October 2, 2017

Via Email: ic.spectrumauctions-encheresduspectre.ic@canada.ca

Senior Director
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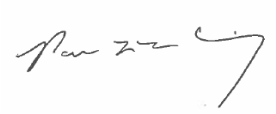
Re: Consultation on a Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band, Notice No. SLPB-005-17

1. Shaw Communications Inc. ("Shaw") is pleased to submit the attached comments to Innovation, Science and Economic Development Canada (the "Department") in response to the Department's *Consultation on a Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band,* Notice No. SLPB-005-17. We have also attached, as Appendix A to our submission, a paper written by Professor Peter Cramton.
2. Shaw appreciates the opportunity to provide its comments and looks forward to participating in this proceeding. If you have any questions please contact the undersigned.

Yours truly,



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Consultation on a Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band, Notice No. SLPB-005-17

Comments

of

SHAW COMMUNICATIONS INC.

October 2, 2017

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I. INTRODUCTION AND EXECUTIVE SUMMARY

1. The following constitutes the initial comments of Shaw Communications Inc. ("Shaw"), on behalf of itself and Freedom Mobile Inc., to Innovation, Science and Economic Development Canada (the "Department" or "ISED") in connection with the proceeding initiated by *Consultation on a Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band,* Notice No. SLPB-005-17 (the "Consultation Document").

2. This Consultation is critically important to the future of mobile wireless connectivity and competition in Canada. A competitive wireless market is, in turn, fundamental to the social, cultural and economic future of Canada. As Canadians strive to give life to the Government's Innovation Agenda, and as our connectivity needs escalate and evolve into the era of 5G and the Internet of Things, the Department must ensure that it adopts spectrum policies that promote a dynamic and sustainably competitive market. We applaud and fully support the direction taken by the Consultation Document. If new competitors, such as Shaw, are able to secure sufficient low-frequency spectrum through the 600 MHz auction as soon as possible, we will have the certainty we need to design and build a strong mobile network alternative.

3. In Canada, a truly competitive mobile wireless environment is only beginning to develop. Three mobile wireless incumbents – Bell, Rogers and Telus – dominate the market with 90% of subscribers and 92% of revenues. Canadians do not get the value and choices they increasingly need as their reliance on mobile data escalates. In many areas of Canada, a strong alternative to the incumbents has not yet emerged, but the evidence clearly demonstrates that the presence of a strong competitor drives pricing discipline, service innovation and choice. Canadians need and deserve this alternative to the incumbents both today and in the future.

4. Shaw is ready, able and willing to step up and complete the job of creating a strong alternative to the incumbents. Although we are a new competitor in the wireless market, we have decades of experience as a network builder and a long track record of customer-focused innovation, including: BlueSky TV,[1] a completely new platform in the Canadian video market; Internet 150,[2] which delivers leading internet speeds at affordable prices to large and small Canadian communities; Shaw Go WiFi,[3] Canada's leading carrier grade Wi-Fi network; and a suite of innovative, enterprise grade IT

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1 Shaw Communications Inc. ("Shaw"), *Blue Sky TV* < online: https://www.shaw.ca/television/blueskytv/ >.
2 Shaw, < online: https://www.shaw.ca/store/internet/internetPackageDetails.jsp?prodId=prod1480004 >.
3 Shaw, *Shaw Go WiFi* < online: https://www.shaw.ca/Wifi/ >.

products designed for Canada's small business segment.[4] We have a bold vision to bring this same spirit of innovation to the future of mobile connectivity in Canada.

5. Shaw's commitment is clear in our actions – we have spent billions of dollars in less than two years on our wireless initiative. We are expanding and enhancing our network to create the most valuable mobile experiences possible with our limited spectral resources – in particular, we have launched LTE-Advanced,[5] the most sophisticated mobile technology commercially available. However, without sufficient low-frequency spectrum, such as 600 MHz spectrum, we will always be disadvantaged on cost-effectiveness, speed, quality, capacity and coverage. No matter how innovative we are operationally or technologically, or how many billions of dollars we spend, without comparable quantities of low-frequency spectrum, we will be forever hobbled in our competitive efforts against the incumbents. On the other hand, if Shaw and other strong new competitors in the market are equipped with the proper tools to challenge incumbent dominance, a new, dynamic wireless environment can finally take hold in Canada.

6. Spectrum is a fundamental barrier to competition in the wireless marketplace. Without spectrum, which is a finite public resource administered by ISED, a mobile wireless carrier cannot operate. Spectrum concentration in Canada corresponds with market power. In Shaw's western Canadian operating footprint, the incumbents control nearly 80% of licensed commercial mobile spectrum. When we look at spectrum frequencies below 1 GHz, the level of concentration is even worse, with incumbents controlling over 91% of the available licensed spectrum, which is directly proportional to their revenue share (92%) and subscriber share (90%). A significant proportion of this low-frequency spectrum was awarded to the incumbents for free, setting the stage for a severe imbalance in the competitive position of the national and regional wireless incumbent providers versus that of any new competitor.

7. In particular, the incumbents that acquired their 850 MHz spectrum for free were able to deploy the spectrum without the additional financial constraints of the substantial expense associated with acquiring spectrum through competitive auction processes. In stark contrast, Freedom Mobile needed to spend hundreds of millions of dollars in an auction even before it could turn its mind to the financial demands of network deployment. On top of that challenge, Freedom also needed to start building its network using only AWS-1 spectrum even though, as explained below, 850 MHz and other low-frequency spectrum is much better suited to providing the coverage required for the

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[4] Shaw, *Advanced Solutions* < online: http://business.shaw.ca/Advanced-Solutions?intcid=ib-Cspot4-homepage-2016-09-06-advancedsolutions >.

[5] LTE-Advanced incorporates numerous enhancements to LTE, including advanced antenna techniques: MIMO, higher order modulation and the ability to aggregate LTE carriers.

foundation of mobile networks. It is therefore no wonder that Freedom is still in the early stages of building out its network.

8. This Consultation regarding the 600 MHz band represents a last chance to correct the significant low-frequency spectrum imbalance in Canada, as there is no foreseeable source of additional low-frequency spectrum on the horizon. For these and other reasons explained below, Shaw therefore believes that the amount of set-aside spectrum should be even greater: in Shaw's view, the Department must set-aside 40 MHz of the available 600 MHz spectrum for bidding solely by Canada's new mobile competitors. Given their widely-acknowledged dominance of the national mobile wireless market, Bell, Rogers and Telus cannot be eligible to bid on the set-aside spectrum. At the same time, the set aside should be available for bidding by those who have demonstrated their ability to become a strong alternative to the incumbents. As proposed by the Department, eligibility should be limited to telecom carriers (wireless or wireline) that have a substantial presence in the relevant Tier 2 serving area. However, Shaw also believes that eligibility for the set-aside spectrum should be limited to players that have established themselves in the mobile market in Canada: in addition to having a facilities-based access network presence in the relevant Tier 2 area, set-aside bidders must also have a substantial, operating mobile network somewhere in Canada, but not necessarily in the relevant Tier 2 area.

9. If the Department does not seize this rare opportunity and implement a sufficient set-aside for strong, new competitors, there will never be an alternative in the market that will be able to challenge the dominance of the incumbents. This follows logically from the following key facts:

   (a) Low-frequency spectrum is extremely valuable to mobile network builders. These signals travel across greater distances and through thick walls and other surfaces. This significantly improves the efficiency, cost-effectiveness and quality of network deployments. The corollary of this is that having a significant low-frequency disadvantage translates into a network, cost and service disadvantage. These disadvantages will be felt even more acutely as we move into the next stage of connectivity innovation with 5G and the Internet of Things.

   (b) Given the value of low-frequency spectrum and the evident low-frequency spectrum advantage that the incumbents enjoy, it naturally follows that the incumbents have the incentive to foreclose new competitors from gaining access to an equitable amount of low-frequency spectrum. As explained further in our submissions below, and as substantiated in the appended paper authored by Professor Peter Cramton, there is strong evidence of this foreclosure risk: incumbents are incented and able to pay a premium that will ensure new competitors are not able to access the fundamentally important low-frequency

spectrum that can support a truly competitive offering. Without regulatory intervention to mitigate this risk, incumbents will be able to effectively block new competitors from challenging the incumbents' market dominance.

10. The low-frequency spectrum disadvantage affects new competitors in all geographic areas, and in all aspects of their network builds. However, it is particularly apparent in deployments outside of densely populated urban areas. Without sufficient low-frequency spectrum, the business case for building networks outside of large cities becomes significantly more challenging. As a result, the prospects of sustainable competition in less populated areas will worsen considerably without a set-aside for eligible new competitors. In Shaw's view, all Canadians deserve real choice in mobile wireless services, including the Canadians that reside outside of our large cities. Choice and competition will drive affordability, as well as the network innovation required to provide the infrastructure for our digital economy in all areas of the country.

11. Shaw and other new facilities-based competitors in the wireless market have shown their commitment, ability and effectiveness in bringing competitive discipline to an uncompetitive market. These players have made great strides since the 2008 AWS-1 auction, by investing billions of dollars in alternative network facilities and punching well above their weight through innovation and choice at competitive prices, all to the benefit of Canadians. These achievements are all the more noteworthy because the barriers to competition have been significant – a seemingly insurmountable head-start advantage for the incumbents spanning decades, discriminatory roaming practices and ongoing uncertainty over wholesale roaming rates, unreasonable terms and conditions of access to public good support structures and, of course, severe spectrum disadvantages. This Consultation can decisively eliminate one of the most critical barriers to true competition in Canada by closing the gap between new competitor and incumbent low-frequency spectrum holdings. We respectfully ask ISED to implement the bold measures required to give life to our vision of a completely new and dynamic mobile wireless ecosystem in Canada.

12. Canadians deserve better than what our mobile wireless market is delivering today, and we have only seen a glimpse of the enormous potential that a strong alternative in the market can offer. This Consultation offers the best and last hope for an impactful regulatory solution to the severe imbalance between the low-frequency holdings of incumbents and new competitors. We need to ensure that this spectrum gets in the hands of those new competitors who can use it, without undermining vigorous bidding or the potential for new competitors to build out and expand. We also need to ensure that the spectrum set-aside does not have the effect of perpetuating a second-class status for new competitors. In order to offer a true alternative now and into the future, new competitors need to be placed on a footing that is as equal as possible to the incumbents. This is

challenging: even with a 40 MHz set aside, the wireless incumbents will still enjoy a low-frequency spectrum advantage. However, a 40 MHz set-aside is as close as we can get to near-parity of low-frequency spectrum holdings between new competitors and the wireless incumbents.

