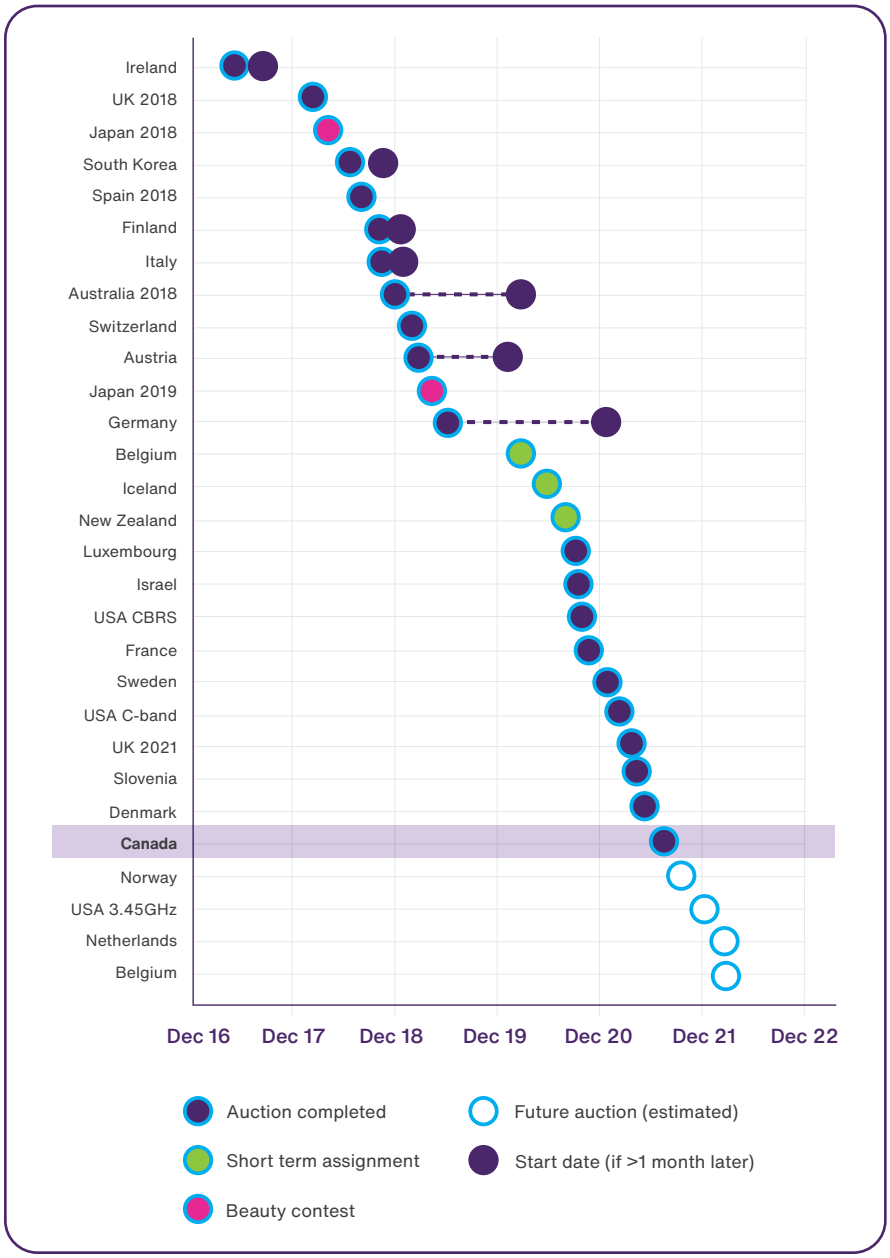

Figure 8: Dates of principal assignments of the 3.4GHz-4.2GHz spectrum (Source: Analysys Mason, 2021)

first spectrum in the 3.4-3.8GHz band, 65.4% of this spectrum had been awarded in the EU 27 (European 5G Observatory and European Commission, 2021).

The slowness with which spectrum auctions have been organized puts Canada four years behind leading 5G markets and trailing at the back of the pack in the OECD. Although slower, low-band 600MHz auctions occurred in 2019, these bands are unable to deliver the majority of the benefits expected from 5G (GSMA, 2020). The delay will impact when Canadian operators can deploy internationally competitive 5G services. As above, the fact that spectrum has been made available slowly in smaller amounts also has the impact of inflating prices, with all the negative effects described in Section 5.2.

5.3.2 Band clearance

Holding spectrum auctions as early as possible (in line with or ahead of global benchmarks) is important because it allows operators to plan and invest in the infrastructure to put spectrum to use, knowing what spectrum they will be able to use, where and under what conditions. It is not, however, the only consideration of timing. Spectrum is not always usable immediately following the auction due to the presence of incumbent legacy users of the spectrum. The length of any associated delay is thus also a significant factor in determining when spectrum can actually be used for new technologies relative to competing jurisdictions. Canada has recently been significantly slower than peer jurisdictions when clearing such incumbents.

The Canadian government has taken a conservative approach to clearing operators currently using key spectrum for 5G for other technologies, such as satellite. The spectrum in the 3800MHz band being auctioned in 2023 for example, the crucial spectrum to allow Canadian operators to catch up with their international peers, will not actually be available for use in urban areas until 2025, and 2027 in rural areas, if at all. This is in stark contrast with other jurisdictions that have made the spectrum available earlier. For example, the US adopted more aggressive mechanisms to clear this spectrum of incumbents to allow 5G to be deployed more quickly (Marcus, 2020; Rosston and Skrzypacz, 2021). All the equivalent spectrum in the US will be available for use in 2023.

The problem of band clearance is complex, and the situation in each jurisdiction is somewhat unique. There are also many potential policy options for clearing bands, both in isolation and combination; regulators can take a command-and-control approach to relocate incumbents, expand incumbents rights, overlay the rights of new users over incumbents and hold two-sided auctions to allow the market to determine the appropriate outcome (for interesting discussion of the US process, see Marcus, 2020; Rosston and Skrzypacz, 2021). Each of these has its own strengths and weaknesses. Furthermore, within each option there are different means to ensure that incumbents and new potential licence holders have sufficient incentive to negotiate and compromise in sufficient numbers and with sufficient cohesion to ensure spectrum use is maximized. This complexity means that it is not possible to give a one-size-fits-all recommendation concerning how Canada should approach the clearance of incumbents, or to recommend that Canada simply emulate other jurisdictions.

Nevertheless, the approach in Canada has evidently indexed heavily on protecting incumbents in the context of 5G, with undoubted costs. If such conservatism is justified, it is striking that incumbents cleared through market mechanisms in other jurisdictions have moved far more quickly than the timetables established in Canada. This is not due to any limit in regulatory power: Canada is in some ways in a stronger position than other jurisdictions with regards the discretion afforded to move incumbents. It is therefore unclear how the slow pace of clearance is justified when comparing Canada to its neighbours. As with many of the other issues considered herein, rigorous independent analysis of the economic impacts of the different potential strategies, published by the government, would help inform and shape this discussion moving forward. If such exceptional delay is warranted, it should be supported by evidence. ISED should explicitly balance the projected impacts of delay against the potential costs to incumbents: where the benefits of the new use outweigh the cost to incumbents, the government must move quickly. If the impact on incumbents will be too great, the government must find ways to move quickly to minimize the costs to incumbents and any delay. If it is a possibility that the government will need to give long periods of time for incumbents to transition, it is critical that the process start as early as possible. By using rigorous analysis to underpin the assessment, spectrum in Canada can be made available on similar timetables to competing jurisdictions on the basis of predictable and consistent reasoning.

Canada must:

- **Beat the global benchmarks** – Be the first OECD jurisdiction to make enough spectrum available to major operators for new services to efficiently meet International Telecommunications Union (ITU) recommended channel sizes, raise quality, lower costs, and prevent artificial shortages inflating auction revenues and retail prices.
- **Focus on Canada's future** – Rapidly release and clear spectrum so that auction winners can use the spectrum to deploy new technologies in a timely manner, in line with competing jurisdictions.

5.4 Quantity

5.4.1 Allocating sufficient spectrum to commercial mobile networks

Countries leading in the 5G race have already assigned large quantities of spectrum, reaching at least the 100 MHz per operator recommended by the ITU and GSMA (GSMA, 2020; ITU, 2017). This is important because the capabilities of 5G require wide, contiguous channels for several reasons: firstly, less spectrum means much lower speeds as limited spectrum becomes congested. Secondly, contiguous spectrum means fewer 'guard bands' filled with empty spectrum to prevent interference. While contiguous spectrum can be achieved post-auction by operators swapping spectrum, this can take a long time and does not always lead to optimal results. This is particularly challenging if one party is unwilling to participate due to financial constraints or because it will provide a competitive advantage to an industry peer. As it is rare that a spectrum swap will result in equal benefits for both parties, it is important to establish contiguity at auction. Thirdly, 5G equipment made to the international standard is designed to work with 100MHz of contiguous spectrum in a single channel.

In Canada, only a total 200 MHz of spectrum was available in the June 2021 auction. As a result, none of the operators in Canada now have the necessary amount of spectrum to support Canada's 5G needs. Canada is therefore more than four years behind leading countries in awarding effective spectrum for 5G. See *Figure 8*, which displays the quantity of 3.4-4.2 GHz spectrum currently or planned to be auctioned in comparable OECD nations.