13. ISED's decision in this Consultation will change competition in Canada, either favourably or by forever confining competitors to a perpetual state of trying to catch up to the incumbents whose dominance was established through the gift of free low-frequency cellular spectrum. Our proposed modifications to the set-aside quantity and eligibility requirements are designed to further promote the likelihood of a truly dynamic competitive market over the long term. This will set the stage for: accelerated progress to achieving the Government's Innovation Agenda and promoting the competitiveness of our economy; enhancing the affordability, quality and variety of wireless services across the country; and creating strong and sustainable choices in mobile connectivity for Canadians throughout the country, including those who live outside of the large cities.

14. Apart from the set-aside, we would note the following with respect to other aspects of the Consultation:

    (a) Shaw supports the Department's proposals for the 600 MHz spectrum licence conditions, other than certain exceptions described in our responses to the Consultation Document's questions. In particular, Shaw supports the proposed deployment obligations. As highlighted throughout this submission, 600 MHz spectrum is particularly well-suited to deployment outside of large cities, and the proposed deployment requirements will ensure that Canadians get the service and competition they deserve.

    (b) Shaw is generally supportive of the proposed auction format design given the circumstances of this auction. In our detailed responses to the questions, we have provided some additional commentary.

    (c) We note the unique circumstances surrounding the availability of 600 MHz spectrum for mobile use, and the transition of over-the-air broadcasters required to facilitate that use. However, in Shaw's view, it is important that we do not delay the auction – even if the spectrum is not available for immediate deployment, new competitors need the certainty of low frequency access to plan for, and design, our network coverage. To this end, Shaw is requesting that the Department hold the auction as soon as possible.

    (d) Even without an accelerated auction, it appears that all successful bidders will likely be required to pay the full auction proceeds, and have their licence terms begin, without the ability to use those licences. This is not in the interest of carriers or that of the public. As

an alternative to this approach, Shaw offers for the Department's consideration, the following proposal. As a result of any lag in time between the usability of the spectrum licences, due to the transition of broadcasters in Canada or the United States, licence winners would pay the initial 50% of auction proceeds within 10 days of the date when provisional licence winners are announced. The remaining 50% would be payable only when the auctioned 600 MHz spectrum won by the licensee becomes available for use on a Tier 2 basis. In order to ensure that ISED has complete security over the balance of the auction proceeds, provisional licence winners would be required to deliver a letter of credit covering this outstanding balance.

15. The remainder of this submission outlines the arguments and evidence in support of Shaw's set-aside and eligibility proposals, including our responses to ISED's specific questions in the Consultation Document.

II. SUSTAINABLE, DYNAMIC WIRELESS COMPETITION WILL FOSTER THE GOVERNMENT'S AGENDA FOR CANADA

16. Recognizing the shift that has taken place in our economy and society to the digital world, as well as the need to increase Canada's competitiveness on the global stage, the Government has embarked on an ambitious Innovation Agenda.[6] This Consultation offers the Government an opportunity to take a significant step toward achieving the goals of this agenda, which is premised on Canada having world-class connectivity infrastructure. An advanced telecommunications system will foster the use of digital technologies, improving the overall productivity and competitiveness of our businesses and entrepreneurs, and driving growth. It will also make possible the development and adoption of transformative new platforms and applications, such as artificial intelligence. However, this dynamic, new ecosystem cannot develop unless there are connectivity services that exhibit the same level of dynamism. If the incumbents continue to dominate, we run the risk of perpetuating today's static mobile market and holding Canada back.

17. At 90% and 92% respectively, subscriber and revenue market shares of the three national incumbents have remained essentially unchanged for the eight years ending December 31, 2015.[7] More recent data as of the end of the second quarter of 2017 suggest that the national wireless incumbents continue their hold on over 90% market share. Specifically, Bell controlled 29.02% of

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[6] Government of Canada, *Canada: A Nation of Innovators,* June 2016 < online: https://www.ic.gc.ca/eic/site/062.nsf/eng/h_00009.html >.

[7] See Canadian Radio-television and Telecommunications Commission ("CRTC"), *Communications Monitoring Report, 2009*, August 2009, Figure 5.5.7 (subscriber share) and Figure 5.5.8 (revenue share); and CRTC, *Communications Monitoring Report, 2016*, October 2016, Figure 5.5.5 (subscriber share) and Figure 5.5.6 (revenue share), hereinafter "CMR 2016".

subscribers, Rogers controlled 33.90% and TELUS controlled 28.36%.[8] The Competition Bureau has confirmed that coordinated pricing takes place between the three national incumbents,[9] while other indicators, such as average monthly churn rates[10] and subscriber penetration rates[11] similarly reflect the deficiency of competition in the market.

18. Strong, sustainable competition would not only position Canada and the Canadian economy for long-term success in the global, innovation economy, it will also improve the lives of all Canadians, regardless of their income levels or where they live. Competition is the key driver of affordability, as it promotes pricing discipline and more valuable offerings to consumers.

(a) The Competition Bureau has recently highlighted that prices are lower in markets with a strong, regional competitor that can bring pricing discipline and an alternative to the wireless incumbents.[12]

(b) Similarly, prices for mobile services are lower in cities where there is an alternative, strong facilities-based provider to the incumbents.[13]

(c) Indeed, as the Department has stated, new facilities-based competitors in the market have begun to deliver innovation and consumer choice at competitive prices, given the empirical evidence from the market, not least of which is that "average new entrants offer prices up to 36% less than the national incumbents"[14] and that lower prices that have been observed

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8 The Canadian Wireless Telecommunications Association, "Wireless phone subscribers in Canada, 2017" *Facts & Figures* < online: https://www.cwta.ca/wp-content/uploads/2017/08/Sub-Stats-2017-Quarter-2.pdf >.

9 Competition Bureau, *Competition Bureau statement regarding Bell's acquisition of MTS*, 15 February 2017 < online: http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/04200.html >, hereinafter, "Competition Bureau Bell Statement".

10 The average monthly churn rates for the three national carriers are also exceptionally low, hovering at around 1.3% to 1.6%, which is even lower than they were in 2011: see CMR 2016, Table 5.5.9.

11 Statista reports that Canada has the lowest subscriber penetration rates of all the countries included in the survey: see Martin Armstrong, "Smartphones Aren't as Ubiquitous as You Think," *Statista*, 25 April 2017, < online: https://www.statista.com/chart/9096/smartphones-arent-as-ubiquitous-as-you-think/ >. Within Canada itself, there are many regional disparities in subscriber penetration rates. For example, there are many potential customers that have yet to subscribe to a mobile service: see CMR 2016, Figure 5.5.9.

12 See Competition Bureau Bell Statement: the Bureau conducted a thorough pricing analysis and found that mobile wireless pricing is substantially lower in areas where a strong regional competitor is present.

13 See Dr. Eric Emch (Bates White Economic Consulting), "An assessment of wholesale roaming policy in Canada: The relationship between competition, regulation, investment and access," 8 September 2017, report prepared for Shaw Communications Inc. in the proceeding initiated by Telecom Notice of Consultation CRTC 2017-259, Section III.A.6, Figure 1, hereinafter, "Emch (2017)", based on NLG Nordicity Group Ltd., *2016 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions,* prepared for the CRTC, pages 79 to 83 (Table C.2.1, Table C.2.2, Table C.2.3, Table C.2.4 and Table C.2.5) < online: http://www.crtc.gc.ca/eng/publications/reports/compar/compar2016.htm >, hereinafter, "Nordicity 2016 Price Comparison Study". Overall, Nordicity found that new entrants' prices for mobile wireless telecommunications services were lower than the incumbents' by a range of 25% to 36% for service basket Levels 1, 2, 3, 4 and 5: Nordicity 2016 Price Comparison Study, page 32.

14 ISED, *Consultation on a Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band*, August 2017, SLPB-005-17, , paragraph 17, hereinafter, "Consultation Document".

in some markets is "caused by the presence of a strong regional competitor" in such markets.[15]

19. There are also many examples of the customer responsiveness and choice that facilities-based competition can engender in the marketplace. As a new facilities-based mobile carrier, Freedom Mobile was among the first to offer unlimited calling and data plans and to reduce overage charges, offering the WINDTab as an alternative to the incumbents' generally uniform offerings.

20. The benefits of strong, facilities-based competition are also clearly evident in the experience of other countries, most notably the United Kingdom and the United States,[16] where consumers generally have access to four facilities-based wireless carriers, and the markets are characterised by falling prices, increased quality and diversity in services and high levels of investment.[17]

21. Given the evidence of the need for more competitive pressure in Canada's mobile wireless market, and the salutary effects of the presence of a strong-facilities based player, the obvious question is why new competitors in Canada continue to struggle in their efforts to counter the dominance of the incumbents. The answer lies in a list of significant barriers to competition, including challenges in negotiating the sharing of radio antenna sites and reasonable roaming rates and arrangements and, of course, a huge spectrum disadvantage. To their credit, the Department and the CRTC have made some progress in addressing some of these barriers, but there is still so much work yet to be done:

    (a) In 2012, the Department decided to make a number of important amendments to its rules for mandatory roaming and tower and site sharing on the basis that it had taken "a considerable amount of time," for new entrants to conclude roaming agreements with the incumbents and that their experience in negotiating tower and site sharing arrangements was even "less successful, considering the number of agreements negotiated and the time that it has taken to reach those agreements."[18] New competitors, such as Shaw, continue to face timing, economic and other challenges in securing reasonable access to sites and towers, which hinders the build-out and enhancement of our networks.

    (b) In 2014, Parliament and the CRTC intervened in response to discriminatory practices and the exercise of market power by the incumbents in the wholesale roaming market. A new

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15 Consultation Document, paragraph 22.
16 Emch (2017), Section VII.C, paragraph 84.
17 Emch (2017), Section VII.A.2, paragraphs 62 and 63, Section VII.A.3, paragraphs 64 and 65 and Section VII.A.4, paragraphs 66 to 70 (US experience) and Section VII.B.2, paragraph 79, Section VII.B.3, paragraphs 80 and 81 and Section VII.B.4, paragraphs 82 and 83 (UK experience).
18 Industry Canada, *Proposed Revisions to the Frameworks for Mandatory Roaming and Antenna Tower and Site Sharing,* March 2012 < online: http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10250.html >.

regulatory regime for wholesale roaming has emerged from this intervention. However, the framework and the associated tariff rates remain subject to review in ongoing CRTC proceedings.[19] In particular, the launch of the CRTC's Wi-Fi First review[20] has introduced significant uncertainty in the policy environment and marketplace, calling into question the business and network deployment plans on which Freedom had been poised to act. The Wi-Fi First Review raises the significant risk that new facilities-based competitors, such as Shaw, will not only be disadvantaged relative to the incumbents, but that they would also face significant disadvantages in the market relative to resale-based models. This is because resale-based models face no investment burden, unlike Shaw and other facilities-based new competitors, who have invested billions in spectrum and the on-going build-out of their networks. Depending on the outcome of the Wi-Fi First Review, and in particular whether resale-based models would unjustifiably gain access to regulated roaming rates without making any investments in Canadian connectivity, the continued build-out of alternative wireless network facilities and the prospects for sustainable competition in Canada are at risk.