This situation is worsened by ISED's use of set-asides. Even where spectrum is clear of incumbents, Canada's three national operators have been limited to a maximum of 150 MHz among them. Following the recent auction, no Canadian operator will meet the ITU's recommended 100 MHz per operator until at least 2023, outside of a few small areas (Analysys Mason, 2021; ITU, 2017) (see *Figure 9*). In fact, national operators have, on average, approximately half of the recommended amount of spectrum. Opensignal directly ties this fact to Canada's drop in international rankings for network quality (Opensignal, 2021).

On the other hand, Canada is provisionally poised to auction more total spectrum in the 3.4-4.2GHz band than most OECD countries. As such, if Canada releases the remainder rapidly and finds the means to quickly

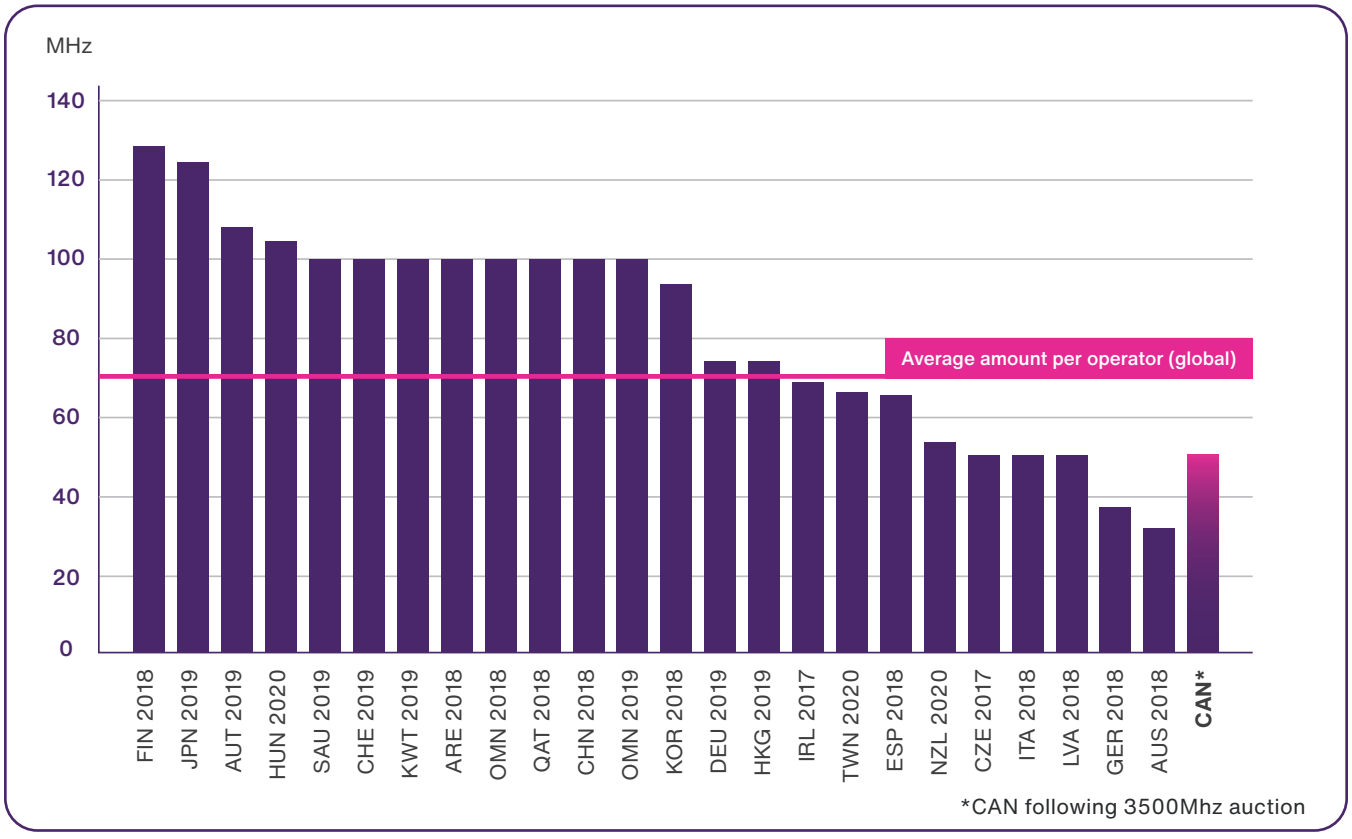

Figure 9: Spectrum assignments in the 3.5 GHz band – maximum average amount per national operator (GSMA, 2020)

clear it of those currently using it for other purposes, Canada can still be in a strong international position. Conversely, if this spectrum only becomes usable between 2025 and 2027 as planned, it seems likely that other countries will have auctioned more spectrum before this timeframe.

As well as quickly releasing more spectrum for exclusive licences, other jurisdictions are also assessing and experimenting with alternatives to exclusive licences with the potential to provide more spectrum, more quickly to mobile operators (Marcus, 2020; Rosston and Skrzypacz, 2021). It is increasingly practical for spectrum to be shared dynamically with opportunistic access to spectrum permitted when it is not in use (Cave and Webb, 2020). This is not entirely unfamiliar to Canada given the experience of rural point-to-point broadband (Remote Rural Broadband Systems, RRBS) (Taylor, 2020). The recent ISED consultation suggests a few approaches to spectrum sharing in Canada (Innovation Science and Economic Development Canada, 2021a). Worryingly, some of the suggested policy options seem to again reflect an emphasis on minimizing the spectrum available to existing operators, such as by precluding existing operators from accessing additional unused spectrum, even when they have used their existing spectrum to the greatest extent possible. Presumably, this again emphasizes potential competition over the rapid rollout of maximally effective next-generation networks. Whatever the outcome of this consultation, it is paramount that such experimentation does not interfere with the rapid auctioning of exclusive licences for 5G spectrum to operators with strong records of deployment. Canadian operators require reliable access to the necessary spectrum as quickly as possible on certain terms.

5.4.2 Spectrum defragmentation

The quantity of spectrum available to a given operator significantly determines the efficiency of networks and their deployment. It is not, however, the only relevant consideration. A further important element is whether the spectrum held by individual operators is contiguous. If spectrum holdings are not adjacent within a band, this can compromise the efficiency of the network and, therefore, policies seeking to maximize the social and economic benefits accrued from the use of spectrum should seek to ensure contiguity where possible.

In spectrum auctions, a policy decision may be taken determining that generic blocks won by a particular operator will automatically be awarded contiguously, with the further assignment phase within the auction determining only where in the band an operator's collective blocks are placed. In this way, the assignment phase avoids presenting a potential barrier to contiguous spectrum. This has been the case in recent auctions in Canada and is undoubtedly positive to the extent that it avoids the need for a costly assignment phase with the potential to result in non-contiguous spectrum.

Problems emerge however, when auctions concern spectrum in a band adjacent to other spectrum holdings, particularly if an operator participating in the auction holds this spectrum. In such circumstances, such as in the forthcoming 3800 Mhz auction, a further policy decision must be made as to whether to guarantee contiguity automatically between both the

band being auctioned and these prior holdings. This policy has not been adopted in the forthcoming 3800 Mhz auction in order to guarantee contiguity with holdings in the 3500 Mhz band, although this will still be possible to achieve in the assignment phase. More generally, the government has committed that there will be opportunity for the holdings in the 3500 Mhz and 3800 Mhz bands to be made contiguous. This is similarly positive.

Current Canadian policy is an undoubted improvement on some of the policies observed in the past decade. The Canadian government has previously set aside specific blocks in positions that make it impossible for incumbents to achieve contiguity with holdings in neighbouring bands, as was the case in the AWS-3 auction. The effect was that Canadian networks were made less efficient for no benefit. This was a clear failure to maximize the social and economic benefits from the spectrum and it is crucial that such policies be avoided in the future. Again, independent economic analysis of the policy options would never have allowed this to occur.

Ensuring that spectrum is awarded contiguously when designing auctions is, however, only one element of ensuring coherent spectrum holdings. As technologies change, so do the most coherent pattern of holdings. The clearing of spectrum and the transition from one spectrum use to another is one consideration, but technological change may also change what is efficient in terms of channel size and the possibility of effectively coordinating the use of spectrum holdings configured in certain ways. As an example, 5G differs from other generations of technologies in that operators have greater flexibility in using different spectrum frequencies in conjunction with one another. This means that existing spectrum holdings may not be allocated efficiently for 5G. Alongside issues of technological change, considerations of what is fair when determining whether to guarantee contiguity at a particular auction and, indeed, the available information which determined each operator's conduct in the assignment phase, will change and expire. As such, the regular defragmentation of spectrum bands to the greatest extent practicable should be considered.

This is particularly pertinent in Canada where the use of pro-competitive measures has resulted in Canada having the fourth least concentrated spectrum holdings of any GSMA monitored country (GSMA, 2020). In the context of such diluted holdings, that the holdings are distributed within bands as efficiently as possible is crucial to ensuring the efficacy of Canada's networks and the cost-effectiveness of their deployment. In addition to diluted holdings, Canada's unusual set-aside policy has had a particularly detrimental effect on the contiguity as the location of set-aside spectrum has acted as a barrier to efficient block placement. Canada's PCS band was also released incrementally through the PCS 1995 process, the PCS 2001 auction and the PCS G block in the 2008 auction (see Industry Canada, 2004). As a result, holdings in the band are fragmented and have been so for some time. Finally, unlike jurisdictions like Australia, which defragmented its 850/900MHz spectrum in 2021 and plans to do the same for 3.4 to 4.0GHz later in 2022, Canada has not been proactive in defragmenting holdings.

To the extent that the government can take steps to provide the means and incentives to rearrange spectrum holdings without imposing meaningful costs on any user, defragmentation should be considered the 'no-brainer' of spectrum policy. If the economic and social benefits of the spectrum can be increased without prejudice to any party, it should at least be periodically considered. Indeed, to the extent minor incentives such as new radios could enable and incentivize users to move to another part of a band, this would represent astonishingly good value for money as a means of increasing network efficiency.

Canada must:

- **Beat the global benchmarks** – Be the first OECD jurisdiction to make enough spectrum available for major operators for new services to efficiently meet International Telecommunications Union (ITU) standards.
- **Focus on Canada's future** – Rapidly release and clear spectrum, so that auction winners can use the spectrum to deploy new technologies in a timely manner, in line with competing jurisdictions.
- **Defragment diluted holdings** – Prioritize the timely defragmentation of Canada's spectrum bands to accrue the largest benefit from efficient spectrum use over the longest possible time.

5.5 Deployment obligations and recovery of fallow spectrum

Most OECD countries successfully incentivize businesses to make use of the spectrum licenced to them (BEREC, 2018). In Canada, however, MVNO and roaming obligations (see Canadian Radio-Television and Telecommunications Commission, 2021, 2015; Industry Canada, 2007) allow regional operators to offer attractive services without deploying their spectrum to the degree that would otherwise be necessary to compete. When combined with relaxed deployment conditions, MVNO and roaming obligations allow regional operators to use their spectrum in only the most valuable areas which their licences cover to satisfy their deployment conditions – the urban areas – and leave vast swaths of their spectrum unused. Under this framework, regional operators have incentives to purchase spectrum subsidized by set-aside before 'warehousing' large portions of it, selling it later on the open market for higher market prices, using it as a valuable asset when being acquired, or even simply leaving it fallow.

The mismatch between deployment and speculation incentives in Canada is a major contributor to rural connectivity, reconciliation and inclusive growth challenges. Under the current framework, several regional operators in Canada deploy less than 20% of their rural spectrum (TELUS, 2020). This huge amount of spectrum, wasted under the current framework, could be far better used by other operators to connect rural, remote and Indigenous communities. Importantly, if regional operators were required to deploy their spectrum, it is likely they would do so to the benefit of those being underserved by existing networks.

The best way to address these perverse incentives are 'use it or lose it' spectrum licence conditions. These require that the winner of a spectrum licence commence operations using the spectrum to deliver services within a set time following the licence being granted (Cave, 2010; Cave and Nicholls, 2017). While such conditions may exist theoretically in Canada, they are insufficiently onerous to ensure operators must really 'use it', nor do they impose adequately strict and straightforward penalties to ensure that operators fear that they may 'lose it'.

Canada's current deployment conditions are a far cry from ensuring operators 'use it', as Canada has conferred spectrum licences with extremely lenient conditions. By way of illustration, the 4G licences acquired by WIND in 2008, which have since been acquired by Shaw, do not require full deployment until 2038, meaning these 4G licences do not need to be fully used until 20 years after the advent of 5G (Innovation Science and Economic Development Canada, 2018). Although deployment conditions from recent auctions appear stricter, they are constructed in such a way that operators that speculate have been rewarded with weak conditions and, conversely, operators that use their spectrum to provide services have been punished with harsh conditions. For example, in areas without a large population centre, recent licences oblige operators to cover 90% of the population using the spectrum covered by their licences after seven years, but only in areas where they have already deployed high-speed 4G (LTE) (Innovation Science and Economic Development Canada, 2021b). Areas without a large population centre where an operator currently has no high-speed 4G coverage are subject to far more lax deployment conditions, between 5% and 30% after seven years (2028). By the time operators without a 4G footprint are required to invest to cover a reasonable proportion of the population, restrictions on reselling set-aside spectrum will have expired and, even if the spectrum is not resold, operators are not expected to deploy their spectrum for the current technological generation until it is likely that the next generation will have come to bear. When one considers how generous these conditions are to those without records of building networks, there can be little doubt that ISED's current interpretation of 'use it' is unsatisfactory. The term 'use it' in Canada must become a more meaningful requirement.

While it is obviously important that government impose a robust 'use it' requirement, the 'lose it' element is no less crucial. It would be reasonable to assume that because deployment conditions are relaxed in Canada, enforcement must be stringent. Unfortunately, Canada has both relaxed conditions and does not meaningfully enforce them. Failure to meet deployment requirements currently means 'ISED may invoke various compliance and enforcement measures if a licencee fails to meet their deployment requirement' (Innovation Science and Economic Development Canada, 2021b). Given how far behind Canada is in making key 5G awards, 'various measures' seven years after the spectrum becomes available are unlikely to have an impact on behaviour. Licence revocation may not even happen if this seven-year deadline is not met as there may be little benefit to revoking the licence so late (GSMA, 2016). In fact, despite having imposed deployment conditions in some form for decades, there is no evidence ISED has ever

revoked a licence for failure to meet such a condition. Rather, ISED has tended not to renew licences at the end of the licence period. This has resulted in operators sitting on subsidized spectrum for decades before selling it to a large operator (that can easily satisfy the deployment requirement) for a profit before the licence comes up for renewal. For example, one regional operator sold its AWS-1 licences in Eastern Canada just before the first deployment condition and renewal was assessed (ISED, 2018a; ISED, 2018b). This dynamic is entirely optional and a product of government policy. A stricter approach that ensures that spectrum is put to good use as quickly as possible, that acts as an adequate financial disincentive for failing to meet agreed deadlines and that entirely prevents speculation is preferable and straightforward.

In all future Canadian spectrum licences, far more stringent 'use it or lose it' provisions should be included. These provisions should focus much more heavily on straightforward deployment requirements in shorter timeframes, with a clear policy that licence revocation will be the consequence of failure to meet deadlines. ISED's recent consultation on Access Licencing demonstrates that ISED itself is of the opinion that far shorter timeframes for deployment requirements are entirely feasible (Innovation Science and Economic Development Canada, 2021a). These shorter timeframes are essential as they allow ISED to revoke licences for spectrum that will otherwise be allowed to sit fallow, before substantial periods of time have elapsed. Deployment requirements should be onerous to hedge against speculation and, most importantly, to ensure operators are compelled to deploy in at least some areas outside of urban centres. Critically, these stringent conditions must treat all operators equally so as not to reward speculators with further opportunities to speculate and disincentivize deployment.

In addition to conditions within future licences, Canada's history of weak deployment conditions mean that, rather than merely accepting huge swathes of fallow spectrum for as long as 20 years, addressing the problem requires some form of 'use or lose it' be applied retroactively to existing licences. Licence holders that are allowing spectrum to sit fallow for a long period of time should have their licences, or parts of their licences, revoked and reallocated to other operators that may put the spectrum to good use. While this may seem radical, it is clear this is an approach that ISED is considering to at least a limited degree (Innovation Science and Economic Development Canada, 2021a). When retroactively altering licences, there is a clear danger of undermining certainty in future investments. The most balanced approach, which Canada should take, is to retroactively impose 'use it or lose it' to all bands in a renewal term (i.e., those bands where the initial licencing term has expired) following their next general deployment requirement milestone. This can be achieved with the general expansion of ISED's proposed Access Licencing Framework to all bands for which there is demand.

Prior to a licence's renewal, a less dramatic policy, 'use it or share it', should be applied to bands following the initial deployment milestone. This requirement would allow licence holders to deploy in areas of priority under their existing licences, but once this is achieved, allow other operators to access any remaining unused spectrum in ways that do not interfere with the use of the remaining spectrum by the licence holder. This strikes a fair balance that ensures investment certainty, prevents spectrum from sitting fallow and undermines speculation by allowing operators that would otherwise be potential purchasers to use spectrum.

Canada must improve its approach to 'use it or lose it', but it is important that Canada also begins to learn from other OECD nations. In France, for example, recently granted licences require large, explicit numbers of new sites, ubiquitous coverage on roadways and that 25% of the new sites be located in rural areas (ARCEP, 2018; Pedro Tomas, 2018). Germany has previously imposed 'shared' deployment obligations, which encourage operators to collaborate to ensure coverage; and Sweden has imposed obligations that focus explicitly on providing coverage to households with no alternative form of internet access (GSMA, 2016). These more nuanced forms of deployment conditions can be more effective at attracting the operators best placed to achieve deployment in underserved areas than Canada's strategy of simply relying on population coverage requirements. Furthermore, other OECD countries have begun to explore 'carrots' as well as 'sticks' in their deployment requirements, such as financial incentives that grant companies rebates or deferred payments on spectrum in exchange for stronger deployment requirements. For example, Austria and Germany have held incentive auctions and auctions, which include rebates in exchange for more stringent rural build commitments (Serentschy n.d.). These 'carrots', alongside 'use it or lose it' in the context of more nuanced deployment conditions, present a significant opportunity for Canada to improve the incentive structures created by its policies and encourage operators to, in line with ISED's stated

Canada must:

- **Prioritize rural, remote and Indigenous Canadians** – Adopt strategies seen in other OECD countries to facilitate rural, remote and Indigenous infrastructure investment through auctions. Examples include exchanging stronger build-out requirements in exchange for rebates, incremental payment of auction costs, or earmarking auction proceeds for rural development.
- **Make sure spectrum holders 'use it or lose it** – Impose and enforce effective "use it or lose it" conditions for all spectrum licences deemed critical for delivering universal coverage, revoking licences in areas where companies purchase spectrum but do not meet robust deployment conditions within 3 years.
- **Encourage operators to 'use it or share it'** – Even when operators comply with deployment requirements, design a 'use it or share it' regime that ensures operators share unused spectrum in the initial licence terms following the first deployment milestone.

policy goal, create the maximum amount of social and economic value from the spectrum they have been awarded. Whatever the policy, it is essential to change course, so that some Canadians don't just begin to enjoy 5G when the rest of the country and the OECD, are beginning to enjoy 6G or even 7G.