(c) Finally, ISED has established pro-competitive measures in a number of spectrum auctions held over the last ten years that have endeavoured to reduce spectrum concentration among the incumbents. Beginning ten years ago, the Department adopted a set-aside for new entrants in the 2008 AWS-1 auction, followed up by another set-aside in the 2015 AWS-3 spectrum auction, as well as band-specific spectrum cap mechanisms in each of the 2014 700 MHz auction and the 2015 2500 MHz spectrum auction. Notwithstanding these measures, spectrum concentration remains one of the most challenging barriers to competition.

III. SPECTRUM CONCENTRATION IN CANADA IS A FUNDAMENTAL BARRIER TO VIBRANT COMPETITION

22. A mobile wireless carrier cannot operate a network without spectrum. Commercial licenced mobile spectrum is generally divided into high- (for example, 2500 MHz), mid- (for example, AWS-1 and PCS), and low-frequencies (for example, 850 MHz, 700 MHz and 600 MHz). It is widely accepted that adequate low-frequency spectrum (less than 1 GHz) is extremely important to mobile network builders, particularly in the early stages of their network build-out. With its vast, sparsely populated expanses, and challenging terrain, low-frequency spectrum is even more important to new network builders in Canada.

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19 See Telecom Decision CRTC 2017-56, 1 March 2017.
20 Telecom Notice of Consultation CRTC 2017-259, 20 July 2017.

23. However, in Canada, spectrum ownership is highly concentrated in the hands of Canada's three wireless incumbents. When ownership is concentrated, firms may be able to exercise market power downstream in the provision of services that use wireless spectrum.[21] In other words, spectrum concentration leads to market power. This is clearly evident in the incumbents' spectrum holdings, on the one hand, and their market share, whether measured in subscriber terms (90%) or revenue terms (92%),[22] on the other hand. Excessive concentration of this essential input undermines competition for wireless services, harming consumers.[23]

24. As described in further detail below, the problem of spectrum concentration is particularly acute for low-frequency spectrum, with cascading effects for network design and planning, timely and efficient deployment, capital and operational efficiency and downstream retail competition.

A. In Canada, Spectrum Is Excessively Concentrated in the Hands of Incumbents

25. New wireless competitors' acute lack of low-frequency spectrum is an absolute barrier to competition, one that the Government is exclusively positioned to alleviate. Notwithstanding targeted pro-competitive measures by ISED in recent years, the incumbents continue to enjoy a considerable spectrum advantage.

26. In most regions of Canada, the Department has issued radio spectrum licences for a total 118 MHz of low band spectrum in the cellular and 700 MHz bands. Yet, new wireless competitors hold at most only 10 MHz of 700 MHz spectrum in any Tier 2 licence area, with the remaining 108 MHz held by an incumbent wireless carrier. On a national, weighted MHz per population basis, Bell, Rogers and Telus hold 90.8% of all low band spectrum across the country, with all others, including the new wireless competitors, currently holding only 9.2%:

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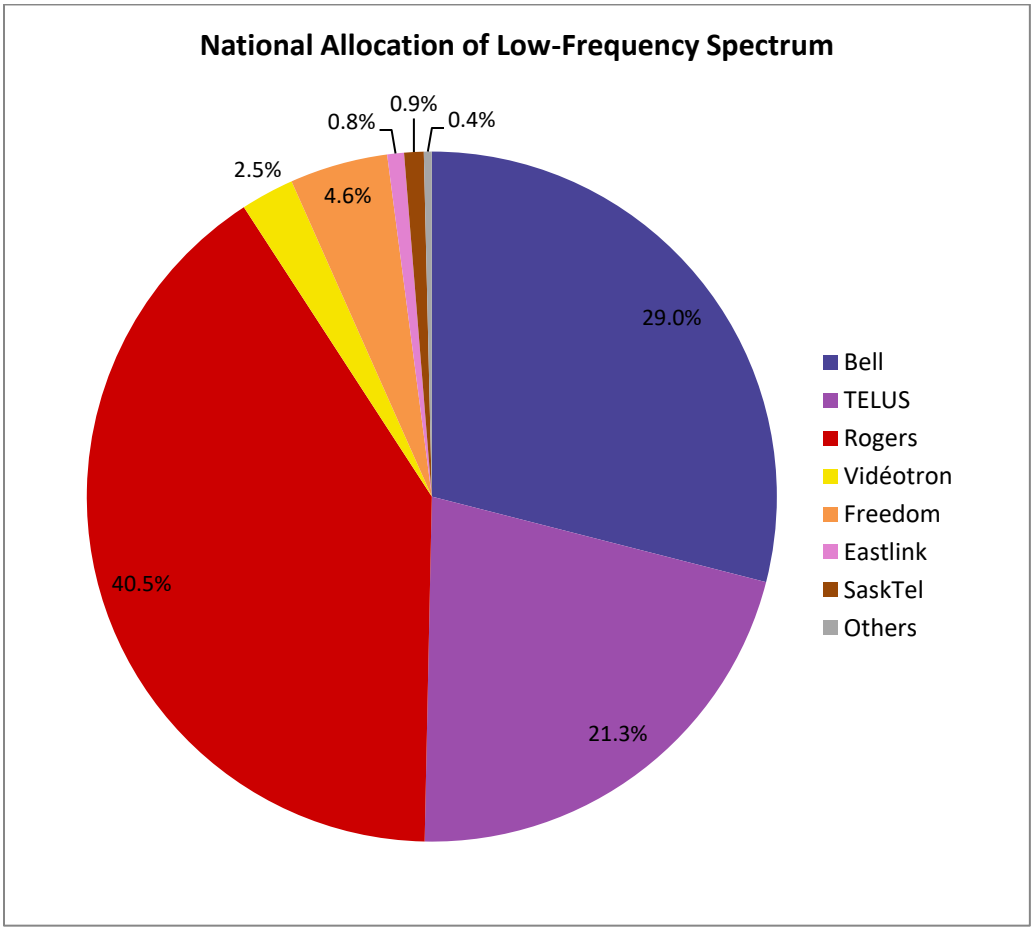
21 See Jonathan B. Baker (Washington College of Law), "Spectrum Auction Rules That Foster Mobile Wireless Competition", paper submitted by T-Mobile in Federal Communications Commission, WT Docket No. 12-268, *In the Matter of Policies Regarding Mobile Spectrum Holdings*, 12 March 2013, pages 3 and 15, hereinafter, "Baker (2013)". Professor Baker states that, "when spectrum ownership is concentrated, firms may be able to exercise market power downstream in the provision of services that use wireless spectrum as an input. Large incumbent firms that recognize this prospect may have an incentive and ability to obtain or maintain downstream market power by keeping spectrum away from their rivals." Accordingly, Professor Baker advised the FCC that it should consider whether excessive concentration of low-frequency spectrum by large incumbents would constrain the ability of rivals with limited access to low-frequency spectrum to compete aggressively in wireless service markets, thereby allowing the large incumbents to obtain or maintain market power.

22 CMR 2016, Figures 5.5.5 and 5.5.6.

23 Peter Cramton (University of Maryland and University of Cologne), "The Critical Importance of the Set-aside in the Canadian 600 MHz Auction", report prepared for Shaw Communications Inc. in the proceeding initiated by *Consultation on a Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band*, Notice No. SLPB-005-17, page 2, hereinafter "Cramton (2017)".

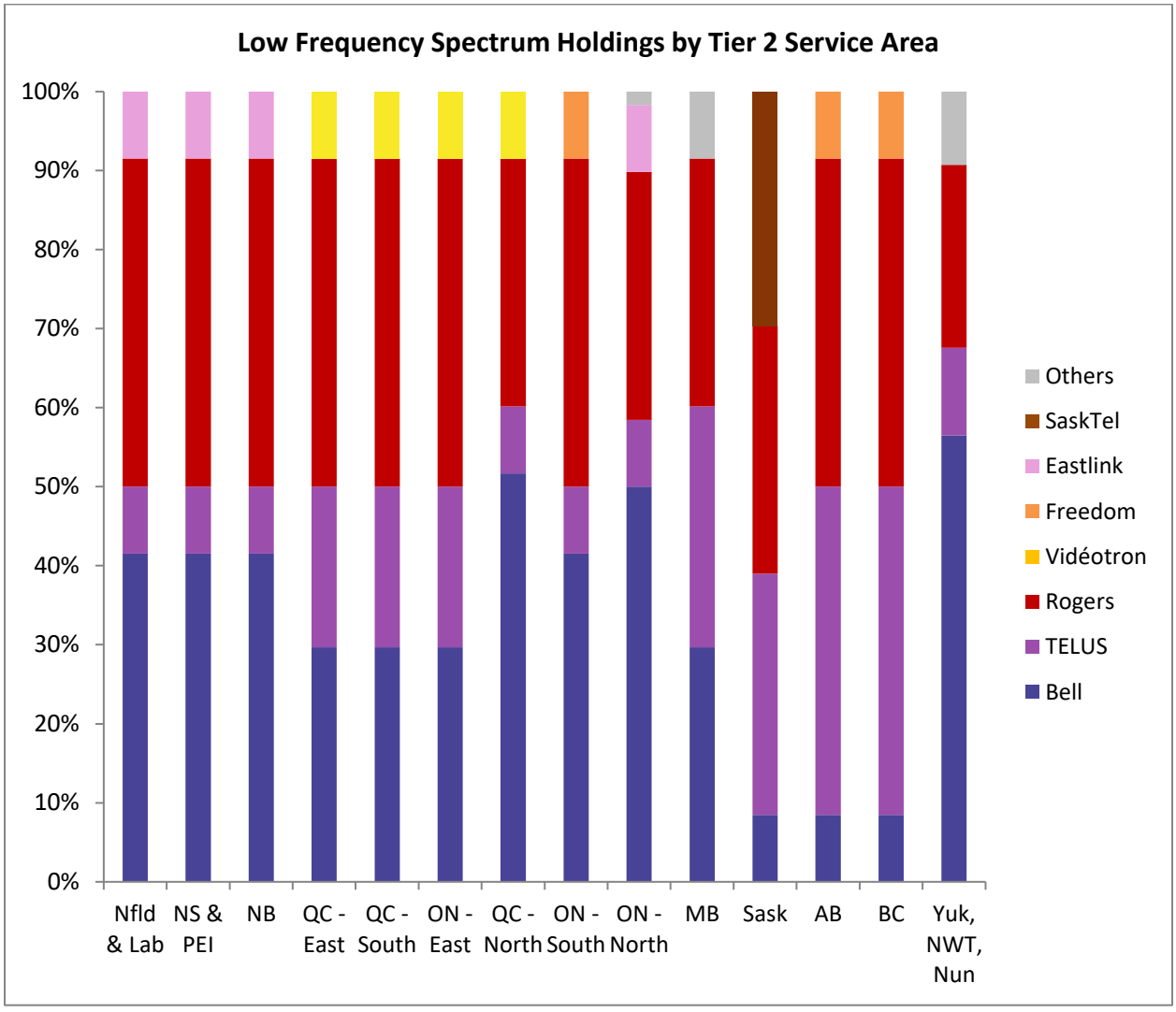
Figure 1 – National Allocation of Low-Frequency (Cellular and 700 MHz) Spectrum[24]