5.6 Governance

The preceding sections have described the many ways in which Canada's recent spectrum policy decisions have poorly served the Canadian public, but this merely reflects the stem of the problem. At root, there is a much more fundamental problem. This problem pertains to the ways in which decisions concerning spectrum policy are taken. It emerges because of the combination of: 1. the political control of spectrum policy and 2., a lack of meaningful evidence-based processes governing policy decisions. The government must address one or the other.

5.6.1 Politics and spectrum policy

As noted throughout the preceding discussion, Canada is one of a small minority of advanced countries where a government ministry directly implements spectrum policy, controlling directly both the high-level policymaking elements of spectrum management and the detailed regulatory elements concerned with policy implementation. It is unusual around the world to give responsibility for both these elements to a politically appointed minister, and it is far more common to separate the two (World Bank, 2011; Telecommunications Policy Review Panel, 2006). In most countries, the government sets high-level policy goals and an independent agency determines how best to achieve them by determining detailed policies, such as the best mechanisms to award spectrum.

This is not new information in the Canadian context. An OECD report from 2005 argued for the reallocation of detailed spectrum policy from politically appointed government ministers to sectoral regulators (OECD, 2005), which in Canada refers to the CRTC. A 2006 Canadian expert panel report commissioned by ISED itself (previously Industry Canada), which provided expert insight into the Canadian context (Telecommunications Policy Review Panel, 2006) argued the same. This was ignored by the government. The expert Canadian panel provided a rationale for its recommendation, stating that 'the movement of [ISED's] spectrum management and regulatory functions to the CRTC would clearly distinguish the role of government — which is to set national telecommunications policies — from the role of the regulator, which is to implement those policies in an independent and transparent manner.' (Telecommunications Policy Review Panel, 2006)

An OECD analysis of Canada's telecommunications industry from as far back as 2002 stated that:

> *'An argument can also be made that licence allocation, that is the regulation of market entry, should be the task of the regulator, the CRTC, whereas spectrum planning, a policy function, should remain with Industry Canada in that wireless communications is increasing in importance a differentiation between policy and regulation, as is the case for the rest of the industry, would be preferable.' (OECD, 2002)*

The expert report for Industry Canada also highlighted that '[Canada's] approach has been abandoned in the United Kingdom, Australia, the United States, most European countries and even in most developing countries' (Telecommunications Policy Review Panel 2006) and, in 2005, of the then 30 OECD countries, only six still had ministries that retained specific, rather than merely general, authority over spectrum — Canada, Japan, South Korea, New Zealand, Austria and Italy (OECD, 2005). Canada is now only more unusual and the wireless sector more important.

There is international acknowledgement of the imperfect alignment between the medium-term economic interests of a country and short-term political interests, and the potential for political pressure to negatively affect decisions in the context of spectrum policy (Telecommunications Policy Review Panel, 2006; OECD, 2005; Baldwin and Cave, 1999). The impact in Canada since these recommendations were made is potentially significant. For example, a decision by ISED not to use every available power to address perceived problems in the industry could open the government to criticism or sacrifice an opportunity to appear responsive to public concern, even when the use of the powers is inappropriate and ineffective. As a further example, lowering the auction revenues enjoyed by the government could be politically difficult, even if it is good policy. Such risks are particularly acute in the context of spectrum because the benefits and harms of poor policy take years to emerge, but many of the political costs and benefits are immediate. This imperfect alignment is why almost all other countries make the awards process as independent as possible: the complexity of the sector does not lend it to political decision-making. The OECD stated the importance of this type of independence for such an important sector in 2002, and the sector has become dramatically more important since that time. The sector is simply too important in modern economies for political interests to result in sub-optimal outcomes.

Furthermore, the involvement of the political process in policy implementation creates great uncertainty. This undermines the development of telecommunications industries, which turn on massive infrastructure investments. Separation from politics provides greater stability in the regulatory process (Industry Canada, 2006; OECD, 2005) and greater continuity (Telecommunications Policy Review Panel, 2006; OECD, 2005), both of which are crucial. Separating responsibilities also provides a significant benefit through the potential for arbitration (Telecommunications Policy Review Panel, 2006; OECD, 2005). By having the government control high-level policy, but the CRTC control detailed policy and implementation, each body, one independent and technocratic and the other political, can represent key stakeholders to address misguided policy. This would substantially improve the likelihood of poor policy being addressed in Canada.

Alongside the disadvantages of leaving spectrum policy with political decision-makers are the disadvantages with separating spectrum regulation from other forms of sectoral regulation. Currently, ISED imposes 'pro-competitive measures' while the CRTC is attempting to regulate the market to ensure it is competitive. This creates obvious scope for incoherence as different arms of government intervene in the market, risking both excessive and insufficient intervention as each body struggles to second guess the behaviour of the other. Even if one were to concede that there is insufficient competition in the Canadian telecommunications market and a problem of retail market power, it is clear from the diluted level of spectrum holdings that it has nothing to do with spectrum. As such, a reasonable question is the extent to which the use of spectrum to attempt to address any such competition issue is an artefact of the current institutional structure rather than optimal policy. Certainly, setting the high-level policy direction and leaving the detailed policy to a regulator with a holistic set of powers is likely to be far more effective at addressing competition issues and market power, particularly when it is unrelated to spectrum holdings. Such a regulator would also possess means of addressing the issue without entirely sacrificing all the other goals of spectrum policy. Bringing these sets of powers together could therefore increase the effectiveness of both (Telecommunications Policy Review Panel, 2006) and allow a single body to concentrate and develop the scarce expertise in telecommunications necessary to make informed decisions (Telecommunications Policy Review Panel, 2006; OECD, 2005; Baldwin and Cave, 1999).

With multiple bodies regulating the industry, they must be highly coordinated in both their outlook and activities to avoid the creation of significant problems. In Canada, there is significant evidence of a lack of coordination. As an example, if the CRTC were in control of spectrum auctions, they would have had the ability to coordinate their MVNO decision more effectively in April 2021 (see CRTC, 2021) with the pro-competitive measures in the June 2021 auctions, so as to ensure the MVNO decision did not prompt mass speculation in the auction.

This is only the most recent example of potential miscoordination, and others are more obvious. As stated by then CRTC chairman Konrad von Finckenstein in the context of a very public dispute between ISED and the CRTC over wireless policy in 2009:

> *'It no longer makes sense to have a single regulator for wireline service providers, but two different civil regulators for wireless service providers. More to the point, the lack of regulatory coherence is an obstacle to innovation and competition, and makes it difficult to maximize economic and social benefits for Canadians' (as quoted in O'Brien, 2010).*

The key problem is how there can possibly be adequate coordination between an independent regulator and a political ministry without this undermining the independence of the regulator.

Despite these immensely important factors, there are some good reasons to retain the existing institutional structure in Canada. The institutional reform necessary to shift spectrum regulation to the CRTC would further complicate or delay pressing issues in spectrum management and will undeniably create significant uncertainty for industries which rely on predictable policymaking to make huge investments. The issue of uncertainty will be even more acute if legislative change is required with all its associated delays, the potential for many different outcomes and the possibility of further tangential reforms. Another consideration is whether, as in the US, there would then need to be division between spectrum regulation for government use rather than public use, and how this would be decided and administered. Furthermore, there would be the potential to lose significant institutional knowledge and experience. Undoubtedly, the delay before such a change resulting in any benefit for Canadians is likely to be protracted and the associated costs would be significant.

Given these competing factors, the best possible option is to thread the needle between institutional change and independent policymaking, while also allowing better alignment and cohesive decision making between the CRTC and ISED. This ties in with the other set of necessary reforms in Canadian spectrum policy: ensuring decision making is based on independent empirical analysis of the policy options in the context of clearly defined and measurable objectives.

5.6.2 Evidence-based policy

Recent research from the Institute of Fiscal Studies and Democracy at the University of Ottawa has concluded that:

> *'In Canada, there is no policy mechanism, formal or informal, that assesses whether spectrum policy is delivering against the government's overall objective for ubiquitous connectivity. Canada urgently needs a performance management framework for spectrum policy.' (IFSD, 2022)*

Related conclusions have been drawn elsewhere, such as by the Office of the Auditor General (2018), which concluded that ISED provided inadequate public information concerning the details of rural coverage. Publication of performance metrics creates the accountability necessary to underpin a performance management framework, and ultimately evidence-based policy.

These are striking conclusions, but conclusions which are not difficult to reconcile with the analysis of Canada's relative international performance described above. To risk political control of spectrum policy when other jurisdictions explicitly remove that risk is one thing; to also neglect a robust performance management framework and evidence-based policy is another. In general, Canada has an issue with the use of evidence in spectrum policymaking, reporting and the associated accountability.

As with other areas of spectrum policy, explicit steps have been taken in other jurisdictions to address this issue and such activities can serve as inspiration for the Canadian system. Two features merit explicit attention:

First, as observed above, one natural advantage of placing spectrum policy with an independent regulator is the ability for government to provide a level of oversight. As a result, the strength of reporting and use of evidence to determine policy may be more robust when spectrum is controlled by an arm's-length institution. If control of spectrum is to remain with ISED and under the control of a publicly appointed figure rather than an experienced subject matter expert, Canada must find a way to recreate these advantages in transparency and reporting. Furthermore, despite the Commission itself being independent of government, the US FCC has gone even further. Steps have been taken to ensure evidence-based policymaking occurs by introducing independence even within the body itself. The Office for Economic Analysis (OEA), established

in 2018, concentrates economic expertise in the FCC within a single office. This has obvious advantages, not least that analysis of the likely effects of a policy or, indeed, the design of an auction to achieve certain policy goals, occurs independent of those suggesting the policy (FCC, 2018). Two explicit disadvantages of the 'disaggregated' model was 'economists lacking independence, and the possibility that the embedded economists are called on simply to support decisions made by non-economists.' (FCC, 2018) These means of creating independent assessment, even within government, may provide valuable lessons for Canada. Bodies such as the Office of the Auditor General in Canada, as well as reporting to Parliament, serve similar and essential functions, but the systematic application of independent expertise to policy is undoubtedly superior. It is worth considering how Canada can best recreate these systems of oversight.

Second, the granularity in reporting provided by bodies such as the FCC indicate that they are in a much stronger position to monitor the impact of their policies, have opened themselves to greater accountability and have empowered the public to undertake their own analysis. For example, the FCC publishes not only coverage statistics, but the number of base stations over time by operator, more detailed coverage data and huge swaths of other statistics (e.g. FCC 2020). This is not to say that the FCC has perfected their reporting, but demonstrates that a more granular approach is certainly not impracticable and that other countries are more advanced in their reporting than Canada.

The conclusion of the IFSD and lessons from other jurisdictions, particularly the US, demonstrate that there is more to be done in Canada. The design of a fully-fledged performance management framework for ISED is beyond the scope of this paper; the IFSD study goes some way to laying the groundwork for such a framework, and the design of any such framework and the KPIs should themselves be put to public consultation. Nonetheless, as a starting point, there are two necessary sets of considerations to ensure that spectrum policy in Canada is evidence based: the first set concerns the nature of the framework itself, determined by a combination of objective setting, KPI definition, policymaking, further KPI definition, measurement, analysis and reporting. The second set concerns who should perform each of these tasks, as well as when and where public consultation should be involved. Each of these elements must be determined carefully, but the focus should be on ensuring that policy rests on as firm an evidence base as possible, that it is as transparent as possible, and that there is as much accountability as possible.

What is most important is that ISED return to first principles when designing the framework. In any policy framework, policies should be explicitly framed in terms of overall objectives. They must seek to achieve something, and that 'something' should be an end related to the policymaker's mandate, not a mere means. As the IFSD state, the overall objective for spectrum policy should be connectivity, and connectivity is a function of ISED's three interconnected goals: quality, coverage and affordability. Each outlook, band plan, assignment mechanism, pro-competitive measure, deployment condition and any other element of spectrum policymaking should consistently tie back to these variables and the potential impact on each. This potential impact should be measured insofar as is possible, as should the actual impact *ex post*.

This 'first principles' approach would mean, for example, not simply measuring the success or failure of a deployment condition based on whether those operators that purchase a licence met the condition, but rather identifying the policy options, including looking at what has been done in competing jurisdictions; analyzing the inherent trade-offs in the design of each condition between affordability, coverage and quality; and being explicit about how these variables are weighted within the options. It requires, at this point, the definition of KPIs to determine the impact of each option, including their potential negative impacts. The feasibility of such measurement should itself be a consideration when choosing whether to adopt a particular policy. After choosing a deployment condition, it then means measuring and reporting on whether the condition worked as expected. The chosen trade-offs and the success and failure of the policy should be explicit and public.

Nowhere would a performance measurement framework have a greater effect in Canada than around pro-competitive measures. As has been stated throughout, the number of operators in Canada is not an end in itself, it is a means to an end. Just as competition policy is about protecting consumers, not competitors, spectrum policy exists to benefit Canadians, not companies. ISED's policy focus on encouraging entry and protecting entrants is intended to increase competition and, in terms of ISED's overall goals, it is intended to eventually increase affordability. This final step linking the policy to ISED's overall objective does not appear to be measured, nor does the extent of the known harms from

such forms of intervention. As KPIs go, the CRTC and Competition Bureau assessment that further regulatory measures were needed to increase competition in 2020 (CRTC, 2021) and ISED's own recognition that prices necessitated a 25% reduction in 2020 (ISED, 2020), more than a decade after the introduction of set-asides, can only be considered a withering indictment of the policy. To the extent that ISED wishes to continue to use spectrum to engineer the market in Canada, it is not unreasonable to assert that the policy must be connected to an outcome for Canadians with a clear causal nexus that can be measured, and that the costs of the policy should be measured too. Indeed, if it has worked as suggested by both the mm-wave consultation (ISED, 2022a.) and ISED's recently published consultation in the spectrum outlook (ISED, 2022b.), ISED should publish the evidence and ideally commission an independent analysis demonstrating it.

Insofar as is possible, Canada's institutional structure necessitates that analysis should be undertaken at arm's length to policymakers, particularly those without political independence. As with the Office of the Auditor General, this could be within government, but would need to be more systematic in its review of ISED policies, both before and after they are implemented. Alternatively, like the FCC, it would be an improvement for analysis to take place with as much independence as possible within ISED itself. However it is done, it is essential that the relevant analyses and data are published to support meaningful public consultation and provide the possibility of fully independent analysis by both industry and academia. As suggested above, such robust analyses would also make it much easier for the CRTC and ISED to coordinate based on a shared, detailed understanding of both the market and the policy environment.

While the recently published Spectrum Outlook Consultation (ISED, 2022) includes welcome consideration of ISED's goal setting and asks questions about the role of spectrum policy in broader policy conversations such as Indigenous reconciliation and environmental protection, these conversations neglect the critical element of ensuring evidence-based policy that measures and reports its success or failure. It is a cornerstone of good policy that a policy's effects are measured and made public. Nonetheless, if the government is reopening its performance frameworks and considering adding further objectives, this is the perfect time to build a modern performance management framework.

Canada must:

- **Go back to first principles -** Maximize the economic, social, and environmental benefits for Canadians from their spectrum resource. Canadian spectrum policy must be about Canadians and not about protecting companies. The government must return to first principles, adopting a laser-focus on the speed and efficiency with which spectrum is deployed to provide high-quality services to as many Canadians as possible without allowing spectrum to become a means of foreclosure.
- **Ensure spectrum policy is evidence-based policy** - Canada's spectrum policy has been allowed to neglect its fundamental purposes because of the absence of any meaningful and transparent assessment of the government's policies, either before or after they are implemented. Canadian decision makers must be explicit about the objectives of spectrum policy and how they are balanced within any proposal, including an independent assessment of likely policy impacts akin to those undertaken by the Office of Economic Analysis of the US Federal Communications Commission. After a policy is implemented, sufficient public data, transparency, and accountability must be ensured such that independent bodies, commissioned by the government, can measure whether policies have been effective and thereby better ensure the desired policy outcomes moving forward.

5.7 Summary

When compared internationally, Canada is a spectrum policy outlier and is under-performing. Canada was the 38th country to auction 5G spectrum. Canada is 23rd of 24 OECD peers in 5G spectrum availability, with no Canadian operator meeting ITU recommendations. Canada is the only country still using set-asides for established operators, and one of only a small minority of countries not to separate spectrum management and allocation.

This benchmarking exercise demonstrates how critical it is that Canada undertakes significant spectrum reform. Canadian spectrum policy results in large amounts of fallow spectrum, particularly in rural and Indigenous communities. This is entirely at odds with universal access and reconciliation.

Canada's policies result in artificially inflated prices, which further disadvantage rural and Indigenous communities that are provided infrastructure years late as capital is absorbed by the government. This is to say nothing of the impact of inflated prices on Canadian consumers and businesses more generally.

Canada is far behind comparable nations in the speed and quantity of spectrum release, with slow clearing and fragmented holdings adding to the problem. Alongside lowering the quality of service available to Canadians, this will mean that Canadian industries and innovators are placed at a distinct disadvantage, years behind their international counterparts.

Canadian spectrum policymakers are also failing to ensure that a scarce public resource is put to use, rather than serving as an object for subsidized speculation. The current mechanisms for awarding spectrum mean that spectrum is awarded to inefficient firms that have little incentive to deploy beyond the limits of urban centres and, in fact, incentives to do the opposite. Current policy encourages large regional companies to warehouse spectrum and sell it for a profit; profits that accrue from the under-provision of services to rural Canada.

Each of these elements result from policy choices that are not observed among Canada's international peers. The costs to Canada and, in particular, rural Canada, are significant. The urban/rural divide will become even more stark as 5G begins to significantly improve lifestyles and livelihoods in urban Canada. Worst of all, 5G could provide immense opportunity for rapid improvement of rural economies and communities, and government policy, not industry, is allowing this opportunity to be squandered.

6. Improving economic and social outcomes with better spectrum policy

The problems with Canada's spectrum policy are reaching a head just when many sectors of the economy should be undergoing tremendous transformation. Because of its widespread implications for industry and services, as well as mass consumer markets, falling behind on 5G is more akin to falling behind on steam power or electrification in earlier periods of transformation than falling behind on 4G. Keeping pace with our peers on 5G is not about streaming videos more quickly; 5G will enable people to be safer while driving vehicles, receive better quality healthcare, benefit from advanced AI systems and efficient industry, and receive water and electricity more cost-effectively and sustainably. Ubiquitous connectivity for almost unlimited devices and the capacity for extreme speeds will impact every part of the economy. 5G thus provides the foundational platform to drive digital transformation. Spectrum policy will either facilitate or inhibit these positive outcomes.