27. On a Tier 2 service area basis, the breakdown of low-frequency holdings is depicted in Figure 2 below. Apart from a few exceptions, Bell/Telus generally hold 50% or more of the licensed low-frequency spectrum through their extensive spectrum sharing arrangements, while Rogers generally holds 40%. In short, two networks effectively control more than 90% of the licensed low-frequency spectrum:

[24] Weighted MHz/Pop estimate, based on licence data contained in ISED's Spectrum Management System, available online at: http://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/home

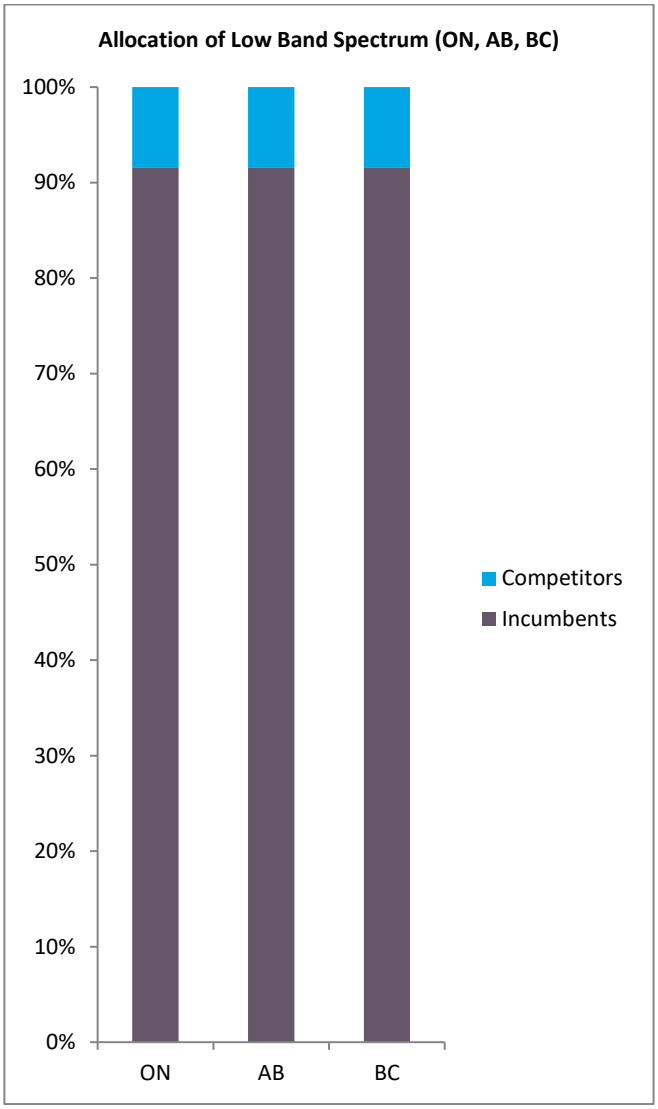
Figure 2 – Distribution of Low-Frequency (Cellular and 700 MHz) Spectrum by Tier 2 Service Area[25]



28. In the provinces where Shaw has deployed mobile services to date, namely Ontario, British Columbia and Alberta, the incumbent wireless carriers hold 91.5% of all low band spectrum:

[25] Weighted MHz/Pop estimate, based on licence data contained in ISED's Spectrum Management System, available online at: http://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/home

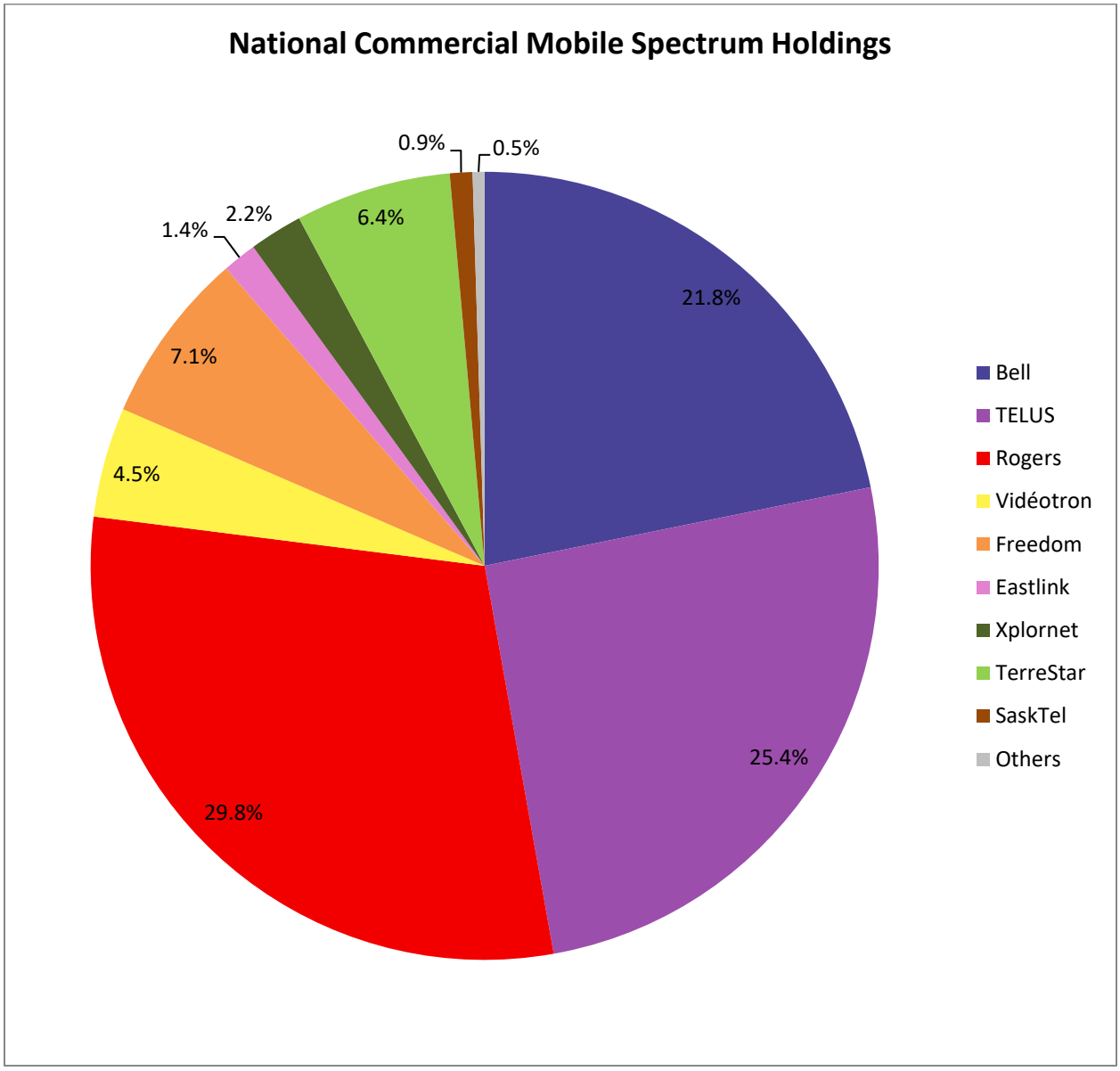
Figure 3 – Allocation of Low Band Spectrum (ON, AB, BC)[26]



29. The incumbents also enjoy a considerable advantage with respect to spectrum holdings generally, across all bands. They control more than three quarters (approximately 77%) of all licensed commercial mobile spectrum in Canada.

[26] Estimate based on licence data contained in ISED's Spectrum Management System, available online: http://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/home.

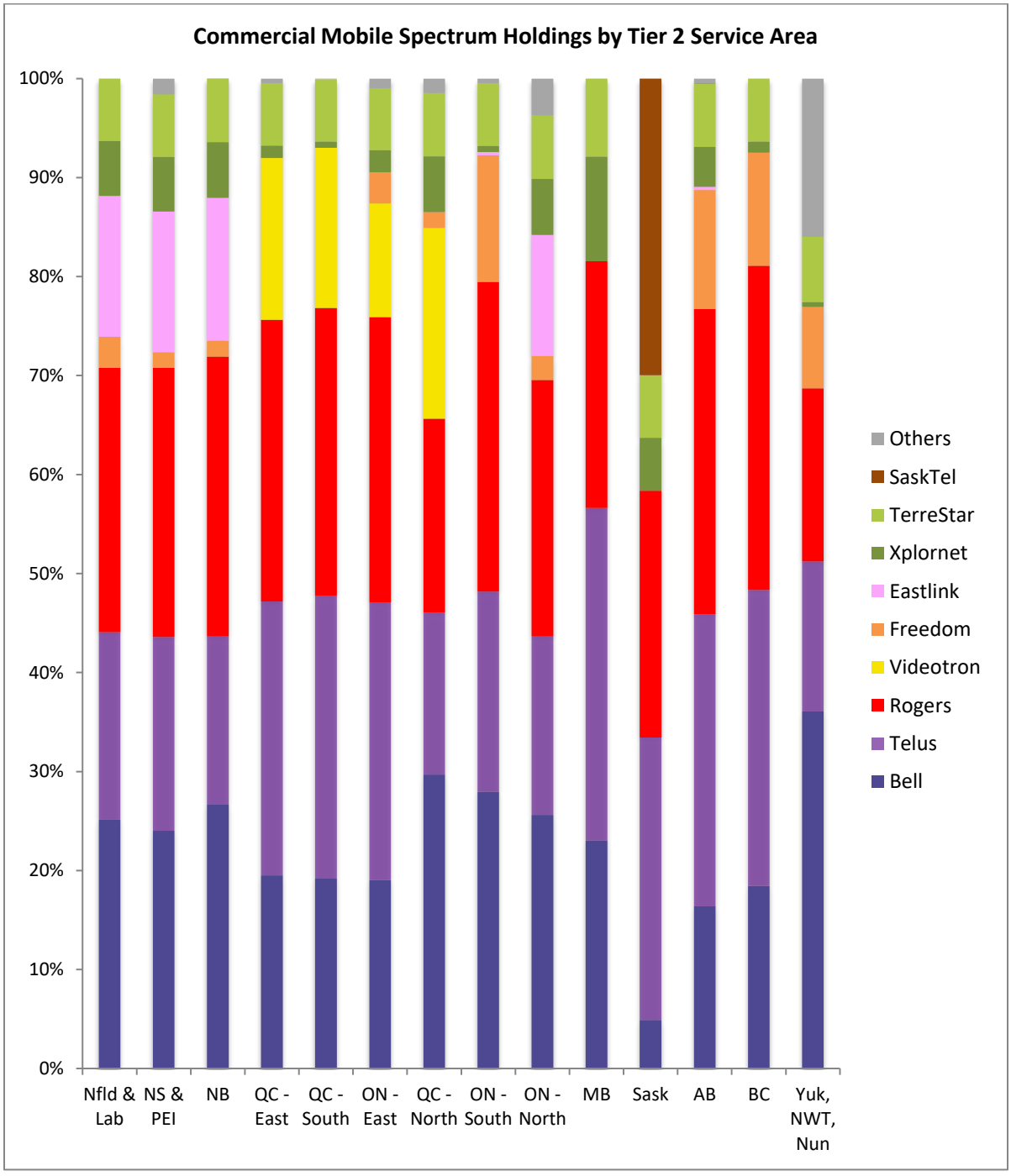
Figure 4 – National Commercial Mobile Spectrum Holdings[27]



30. In Shaw's western footprint, the national incumbents control close to or above 80% of the spectrum. The following graphic illustrates the overall spectrum holdings in Canada, on a Tier 2 service area basis:

[27] Weighted MHz/Pop estimate, based on ISED's *National Holdings of Commercial Mobile Spectrum*, July 14, 2016 < online: http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11210.html > updated to reflect licence transfers approved by ISED after this date.