This section summarizes the significant and wide-ranging outcomes that better spectrum policy can generate for Canadians, including impacts on the economy, labour, innovation and competitiveness, public services, society and the environment.

6.1 Economic impact

The economic opportunity from 5G is demonstrated by the value that 5G is projected to create in the coming years. By 2035, 5G is expected to lead to $13.2 trillion USD in GDP worldwide (World Economic Forum and Price Waterhouse Cooper, 2020), with 5G itself generating $2.2 trillion USD in GDP and $588 billion in tax revenue (GSMA, 2019). The European Commission projects that 5G will generate €213 billion worldwide in 2025 and lead to $113 billion in benefits per year across the automotive, health, transport and energy sectors (European Commission, 2021).

In Canada alone, 5G will generate $200 billion in GDP for Canada's economy over 20 years, but Canada could create at minimum an additional $40 billion of GDP if the timeliness and quantity of our auctions policy and the amount of spectrum auctioned were aligned with leading OECD countries. (GSMA, 2020) (*Figure 10*). The Canadian wireless industry already contributes $47 billion per annum to Canadian GDP. (Statistics Canada, 2022) Some projections expect this to double to $94 billion per annum due to the impact of 5G (PwC, 2021). Both of these figures dwarf the total $26.4 billion that the Canadian government made in spectrum auctions between 1999 and 2021, and the $8.9 billion made from 5G spectrum auctions.

Economic impact

For each year 5G is delayed, Canada's GDP stands to lose up to **$94B CAD** (PwC).

Postponing 5G delays income for **250K** permanent jobs (Accenture).

Bringing Canada's 5G policies "in line with international best practices" results in additional **$40B** in GDP (GSMA).

Postponing broadband delays societal benefits: telework, health, education, infrastructure, environment, agriculture.

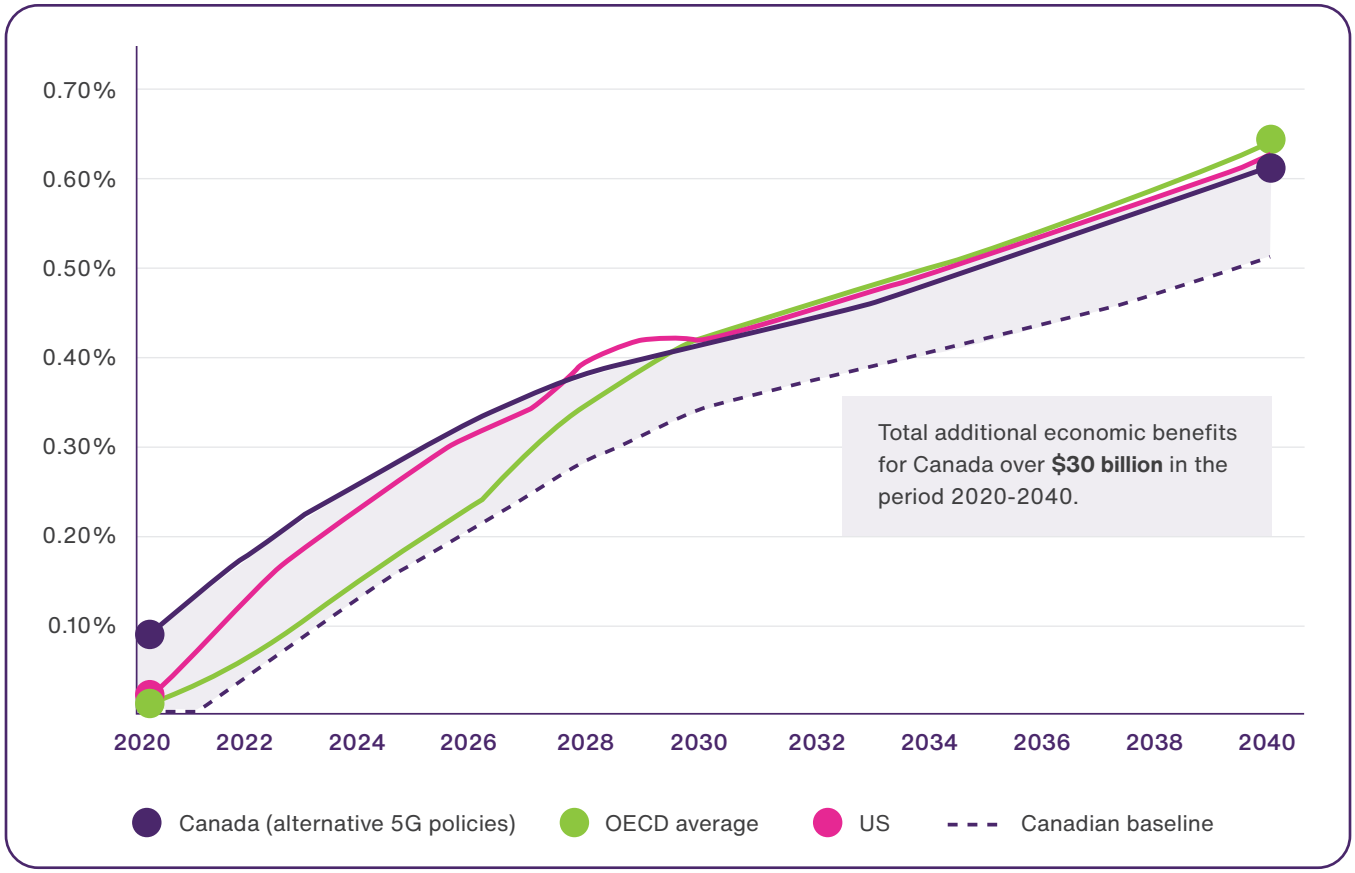

Figure 10: Canada's costly spectrum policy (In USD) [GSMA, 2020]

6.2 Jobs

In the coming years, 5G is expected to have a significantly positive impact on the labour market: creating jobs, facilitating retraining and upskilling, and changing the way that many Canadians work. The Canadian wireless industry currently employs 150,000 people in Canada (Statistics Canada, 2022). This includes jobs created by the industry itself, its supply chain and impacts on spending from wages (Statistics Canada, 2022). These are secure, well-paying jobs, with pay in the wireless sector on average 20% higher than in other service industries (Statistics Canada, 2022). 5G is expected to contribute a further net 250,000 jobs, bringing the number of Canadians employed by the wireless services industry to 400,000 (Accenture, 2019). This is to say nothing of the jobs created in other industries based on the technologies that 5G enables, from smart factories to VR video games.

As 5G is a general-purpose technology, it will reshape many industries and thereby disrupt the labour market. This has both potential benefits and downsides, although these new technologies, like other general-purpose technologies, are likely to create more jobs than they destroy. 5G will also improve how training and retraining occurs, with employees better able to learn at their convenience and without necessarily disrupting existing employment. 5G thereby both creates and solves the potential problem if government and training institutions are sufficiently flexible. It is also noteworthy that the jobs likely to be disrupted are those that are low skill, repetitive, low paying and insecure. 5G is thus also a stepping-stone toward the high-skill, high-wage economy to which Canadian policy is oriented.

The COVID-19 pandemic has provided a natural experiment to demonstrate the transformative effect of digital technology on the way we work (Dingle and Neiman, 2021). During the pandemic, Canada's high-quality and ubiquitous networks seamlessly adapted to allow many Canadians to work from home through remote connections to their workplace and video calling. According to Statistics Canada, approximately 40% of Canadians worked online, with at least half expected to continue remote working after the pandemic (Statistics Canada 2021b). Beyond keeping the economy running during the pandemic, teleworking offers employees

greater flexibility in work schedule and drastically reduces commute times, without negatively impacting productivity (Statistics Canada, 2021b).

5G represents the next frontier in remote working, presenting the opportunity for improved interaction through virtual reality and allowing increased remote monitoring and object manipulation. As a critical feature of the future labour market, teleworking, enabled by high-quality networks, will deliver not only economic benefits, but also improvements to health and environment.

6.3 Innovation and competitiveness

5G will have a dramatic impact on innovation and competitiveness in many industries. Agriculture, for example, will benefit from increased scope for smart technologies and IoT technologies, improving monitoring of crops, livestock and even soil conditions. Supply-chain management and tracing will improve dramatically, promoting health and safety and dramatically reducing waste. This is critical. Not only do Canadians currently waste 58% of all food, but the agriculture sector will need to cope in the coming decades with immense global population growth, changing weather patterns, soil degradation and water scarcity. From IoT to smart irrigation through connected farm machinery and drones, 5G stands to revolutionize, preserve and protect the Canadian agricultural sector.

5G is the lifeblood of the forthcoming automation of motor vehicles, which require constant and low-latency connectivity. These vehicles will increase mobility, shorten commute times, improve road safety and reduce pollution (GSMA, 2020; CCA, 2021). Mobility for older adults and people with disabilities will dramatically improve as 5G-enabled automation eliminates the demands of private travel on human drivers. Intelligent transportation systems that integrate data from other connected vehicles and connected infrastructure will improve commute times and reduce pollution by optimizing the distribution of public transportation. Finally, autonomous vehicles and driving assistance will increase the safety of emergency responders (GSMA, 2019).