Figure 5 – Commercial Mobile Spectrum Holdings by Tier 2 Service Area[28]



31. Even with several pro-competitive measures implemented in spectrum auctions over the last decade, the trend in spectrum holdings concentration has not changed meaningfully. The situation

28 *Ibid.*

is particularly dire in regards to low-frequency spectrum, given that cellular spectrum was handed to Rogers, Bell, Telus, and other regional incumbents for free over 35 years ago. In the 700 MHz band, only 10 MHz was protected from incumbent bidding (via caps), such that a full 40 MHz of 700 MHz spectrum was available for open bidding by the incumbents. The result was that the national incumbents obtained 6 of the 7 blocks available in virtually all areas of the country. As described in more detail below in our response to question 1B, we are still not on a trending pattern of reducing spectrum concentration in Canada. More needs to be done.

B. Why Is Low-Frequency Spectrum So Valuable to New Competitors?

32. As demonstrated above, Canada's incumbents have a profound advantage over new competitors in their spectrum holdings, particularly in low-band spectrum. Network operators need and use a mix of lower and higher spectrum frequencies to leverage the various, respective technical attributes of each band.[29] In the absence of this mix, new wireless competitors simply cannot compete against incumbents.[30] In this mix, why is low-frequency spectrum so valuable?

33. Low-frequency signals have less attenuation, resulting in better in-building penetration, reducing dead spots and allowing for more cost-effective deployment and better service in urban areas. In addition, low frequency signals propagate farther in the environment, requiring fewer cell sites to cover an area. Given its physical characteristics, low-frequency spectrum is essential for establishing and expanding wireless network coverage, particularly in the early stages of building out a network, as is the case today for new wireless competitors. A base station in a low frequency band will have greater geographic coverage and superior in-building penetration than a similar station offering service in a higher band. While higher frequency spectrum can augment network capacity and throughput, which is valuable as demand grows, it cannot serve as a substitute for the coverage function uniquely served by low-frequency spectrum.

34. With its unique physical attributes, low-frequency spectrum is less costly and operationally more efficient to deploy in any area. When an operator has sufficient capacity of low-frequency spectrum, it can enhance peak data rates, network capacity, network quality, and end-user experiences, while reducing capital and operational costs by minimising the number of antenna sites required. This is especially, though not only, true for deployment in difficult terrain and less densely populated

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29 Baker (2013), pages 14-15.

30 The U.S. Federal Communications Commission ("FCC") recognizes that "competition in the mobile wireless marketplace will be better promoted by multiple service providers having the opportunity to access both low-band spectrum that can provide coverage and in-building penetration, as well as higher band spectrum that can provide the increased throughput for mobile broadband applications": see FCC, *Annual Report and Analysis of Competitive Market Conditions with respect to Mobile Wireless, Including Commercial Mobile Services -- 19th Report*, 23 September 2016, paragraph 51 < online: https://www.fcc.gov/document/19th-mobile-wireless-competition-report >, hereinafter, "FCC 2016 Annual Report".

settings. In contrast, the physical properties of higher frequency spectrum make it costlier and less practical for providers to use in establishing and expanding coverage. These technical and operational ramifications of the differences between low- and high- frequency spectrum affect the timing within which network builders can address a market. Those carriers with sufficient low-frequency spectrum can compete more quickly and efficiently. Those without it are unable to compete on an equal footing.

35. In many respects, in a mobile wireless market with entrenched incumbents, access to any newly available low-frequency spectrum is much more important to new competitors.

(a) New competitors, like Shaw, are still in the early stages of building their networks – achieving coverage, and all of its attendant costs and administrative burdens, is our foremost concern. As emphasized by Professor Cramton, "…low-band spectrum provides the foundation of coverage on which capacity can be built. This is true, regardless of the wireless standard – 3G, 4G, and 5G – in question because all are best built on a foundation of low-band spectrum."[31]

(b) Relative to the new wireless competitors, who desperately need low-frequency spectrum in order to achieve coverage and quality in an efficient manner, the marginal utility of additional low frequency spectrum is low for the national wireless incumbents. This is reinforced by the recent U.S. 600 MHz spectrum auction, which did not see vibrant participation from the incumbents.

(c) At the same time, the cost impact for providing service without a mix of spectrum types is not symmetric: it is higher for providers, like Shaw, that to date have mainly only had the use of higher frequency spectrum. As discussed further below, in such circumstances, an incumbent holder of low-frequency spectrum will therefore be incented to disadvantage rivals (raising their capital and operational costs) by denying them access to any newly available low-frequency spectrum.[32]

(d) Having sufficient low-frequency spectrum would enable new competitors to leverage their existing and future higher frequency spectrum holdings in an efficient and effective manner to fully realize the potential of those bands as well. Without low frequency spectrum, network deployments using high frequency bands alone become cost prohibitive, particularly in low-to-medium-density service areas. This, in turn, limits the potential deployment of higher frequency bands. In some areas of the country, where population

31 Cramton (2017), page 4.
32 See Baker (2013), page 15.

density is particularly sparse, low-frequency spectrum is, practically speaking, the only feasible deployment option.

36. As explained above, the low-frequency disadvantage faced by new competitors, such as Shaw, has a significant effect on relative deployment costs, deployment timelines, and our ability to take advantage of different frequency bands to optimize network speed, quality, capacity, coverage and ultimately, the customer's experience. Despite our significant and continuing investments in our network, these disadvantages are reflected in network performance results, as shown in a recent report by PCMag, which identified coverage and other issues with Freedom Mobile's network in a number of geographic areas.[33] These results are unacceptable to Shaw. However, no matter how much money we invest, or how innovative we are technologically or operationally, the only way we can overcome these challenges is through equitable access to low-frequency spectrum. Timing also matters, highlighting the urgency of getting more low-frequency spectrum into the hands of new competitors. 600 MHz and other low-frequency spectrum provides the opportunity to build the foundation of any mobile network, yet, Shaw and other facilities-based competitors have had to start their network builds without sufficient low-frequency spectrum.

37. The Department recognises that spectrum is a critical input for wireless carriers and that for new wireless competitors in particular, additional 600 MHz would enable them to "effectively compete with the services offered by the more established wireless service providers"[34] (emphasis added). Recognizing the problem is the initial step – the paragraphs above all reinforce the extent of the problem and the urgent need for intervention. What we now need to consider is the appropriate remedy. Consistent with the requirements of telecommunications policy that regulation be proportionate,[35] a decisive, impactful measure must be adopted to reverse the wide disparity in the spectrum holdings of new competitors compared to incumbents. This Consultation provides a unique opportunity that will not be repeated to adopt a measure that begins the slow and challenging process of overcoming the mobile incumbents' market power.[36]

38. This takes us to Shaw's responses to the questions included in the Consultation Document.

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33 Sascha Segan, "Fastest Mobile Networks Canada 2017"*, PC Magazine*, 11 September 2017 < online: https://www.pcmag.com/article/348825/fastest-mobile-networks-canada-2017 >.

34 Consultation Document, paragraph 18.

35 *Order Issuing Direction to the CRTC on implementing the Canadian Telecommunications Policy Objectives,* SOR/2006-355.

36 Baker (2013), page 15.

IV. RESPONSES TO SPECIFIC QUESTIONS POSED IN THE CONSULTATION DOCUMENT

A. Q1 – Pro-Competitive Measures

1. Q1A – Proposal to use a set-aside

Q1A—ISED is seeking comments on its proposal to implement a set-aside as a pro-competitive measure in the auction process for the 600 MHz band.

39. In Part II above, we describe the enduring dominance of the incumbents in Canada's wireless market and the persistent barriers to competition faced by new wireless competitors. In Part III above, we detail the correlation between the incumbents' dominance of the market and the ongoing concentration of spectrum in their hands. Although new competitors face a variety of barriers to competition, the extreme concentration of low-frequency spectrum in the hands of the incumbents effectively guarantees that the incumbents will be able to preserve their market power until the spectrum imbalance is corrected. Remedying this imbalance is not the only measure needed to enhance competition in Canada's mobile wireless marketplace, but it is essential to doing so.

40. The Framework for Spectrum Auctions in Canada identifies market conditions in which a spectrum set-aside should be considered. As recognised by the Consultation Document,[37] each of these conditions applies in the current context:

(a) the wireless incumbents possess market power in the provision of mobile services in Canada;

(b) new competitors, such as Shaw, will use the licences to be issued as a result of the 600 MHz spectrum auction to provide services in competition with the incumbents; and

(c) the anti-competitive effects of the incumbents acquiring the licences are not outweighed by potential economies of scope arising from the integration of the spectrum in the incumbents' networks – the incumbents already have considerable low-frequency spectrum, such that the marginal utility of additional low-frequency spectrum by the incumbents is low, especially relative to that of the incumbents.

41. Implementing an appropriate set-aside is an essential step toward reducing the extreme variance in low-frequency spectrum holdings between the incumbents and new competitors.

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37 Consultation Document, paragraphs 18 and 22 to 24.

(a) In the absence of a set-aside, the risk of incumbent foreclosure is too high

42. As stated in the Consultation Document, "there is a risk that competition in the post auction marketplace could suffer without measures to facilitate regional carriers' access to spectrum."[38] The dominance of the incumbents is not in question: they control 90% of subscribers and 92% of revenues in the market. The excessive concentration of low-frequency spectrum in the hands of the incumbents is also not in question: they control over 90% of the licensed low-frequency mobile spectrum in Canada. At the same time, as explained above, new competitors need low-frequency spectrum much more than the incumbents do.

43. In circumstances where firms, such as Canada's wireless incumbents, are able to exercise market power downstream in the provision of services that use wireless spectrum, they also understand and are able to act on their strategic incentive to obtain or maintain downstream market power by paying a premium beyond the value of the spectrum to them in order to keep smaller rivals from acquiring the spectrum[39] – this is what the economic literature refers to as the "foreclosure risk" in spectrum auctions. Even though there is greater societal value to be derived from the award of spectrum to new competitors, an incumbent will be motivated to bid an inflated amount for the chance to block the competitor from acquiring spectrum and thereby reduce competition in the wireless market.[40]

44. Professor Peter Cramton's paper, included as Appendix A with this submission, substantiates the incumbents' strong incentives to foreclose new competitors. As recounted by Professor Cramton, AT&T and Verizon effectively did "not show up at the auction," obtaining no spectrum, or very little spectrum, in the U.S. 600 MHz auction and thereby demonstrating that additional low-frequency spectrum was of low marginal utility to both of the two largest and most established wireless carriers in the United States. After all, prior to the U.S. 600 MHz auction, Verizon already held 46 MHz of low frequency spectrum and AT&T considerably more than this amount, on a national weighted average basis.[41] Notwithstanding their near-zero economic demand for 600 MHz spectrum, the dominant U.S. wireless carriers "feigned great interest in the 600 MHz spectrum", and lobbied "strenuously against a set-aside."

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38 Consultation Document, paragraph 22.
39 Baker (2013), page 3.
40 Cramton (2017), page 3.
41 Mike Dano, "In 2017, how much low-, mid- and high-band spectrum do Verizon, AT&T, T-Mobile, Sprint and Dish own, and where?" *Fierce Wireless,* May 30, 2017 <online: http://www.fiercewireless.com/wireless/2017-how-much-low-mid-and-high-band-spectrum-do-verizon-at-t-t-mobile-sprint-and-dish-own >. At the present time, across different major urban markets in the United States, AT&T holds anywhere between approximately 65 to 125 MHz of low-frequency spectrum and Verizon, anywhere between approximately 20 MHz to 45+ MHz of low-frequency spectrum.

45. In Professor Cramton's view, the dominant U.S. wireless carriers were clearly driven to foreclose competition by T-Mobile, amongst other potential rivals.[42] He believes the same dynamic is likely to play out in Canada noting that "[t]he economic setting of the Canadian 600 MHz auction is similar, with the exception that the competition problem is more severe in Canada, since the dominant incumbents command an even more dominant position in Canada both in terms of market share and low-band spectrum holdings."[43]

46. There are other empirical examples of the foreclosure risk. In the 2008 AWS-1 auction in Canada, despite actively bidding to acquire open (non-set-aside licences), the new entrants won only seven (7) very insignificant such licences in the AWS-1 band. Not only did this demonstrate foreclosure risk, it also showed how incumbents will engage in foreclosure tactics on a coordinated basis. In that auction, the incumbents managed, in effect, to not compete against one another in any given licence area, and effectively competed only against new entrants.

47. The Canadian 700 MHz spectrum auction, which included a spectrum cap mechanism rather than a set-aside, provides another illustration of the power of the national incumbents in a spectrum auction. In this auction, the national wireless incumbents won 85% of the spectrum by MHz/pop, including 100% of the most sought after lower paired blocks (A, B, and C). The four regional operators at the time – Videotron, Eastlink, MTS and Sasktel were relegated to the much less desirable upper C1 block that was a distant third choice for each of the incumbents.

48. In light of the foreclosure risk, and in view of the current structure of the Canadian wireless market, Professor Cramton has recommended that ISED implement a spectrum set-aside. In his view, "[a]bsent a significant set-aside, foreclosure of competition would be likely—causing tremendous long-term harm to consumers."[44]

(b) Spectrum set-aside will enhance competition and therefore allow market forces to thrive

49. The benefits of a pro-competitive set-aside have already been seen in the Canadian marketplace. In Canada, the Department injected much-needed competition into the mobile wireless market by implementing a set-aside of 40 MHz of AWS spectrum exclusively for new entrants in the 2008 AWS-1 auction. Although the incumbents and their experts warned of dire consequences to auction revenues and competitiveness from the AWS-1 set aside, none of these consequences

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42 Cramton (2017), pages 4 and 5.
43 *Ibid.*
44 Cramton (2017), page 5.

materialized. The result was a highly competitive auction that generated $4.25 billion in revenue, nearly three times initial revenue expectations.[45]

50. Moreover, the competitive dynamic that was unleashed by this process has been impressive. As of the spring of 2014, it was estimated that new facilities-based wireless carriers had invested over $3 billion since the 2008 AWS auction in mobile wireless assets.[46] Since then, Shaw alone has spent well over $2 billion, first in acquiring Freedom, then in network upgrades and improvements that led to the recent launch of our LTE-Advanced network in Calgary, Edmonton, Vancouver, Toronto and Ottawa, and more recently in spectrum acquisitions that will allow us to more efficiently and effectively serve our footprint in Western Canada and Ontario.

51. Critically, as explained in Part II above, the pricing and service benefits to Canadians of enabling a strong facilities-based competitive alternative in the marketplace have been undeniable. These benefits are already being felt even though new competitors are working at a disadvantage with their limited spectrum portfolios. This only serves to demonstrate how much more they *could* bring to the market if only they were equipped with comparable quantities of low-frequency spectrum. In Shaw's view, this would change the game, finally creating the potential for a truly dynamic wireless environment to emerge from today's stagnant conditions. As Shaw has argued in the CRTC's Wi-Fi First proceeding, with support from Dr. Eric Emch, pro-competitive spectrum policies will also enable further service-based innovation and competition by facilitating a more robust wholesale wireless market in Canada.[47]

2. Q1B – Amount of set-aside spectrum

Q1B—ISED is seeking comments on its proposal to set aside 30 MHz of spectrum in the 600 MHz band for eligible entities and to have open bidding (no pro-competitive measures) on the remaining 40 MHz in the band.

52. As discussed above, low-frequency spectrum is at once a unique and scarce public resource that, at present, is disproportionately allocated to the incumbent wireless carriers. These considerations,

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45 Peter Cramton, "The Rationale for Spectrum Limits and Their Impact on Auction Outcomes, paper prepared for T-Mobile , September 2013, page 7 < online: http://apps.fcc.gov/ecfs/document/view?id=7520942733 >, hereinafter "Cramton (2013)," citing Kyle Hyndmany and Christopher F. Parmeter, "Efficiency or Competition? A Structural Econometric Analysis of Canada's AWS Auction and the Set-Aside Provision 4" (2013).

46 Margaret Sanderson (Charles River Associates), "Wireless Retail and Wholesale Services in Canada. Assessing the State of Competition", May 2014, report prepared for Bell Mobility in the proceeding initiated by Telecom Notice of Consultation CRTC 2014-76, pages 22 and 23.

47 Emch (2017), Section II, paragraph 9; and Shaw Intervention dated 8 September 2017, paragraphs 9 and 70 regarding Telecom Notice of Consultation CRTC 2017-259.

as applied to the Canadian wireless market, corroborate the correctness of ISED's proposal to use a set-aside measure in the 600 MHz spectrum auction.

53. The scarcity, unique characteristics and lopsided holdings of low-frequency spectrum lead to the conclusion that a 30 MHz set-aside will not sufficiently redress the current low-frequency spectrum concentration problem in Canada. Shaw therefore supports a set-aside of 40 MHz of spectrum in two 10+10 MHz paired blocks. This is supported by Professor Cramton's recommendations.[48]

(a) 40 MHz set-aside will yield better outcomes for consumers and competition

54. Shaw has already canvassed above the evidence of the low marginal utility to incumbents of additional low-frequency spectrum, relative to the foundational, significant needs that new wireless competitors have for low-frequency spectrum.

55. It is important to note that even a 40 MHz set-aside will not bring the new wireless competitors to near-parity with the wireless incumbents, given what the incumbents already hold in the cellular and 700 MHz spectrum bands. With a 40 MHz set-aside, post-auction, the incumbents could hold more low-frequency spectrum across the country on a population-weighted basis than any one of the new wireless competitors could realistically obtain, especially given the extensive spectrum sharing arrangement between Bell and Telus. With 30 MHz of 600 MHz spectrum available for open bidding by the incumbents, they will be able to compete and obtain the spectrum they need to supplement their current low-frequency holdings.

56. From a different perspective, if ISED were to adopt a 30 MHz set aside, and we look at the impact of that, together with the other pro-competitive measures for low-frequency spectrum that ISED has undertaken (*i.e.,* the 700 MHz spectrum auction), the ratio between the spectrum that will have been open for all bidders, including incumbents, versus the spectrum that has been subject to caps and set asides would be 66% to 33%. In other words, under this scenario, by the time of the close of the 600 MHz spectrum auction, ISED would have protected an aggregate of 40 MHz of paired spectrum for new competitor bidding while making 80 MHz available on an open basis. Given the extraordinary imbalance in low-frequency spectrum that the incumbents enjoy, this ratio doesn't do enough to establish a more equitable balance.

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48 Cramton (2017), page 5.

57. As suggested by Professor Cramton, increasing the size of the set-aside to 40 MHz would not undermine the potential competitiveness of the auction – in fact, the auction would likely be more competitive, with more competition from both new competitors and incumbents:[49]

> A key advantage of the 40 MHz, rather than 30 MHz, set-aside is that it prevents the dominant incumbents from splitting the non-set-aside blocks, (2-2 between Rogers on the one hand and Bell/Telus, who have an extensive spectrum sharing arrangement, on the other hand), at low prices, as we have observed in other auctions (Ausubel et al.; Grimm et al. 2003). With only 30 MHz available for the dominant incumbents, if they choose to compete for more low-band spectrum, they must fight to determine who gets more, since the only possibilities for the dominant incumbents is 2-1, 2-0, 1-1, 1-0, 0-0, and the reverse.[50]

58. The gift of low-frequency spectrum without any up-front payment was the seminal moment for the incumbents' dominance. It was not a product of efficiency or competition. In the first 15 years of mobile wireless services, the incumbents were handed on average approximately 25 MHz of low-frequency cellular spectrum and anywhere from 10 to 40 MHz of mid-frequency PCS spectrum through comparative selection and review processes, rather than competitive auctions. With these spectrum assets, acquired for free, the wireless incumbents were able to build their networks. There is no question that the incumbents invested many billions of dollars to build out their networks, but they did so without the challenge of also having to pay for the low-frequency spectrum licences that were ideally suited to establishing network coverage – a critical need in the early days of building out a mobile network.