Alongside significantly increasing productivity and efficiency in existing industries, 5G stands to provide a foundation for new global industries within which Canada is seeking to compete. The AI industry, for example, is currently subject to an immense, global power struggle for supremacy. The creation of a successful AI industry in Canada depends upon immense amount of effective data collection and the ability to deploy AI technologies remotely. Both turn upon the existence of the highest quality infrastructure across Canada and, fundamentally, global leadership in 5G. Domestic demand for AI-driven apps and a sufficient data supply are prerequisites of a domestic AI industry. Discussing Canada's global position in the race for AI without discussing 5G infrastructure is akin to discussing the self-driving car industry without any consideration of Canada's roadways: it is a prerequisite and, certainly, cannot be taken for granted.

It must also be taken into consideration that the increases in data collection and the demands placed on connectivity by new technologies, such as AI, will not wait for improved infrastructure in rural, remote and Indigenous communities. New technologies adopted by those in urban centres with access to improved networks will raise the expected quality of connection available to all. At a technological inflection point such as the emergence of 5G, combined with AI, the dissatisfaction of those in areas where networks are not upgraded, or are upgraded more slowly, will increase as the expected quality of connection increases. The experience of such users will degrade as the standard shifts, and a lack of adequate access, will become more and more apparent as increasing benefits accrue to those in urban centres who can access new technologies, which are inaccessible on slower connections.

6.4 Public Services

5G also presents a huge opportunity to revolutionize the delivery of public services. The COVID-19 pandemic has already demonstrated the potential for a dramatic increase in the use of digital public services, which prior to 2020, relied upon in-person delivery. It seems unlikely that the delivery of public services will ever fully return to their pre-pandemic limitations, but the delivery of public services through digital infrastructure relies upon universal access and adoption. This means that crucial innovation in how Canada delivers public services necessitates the closure of digital divides along many demographic and geographical lines. The ubiquitous availability of high-quality wireless infrastructure, which turns on spectrum policy, is therefore a critical element of modernizing public-service delivery in Canada.

5G presents a means by which not only to improve the digital delivery of public services, but will offer

new methods and means of delivery. Just as with new technologies such as AI, such new methods will increasingly put pressure on old, slower connections. Unlike industry however, the government's obligations to the public will mean that ubiquitous access and adoption are prerequisite for the adoption of any mode of service delivery. Failure to adopt appropriate spectrum policy is therefore likely to result in bottlenecks in improvements in public-service delivery, with Canadians stuck with services defined by the lowest common denominator. This is yet another cost of a spectrum policy that does not prioritize infrastructure deployment and crowds out investment.

5G will have particularly notable impacts on healthcare. Access to reliable and ubiquitous high-speed wireless broadband will improve healthcare for Canadians by allowing remote diagnosis and even surgery, expanding access and availability to healthcare far beyond existing telemedicine and moving care closer to Canadians. (GSMA, 2020) RAND Europe (2021) estimates that merely by using online family doctor consultations, where appropriate, reduces travel times, missed appointments and unnecessary emergency room visits, can generate at least $5.7 billion of economic benefit per year, or about 2% of Canadian healthcare spending, as well as bring healthcare services to the 5 million Canadians who lack access to physicians. Far from merely improving video calls, 5G allows ubiquitous access to much more effective technologies such as virtual reality, which can also be used for medical assessment. 5G will allow mass automation, remote object manipulation and constant monitoring, making healthcare far more efficient, effective and safer. This is crucial at the current juncture: with an aging population and a crisis in the supply of healthcare workers across the global, and particularly in Canada, new technologies are needed, which will allow the existing workforce to become more efficient and to improve their working conditions in order to increase retention.

As seen throughout the COVID-19 pandemic, the combination of connectivity and education can introduce immense flexibility and new modes of learning. High-speed broadband will improve the quality of education for students across the country, particularly where online learning opportunities are a better alternative to local classes or when students are unable to access specialist education, (GSMA, 2020). New technologies such as VR and AR, along with improved video-calling and remote monitoring, will improve the experience of students and teachers with remote education options, as well as enhance their effectiveness. The potential impact on education should not be underestimated – the introduction of VR as a potential teaching tool, for example, present fascinating opportunities for new methods of teaching as well as improving student-teacher interactions when working remotely. This is true when considering practical, vocational skills training and learning to work with dangerous or expensive materials and systems, and it does not take much imagination to think of all the interesting ways a teacher could use these technologies to keep students engaged. A further boon is the flexibility such technologies introduce into the education system, with adult retraining able to be made more adaptable and therefore accessible to those who would currently struggle to access training. A single parent, for example, may not be able to access night schools after work and after the children are in bed, but an effective online course than can to be taken on the way to work or late in the evenings could change their life.

Many other forms of public service can be similarly improved through digitization if 5G access is made ubiquitous. Again, universal access is a prerequisite for the deployment of these forms of program. While this turns in part upon demand-side policies, which improve adoption rates, particularly among population facing digital divides, a necessary element is that infrastructure is deployed to permit universal access. Rural connectivity and 5G are the backbone of achieving these forms of benefit, and these depend to an exceptional extent on congenial spectrum policies.

6.5 Social

Alongside this economic element, 5G will deliver social value across 11 key areas related to the UN Sustainable Development Goals (World Economic Forum and Price Waterhouse Cooper 2020), contributing to good health and well-being, enhancing infrastructure, promoting sustainable industrialization and fostering innovation (World Economic Forum and Price Waterhouse Cooper, 2020). Other benefits include contributing to responsible consumption, enabling sustainable cities and communities, and promoting decent work and economic growth (World Economic Forum and Price Waterhouse Cooper, 2020).

5G can also address a significant digital divide across the country, namely in some rural, remote and Indigenous communities. This is particularly the case because of the possibility of using 5G signals to

deliver broadband to people's homes in areas where it is economically infeasible to lay fibre cable. The economical necessity of this is clear, with attempting to use cable to close the digital divide faced by rural communities tens of billions of dollars more expensive than using a mixture of wired and wireless provision. Using wireless however, depends upon access to large amounts of spectrum. Carrying the internet traffic from people's homes is far more demanding than the relatively light use currently experienced from mobile devices, with residential customers expecting to use a wireless connection in the same manner as those in urban areas connected by cable. Large amounts of internet traffic require large amounts of spectrum, and it is this issue in particular that Canada's current policies create. Critical spectrum, which could be being used to connect rural communities, Indigenous lands and those currently suffering from low-speed internet more generally due to geographical placement is being wasted, used for speculation, and the spectrum that is available is sold at such high prices that infrastructure rollout and investment is crowded out.

6.6 Environment

5G intersects with the climate crisis, eco-diversity, the preservation of water resources and almost all other forms of environmental policy. Empirical analysis consistently demonstrates the net-emissions reducing effects of connectivity as economic and social activities are performed online and remotely. Even in the absence of digital climate policies (Farrpoint, 2022), recent economic analysis demonstrates that Canada has already saved 70 Mt (equal to the annual emissions of Greece), just by adopting connectivity to current levels (Briglaur, 2022). Analysis has suggested that further use of digital, facilitated by 5G, will enable emissions reductions of up to 20%, getting Canada up to 60% of the way to meeting its 2030 Paris Agreement climate targets (Farrpoint, 2022; GeSi, 2021; WEF, 2021). This saving comes from reductions in travel, such as for healthcare, improvements in industrial performance in industries such as agriculture and reductions in energy use. Soil monitoring, targeted pesticide use and supply chain management through 5G-enabled sensors, for example, all stand to improve Canada's environmental record and have the potential to reduce emissions significantly. 5G itself is many times more efficient in terms of emissions from infrastructure than 4G, and thus adopting 5G will reduce emissions by itself for the same level of online activity (Farrpoint, 2022; GeSi, 2021; WEF, 2021). This all depends on the government recognizing this relationship and understanding that **digital policy is climate policy** (Farrpoint, 2022). Spectrum policy as currently formulated works in the opposite direction, dividing the spectrum resource into inefficient, small quantities and delaying the deployment in the rural areas where the most significant environmental benefits stand to be accrued.

Better spectrum policy is better economic, health, education, social and environmental policy.

There are clearly myriad benefits to the adoption of 5G and the ubiquitous availability of extremely high-speed wireless connectivity for millions and millions of devices. We must modernize spectrum policy to reap these benefits.

By changing spectrum policy to facilitate 5G rollout, not only will consumers enjoy lower prices because spectrum costs will be reduced, but economic activity and wealth will be better distributed across Canada. Rural, remote and Indigenous communities will be better able to participate in the wider economy and receive better service provision where they live. They will be able to enjoy better learning outcomes through remote teaching, better health outcomes through telemedicine and better services of all kinds as remote service provision intensifies competition, driving down prices and driving up quality. Furthermore, reducing the need to travel long distances for services will contribute toward greenhouse gas emission targets and sustainability in general, and the ability to live and work from anywhere will allow people better access to the housing market.

As the data has shown, Canada is already four years behind in auctioning spectrum, will be six years behind when it finally auctions the recommended amount of spectrum for any operator, distorts auctions so that spectrum costs are six times the OECD average price, will impose further delays as spectrum incumbents are cleared, and with recently auctioned spectrum, does not require that any infrastructure then be built for five years in urban areas and seven years in rural areas after the auction. Looking at the timeline for the rest of the world from PwC and the World Economic Forum, Canada is being left behind while other countries begin to enjoy the advantages of 5G and greater wireless connectivity in general (see *Figure 11*). Canada's current spectrum policies are slowing economic, social and environmental progress, denying Canadians all the benefits being enjoyed in other jurisdictions and, worst of all, it is not clear why these policy choices have been made.