59. It is no coincidence in Shaw's view that the incumbents' market share, whether measured in subscriber (90%) or revenue share (92%) terms, remains essentially unchanged from over a decade ago and roughly corresponds to the proportion of low-frequency spectrum that the incumbents control. It also isn't surprising that the incumbents would seek to preserve their spectrum advantage as much as possible. The incumbents' free low-frequency spectrum holdings are illustrated below:

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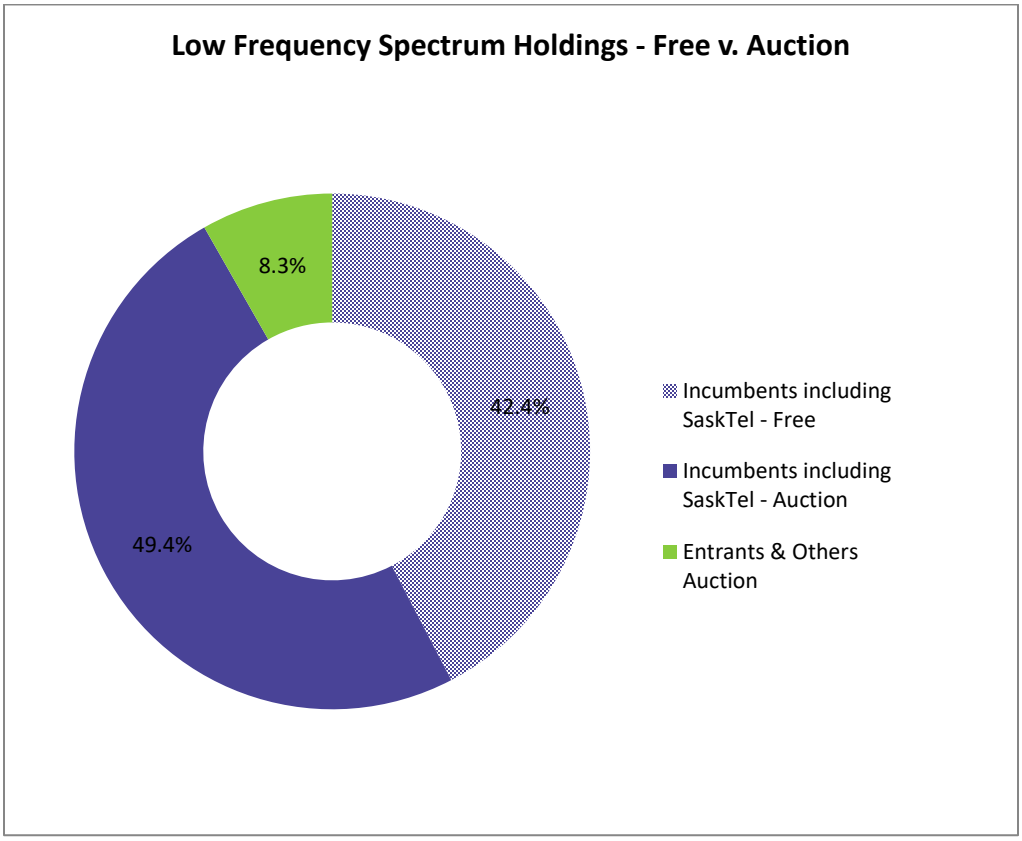
49 Cramton (2017), pages 2 and 3.
50 *Ibid.*, pages 5-6.

Figure 6 – Low-Frequency Spectrum Holdings – Free v. Auction[51]



60. In contrast, each of the largest operating new wireless competitors that entered the market after the 2008 AWS-1 auction faced the substantial financial burdens and risks associated with acquiring spectrum through a highly competitive auction process that generated record-breaking revenues for the Government. However, the new wireless competitors had no established mobile revenue stream to finance these acquisitions or the launch of their services. In addition, the new competitors only held AWS-1 spectrum, which meant that the relative cost of any build-out would automatically be higher than for the incumbents, given that the new competitors had no low-frequency spectrum for underlay network coverage.

51 Weighted MHz/Pop estimate, based on licence data contained in ISED's Spectrum Management System, < online: http://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/home >.

(b) This is the last chance for near-parity of low-frequency spectrum

61. The upcoming 600 MHz auction is the last foreseeable opportunity for the Department to address the current imbalance in low-frequency spectrum held by new facilities-based competitors. New competitors require a measure that brings them closer to parity in low-frequency spectrum holdings.

62. In Shaw's view, a 40 MHz set-aside would also be more effective at leveling the playing field from an LTE configuration perspective. In particular, a set aside of 40 MHz, with (2 blocks of 10+10, as elaborated upon below in our response to Question 1E) would: (i) maximize network capacity achievable in a single LTE channel; (ii) maximize peak data rates achievable in a single LTE channel; (iii) maximize end-user experience; (iv) maximize capital expenditure efficiency; (v) maximize coverage for the benefit of consumers; (vi) reduce the number of cell sites required in a network; and, (vii) improve network quality as a result of wider channelization.

63. Even with several pro-competitive measures implemented in spectrum auctions over the last decade as outlined above, the trend in spectrum holdings concentration has not changed meaningfully. In the AWS-1 and AWS-3 auctions, the Government set aside a total of 70 MHz and the amount available in the open auctions was 70 MHz (combined between the two). Roughly speaking, the end result was that approximately 50% was open and 50% was set-aside.

64. We are at a highly sensitive juncture in the market's evolution to true, sustainable competition. If ISED does not achieve a balance in low-frequency spectrum holdings today, it will effectively relegate new competitors to a second-tier status on a permanent basis for the future. A decisive, impactful intervention is therefore required. Bringing low-frequency spectrum holdings into better balance will go a long way to establishing the conditions that are necessary for a truly dynamic market to take hold, providing valuable, affordable and differentiated offerings to Canadians.

3. Q1C – Eligibility to bid on set-aside spectrum

Q1C—ISED is seeking comments on its proposal to limit the eligibility criteria to bid on set-aside spectrum to those registered with the CRTC as facilities-based-providers, that are not national incumbent service providers, and that are actively providing commercial telecommunication services to the general public in the licence area of interest, effective as of the date of application to participate in the 600 MHz auction.

65. We understand that the Government's primary objective in this auction is to ensure that Canadians in all regions of the country have a choice of innovative and competitively-priced mobile connectivity alternatives. The proposed eligibility requirements promote this outcome. However, Shaw believes

that the proposed eligibility requirements could be further clarified and tailored so that strong new players put this spectrum to use within a reasonable timeframe following the auction.

66. As explained in the Consultation Document, the policy objective of the set-aside is to enable existing new facilities-based competitors, *i.e.*, those that have "launched wireless services in recent years [to] benefit from an opportunity to acquire access to additional spectrum to support network improvements to meet the wireless traffic demands of their growing subscribership."[52] As such, Shaw concurs with the view "that the ability to bid on the proposed set-aside spectrum should be limited to a particular sub-set of regional service providers that are best positioned to compete in the commercial mobile services market."[53]

67. Shaw believes that limiting set-aside bidding to a new competitor ensures that this highly valuable low-frequency spectrum is allocated to parties that are able to create a strong, sustainable alternative to the incumbents. To this end, they must have (i) substantial, existing telecommunications facilities in the relevant Tier 2 area to leverage, but they must also have (ii) a substantial presence in the mobile market, somewhere in Canada. This will ensure timely deployment that will maximize the benefit of the spectrum for Canadians, while also setting the stage for effective and sustained competition in the post-auction marketplace.

68. As explained in further detail below, Shaw proposes that the tests proposed by the Department be clarified to require that an applicant that wishes to bid on set-aside spectrum furnish proof that it is actively providing:

    (i) Commercial mobile wireless services anywhere in Canada using a radio access network that it owns and operates; and

    (ii) Commercial telecommunications services in the Tier 2 area of interest using access facilities, whether wireline, mobile wireless or fixed wireless, that it owns and operates.

69. The foregoing reflects three narrow but essential clarifying modifications to the proposed eligibility criteria to further assure that the Department and industry achieve the stated policy objectives in the 600 MHz spectrum auction.

70. First, Shaw proposes that the eligibility criteria set out at paragraph 29 of the Consultation Document must explicitly provide that the ability to bid on the set-aside spectrum should be limited to existing new mobile wireless competitors that are actively providing commercial wireless services to the public somewhere in Canada using radio access network facilities that are owned and operated by the entity in question. This will ensure that only providers that have demonstrated the

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52 Consultation Document, paragraph 27.
53 Consultation Document, paragraph 29.

capability of launching and offering commercial mobile services are able to gain access to this highly valuable spectrum, while preventing spectrum speculators from acquiring frequencies that are badly needed to enhance connectivity and competition in Canada.

71. The assessment of "active provision of commercial wireless services to the general public" for purposes of this first clarification of paragraph 29 would require a potential bidder for the set-aside spectrum to file with ISED, along with its application to participate in the auction, evidence relating to the commercial mobile wireless services that it offers, the retail/distribution network used to offer the services in Canada and the means by which subscribers access services and the number of subscribers.

72. However, the set-aside eligibility rules should not be so overly restrictive as to preclude Shaw or other existing regional service providers that are currently actively engaged in building out their radio access networks from bidding on available 600 MHz spectrum outside of their existing mobile footprints or license areas. For example, in the current context, there is no sound basis to limit bidding on Tier 2 licence areas to only those regional service providers that are already licenced in the Tier 2 area in question, as was the case in the AWS-3 licensing framework.[54] This would undermine the competitiveness of the auction and the expansion of competitive networks. It would be particularly prejudicial to new competitors that are still in the early stages of their deployment efforts.

73. Rather, any licensed mobile provider that has otherwise established that it is actively engaged in offering and providing commercial mobile wireless services to the public somewhere in Canada and that can demonstrate that it is offering any "commercial telecommunications services," whether wireless or wireline, to the public in a given Tier 2 area, should be eligible to bid on the set-aside licences in the Tier 2 area in question.

74. Shaw notes that the current wording of paragraph 31, when read together with paragraph 29, is consistent with Shaw's view that it was not the Department's intention to limit regional service providers to only bidding in Tier 2 licence areas where they are already actively offering or providing *commercial mobile wireless* telecommunications services. Instead, paragraph 31 refers to proof

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[54] Industry Canada, *Technical, Policy and Licensing Framework for Advanced Wireless Services in the Bands 1755-1780 MHz and 2155-2180 MHz (AWS-3),* 18 December 2014, paragraphs 64 and 65. In the AWS-3 auction, eligibility to bid on the set-aside spectrum was limited as follows:

- limit the eligibility to bid on set-aside spectrum to operating new entrants, since new entrants that are already offering wireless services benefit from an existing network and subscribers, and will be able to add set-aside spectrum to improve their mobile networks.
- he Department also proposed that the active provision of commercial wireless services, including a minimum coverage within each Tier 2 licence area, would be assessed when determining an applicant's eligibility to bid on the set-aside spectrum.

that the applicant is actively providing *a commercial telecommunications service* (i.e., wireless *or* wireline) in the Tier 2 licence area.