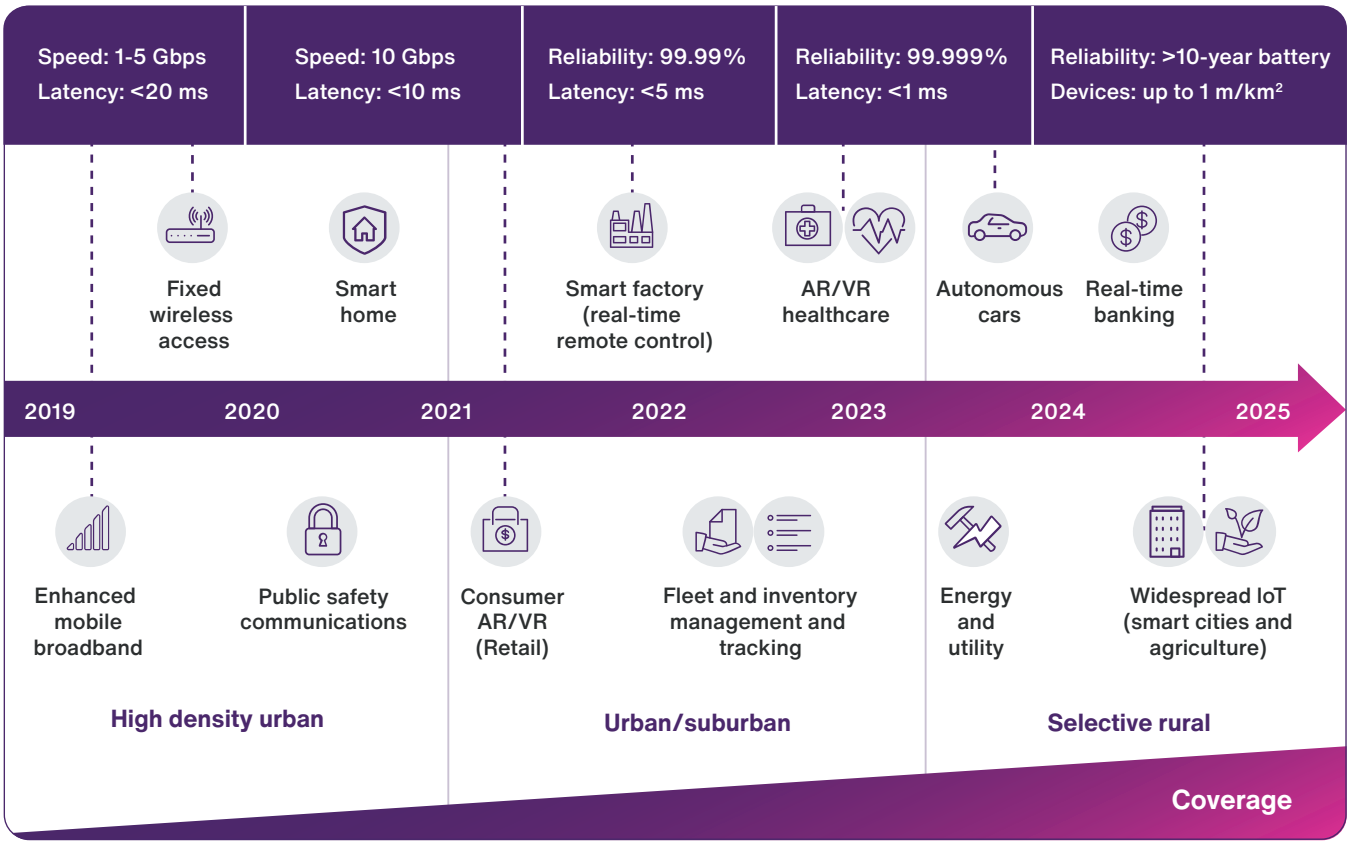

Figure 11: 5G use cases enabled across industry sectors by evolving features of 5G (World Economic Forum and PwC, 2019)

7. Conclusion: A vision for Canada's spectrum policy

On almost every important measure, Canada currently lags other advanced countries in spectrum policy. As a result, Canada has lost its position as a world leader in mobile network quality at the time when 5G is making mobile networks essential for all parts of the economy. Although this is extremely concerning, the situation can improve if policymakers are willing to act, focusing their efforts on the economic and social benefits of spectrum use, fostering innovation and promoting universal connectivity rather than focusing on supporting a minority of operators to the exclusion of all else. The 10 recommendations outlined in this white paper span immediate, short-term action to alleviate the current weaknesses of spectrum policy and medium-term calls for institutional reform. As an immediate catalyst, a comprehensive review of the process of spectrum policymaking should be undertaken to ground near-term decisions in evidence and begin the process of a fundamental shift to evidence-based, transparent and accountable decision making.

5G presents immense opportunity, but as with many forms of technology, it will disrupt processes, laws, regulations and policies as much as it will change the economy and society. It is uncontroversial to suggest that existing regulatory and legal frameworks are often unprepared for disruptive technological innovations. Technological disruption in the Canadian telecommunications sector is particularly challenging because the sector is so heavily regulated. Policymakers need to be more than just responsive to emerging technologies, they have to adapt beforehand so that industry can continuously modernize. Spectrum policy has not been significantly changed or even reviewed for over a decade in a heavily regulated sector that is in the process not only of technological transformation, but is also enabling technological changes in just about all sectors of the economy. This is a recipe for falling behind one's global competitors; the warning signs are outlined throughout this white paper.

Nonetheless, the implementation of the recommended changes outlined in this white paper would lead to marked improvements in the quantity of spectrum and capital necessary for immediate infrastructure investment, as well as the effectiveness of future evidence-based policy decisions informed by a review of current decision making.

In the short term, Canada must end its preoccupation with using spectrum policy to ensure a fourth carrier, particularly through harmful set-asides, if it is to put itself in a stronger position for future generations of wireless technology. This will allow Canada to better reap the immense economic and social benefit of the 5G era and the technological eras to come. While much in this white paper should be a cause for concern, through the enactment of key policy changes, meaningful progress can be made. Canada has spent the last generation building and deploying wireless network technology that leads the world, and there is no excuse for anything less in the future.

Ten recommendations for spectrum policy reform

There are 10 changes, which a survey of the international empirical, academic and policy literature suggests Canada should implement. Most critically:

1. **Go back to first principles -** Maximize the economic, social, and environmental benefits for Canadians from their spectrum resource. Canadian spectrum policy must be about Canadians and not about protecting companies. The government must return to first principles, adopting a laser-focus on the speed and efficiency with which spectrum is deployed to provide high-quality services to as many Canadians as possible without allowing spectrum to become a means of foreclosure.
2. **Spectrum policy must be evidence-based policy -** Canada's spectrum policy has been allowed to neglect its fundamental purposes because of the absence of any meaningful and transparent assessment of the government's policies, either before or after they are implemented. Canadian decision makers must be explicit about the objectives of spectrum policy and how they are balanced within any proposal, including an independent assessment of likely policy impacts akin to those undertaken by the Office of Economic Analysis of the US Federal Communications Commission. After a policy is implemented, sufficient public data, transparency, and accountability must be ensured such that independent bodies, commissioned by the government, can measure whether policies have been effective and thereby better ensure the desired policy outcomes moving forward.

To allow Canada to keep pace with international leaders in spectrum management and policy, it is further recommended that Canadian policymakers emulate and surpass other international best practices:

3. **Beat the global benchmarks -** Be the first OECD jurisdiction to make enough spectrum available to major operators for new services to efficiently meet International Telecommunications Union (ITU) recommended channel sizes, raise quality, lower costs, and prevent artificial shortages inflating auction revenues and retail prices.
4. **Focus on Canada's future -** Rapidly release and clear spectrum so that auction winners can use the spectrum to deploy new technologies in a timely manner, in line with competing jurisdictions.
5. **Defragment diluted holdings:** Prioritize the timely defragmentation of Canada's spectrum bands to accrue the largest benefit from efficient spectrum use over the longest possible time.
6. **Prioritize rural, remote and Indigenous Canadians -** Adopt strategies seen in other OECD countries to facilitate rural, remote, and Indigenous infrastructure investment through auctions, combining both positive and negative incentives.
7. **Set aside 'set-asides' -** End the possibility of providing set-asides for established operators which, while imposing costs on Canadians through the highest spectrum prices in the world and leaving them with the 4th least concentrated spectrum holdings, has failed to increase competition.
8. **Ensure speculators 'break even at best' -** Create rules to ensure that companies that have purchased subsidized spectrum through a set-aside or other measure intended to increase competition cannot use it to profiteer, by:
   - Continuing to ensure that deployment conditions are as aggressive and ambitious as is practicable for the spectrum is question to ensure squatting and flipping is unprofitable;
   - Conditioning resale on meeting initial deployment conditions, in both principle and practice; and
   - Blocking transfers of set-aside spectrum until deployment conditions are met.
9. **Make sure spectrum holders 'use it or lose it' -** Impose and enforce effective "use it or lose it" conditions, revoking licences in areas where companies purchase spectrum but do not meet robust deployment conditions and, once a full licence term has passed, use an expanded access licensing framework to make spectrum available to those willing to put it to use.
10. **Encourage operators to 'use it or share it' -** Even when operators comply with deployment requirements, design a 'use it or share it' regime that ensures operators share unused spectrum in the initial licence terms following the first deployment milestone where this will not affect their operations.

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