75. Finally, the requirement for demonstration of active provision of commercial telecommunications services in a Tier 2 licence area of interest should be further narrowed to require demonstration that the service is being provided using *access facilities that are owned and operated* by the applicant. This would provide the necessary assurance to the Department that licence winners in each Tier 2 area are immediately able to leverage existing facilities for rapid deployment. In the absence of these modifications, *de minimis* or inactive facilities could allow for eligibility, which would be inappropriate.

76. These small but essential amendments will ensure that bidding on the set-aside is limited to those that are "best positioned to compete in the commercial mobile services market"[55] and are ultimately able to provide a strong, compelling alternative to the dominant incumbents. These amendments would also ensure deployment of the spectrum in the short-term and prohibit speculative participation in the auction and the holding or trading of spectrum, which would not be in the public interest.

77. To summarise, Shaw proposes that eligibility to bid on the set-aside spectrum in any Tier 2 licence area be limited to persons or entities that are, as of the deadline for the submission of applications to the Department to bid in the 600 MHz auction:

(a) Licensees of commercial mobile terrestrial spectrum that are actively providing commercial wireless services to the public somewhere in Canada using radio access network facilities that are owned and operated by the entity in question;

(b) Not a national wireless incumbent (i.e., any entity with more than 10% of national wireless subscriber market share);

(c) Registered with the CRTC as a facilities-based carrier; and

(d) Actively providing commercial telecommunication services to the public in the relevant Tier 2 licence area using access facilities that the person or entity owns and operates.

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55 Consultation Document, paragraph 29.

4. Q1D – Limit on transferability of set-aside spectrum

Q1D—ISED is seeking comments on its proposal to limit the transferability of the set-aside spectrum for the first five years of the licence term.

78. Shaw agrees with the limits on transferability of set aside spectrum for the first five years. This preserves the integrity of the set-aside over a reasonable period of time.

5. Q1E – Block sizes for set-aside spectrum

Q1E—ISED is seeking comments on its proposal to auction the set-aside spectrum as three separate paired blocks of 5+5 MHz.

79. As discussed above, Shaw believes that 40 MHz of spectrum should be set aside for bidding by eligible bidders and that under this configuration, the set-aside spectrum should be auctioned in two paired 10+10 MHz blocks.

80. However, should ISED proceed with a 30 MHz set-aside, the available amount should be auctioned in three equal 5+5 MHz blocks.

81. In Shaw's view, these configurations balance the need to acquire optimally sized blocks for LTE deployment with the need to create opportunities for bidding by different players on the set-aside spectrum.

B. Q2 – Licence Areas

Q2—ISED is seeking comments on its proposal to use Tier 2 service areas across the country, except in the three Territories (Yukon, Northwest Territories and Nunavut) where Tier 4 service areas would apply.

82. Shaw agrees that the use of Tier 2 service areas across the country, except in the three northern Territories would be appropriate. This geographic division reflects the physical propagation characteristics of 600 MHz spectrum and is large enough that the number of price clock rounds in the auction would not become overly burdensome, while at the same time being small enough to accommodate bidders with specific geographic interests. In the post-auction market, Tier 2 service areas would also facilitate and streamline coordination among licensees.

C. Q3 – Auction Format and Rules

Q3—ISED is seeking comments on:

a. the proposal to use generic licences and;

b. the proposal to categorize all blocks won by set-aside-eligible bidders as set-aside blocks.

83. Shaw supports ISED's proposal to implement an auction of generic blocks in an initial allocation phase, with a separate assignment stage to determine specific contiguous frequency assignments.

84. The proposal to categorize all blocks won by set-aside-eligible bidders as set-aside blocks is appropriate. Were it not to take this step, ISED could introduce elements into the auction that could be exploited. The auctioneer would not want to encourage set-aside bidders to bid more aggressively to win blocks simply for the opportunity to flip them quickly post-auction, nor would the auctioneer want to encourage the large incumbents to bid less aggressively because they may have a secondary avenue for acquiring the 600 MHz spectrum.

D. Q4 – Information Disclosure

Q4—ISED is seeking comments on:

a. the use anonymous bidding during the auction; and

b. the information that will be disclosed to bidders during the clock rounds, as described in annex A (which would also apply to the CCA with a modified activity rule set out in annex B) and annex C.

1. Q4a – Use of anonymous bidding

85. Shaw supports anonymous bidding. It has become a common practice in high-stakes auctions, such as the proposed 600 MHz auction.

2. Q4b – Information disclosed during clock rounds

86. During the clock rounds of the two CCA designs that ISED proposes (WARP CCA and GARP CCA), ISED generally proposes to publish aggregate demand information by service area. This is consistent with the information disclosure rules that occurred in the 700 MHz and 2500 MHz spectrum auctions (both WARP CCAs) and in other CCAs worldwide.

87. In the final clock round, however, ISED proposes to withhold aggregate demand information. This is consistent with auctions implemented in the 700 MHz and 2500 MHz spectrum auctions, but it is inconsistent with the ECCA that ISED has also proposed here.

88. Shaw suggests that in the event ISED implements a CCA, it should disclose aggregate demand in the final clock round in the 600 MHz auction as well. In the 700 MHz auction, the rationale for withholding aggregate demand information in the final clock round was closely related to the fact that in the 700 MHz auction, there was no set-aside. This resulted in a valid concern on the part of the smaller bidders that disclosure of aggregate demand would lead to aggressive bidding (and foreclosure) by the incumbent wireless carriers. In the 600 MHz auction, this concern is not as pronounced, given the proposed use of a set-side.

89. ISED should establish consistent rules regarding the disclosure of aggregate demand information in all three proposed auction designs. That is, aggregate demand information should be provided in the final clock round of a WARP CCA or in the final clock round of a GARP CCA (in addition to all preceding rounds).

E. Q5 – Enhanced Combinatorial Clock Auction (ECCA) Format

Q5—ISED is seeking comments on:

- **a. The advantages and disadvantages of the three auction formats being considered for the 600 MHz auction:**
  - **i. Combinatorial clock auction, using the WARP-based activity rule (annex A);**
  - **ii. Combinatorial clock auction, using the GARP-based activity rule (annex B);**
  - **iii. Enhanced combinatorial clock auction (annex C).**
- **b. Where there is a preference for one of the options, respondents are asked to provide a rationale and explanation.**

1. CCA using WARP-based activity rule

90. The CCA with the WARP-based activity rule has been used in the 700 MHz auction and the 2500 MHz auction in Canada. Thus, Canadian participants are familiar with the rules and how they affect bidding.

2. CCA using GARP-based activity rule

91. The CCA with a GARP-based activity rule is similar to the CCA with a WARP-based activity rule. A GARP-based activity rule is somewhat more restrictive on bid flexibility. However, Shaw believes that bidders that understand a WARP-based activity rule would also understand and would be able to compete effectively in a CCA with a GARP-based activity rule. Moreover, from ISED's perspective, the difference in outcomes between a WARP versus a GARP CCA would be expected to be reasonably similar.

3. ECCA

92. The ECCA would represent a more significant change in auction format from a WARP or GARP-based CCA. In particular, the pricing rule is different and there is more emphasis on maintaining the final clock round outcome in the ECCA than there is in the CCA.

93. The ECCA has potential benefits over the CCA design. Most of all, it provides greater certainty about auction outcomes by skipping the supplementary round when there is no excess supply and by providing bidders with protection prices when there is a supplementary round.

94. It should be noted, however, that pricing in an ECCA involves the auctioneer assuming that clock round bids will be increased to their maximum amounts under the GARP-based rule. In general, this is a strong assumption that could increase auction prices. However, Shaw believes that the impact of this assumption can be mitigated while preserving the desirable features of the ECCA as long as ISED uses restraint in setting bid increments.

95. If ISED were to use large increments during the clock rounds, the ECCA pricing assumptions could result in the auctioneer inferring a package bid for a participant that is significantly larger than what that bidder would submit on its own. Therefore, should it favor an ECCA, ISED could allay this concern by using sensible bid increments at auction.

F. Q6 – Structure of Assignment Stage

Q6—ISED is seeking comments on:

a. The proposal that winners of more than one block in a single service area be assigned contiguous blocks; and

b. The proposed structure of the assignment stage, including the order of the assignment rounds and the combination of service areas into a single assignment round.

1. Q6a – Assignment of contiguous blocks to winning bidders

96. Shaw supports the proposal that winners of more than one block in a single service area be assigned as a single contiguous block. The guaranteed assignment of contiguous spectrum in an assignment stage is a crucial element of the overall auction design.

2. Q6b – Structure of assignment stage

97. Shaw supports the proposed structure of the assignment stage, including the order of the assignment rounds and the grouping of multiple service areas in the event that the winning allocations and winning bidders in those rounds are identical**.**

G. Q7 – Increasing Prices in the Clock Rounds

Q7—ISED is seeking comments on the proposed methodology for incrementing prices during the clock rounds, as described in annex A.

98. Shaw supports the proposed methodology for incrementing prices during the clock rounds as discussed in Appendix A of the Consultation Document.

H. Q8 – Bidder Participation – Affiliated and Associated Entities

Q8—ISED is seeking comments on the proposed Affiliated and Associated Entities rules that would apply to bidders in the 600 MHz auction.

99. Shaw has no comment on this question at this time.

I. Q9 – Other Communication Rules

Q9—ISED is seeking comments on the proposed rules prohibiting collusion and other communication rules, which would apply to bidders in the upcoming 600 MHz auction.

100. Shaw supports the proposed anti-collusion and other communications rules that would apply to bidders in the upcoming 600 MHz auction.

J. Conditions of 600 MHz Licences

1. Q10 – Licence term

Q10—ISED is seeking comments on its proposal to issue spectrum licences in the 600 MHz band with a 20-year licence term and the proposed wording of the condition of licence above.

101. Shaw supports the proposed 20-year licence term for licences issued pursuant to the 600 MHz auction. 20-year licence terms are consistent with the timeframes associated with investment in the development and deployment of network infrastructure, technologies, and innovation in the mobile wireless industry today. As such, they are realistic and foster incentives to invest for all licensees.

2. Q11 – Licence transferability and divisibility

Q11—ISED is seeking comments on the proposals on the condition of licence related to transferability and divisibility, and the proposed wording above.

102. Shaw supports the proposed condition of licence regarding licence transferability and divisibility.

3. Q12 – Deployment requirements

Q12—ISED is seeking comments on the proposed deployment condition of licence as stated above.

103. Shaw does not have any material concerns with the deployment requirements as set out in Annex F of the Consultation Document. The proposed deployment requirements are reasonable and appropriate for ensuring that this valuable spectrum is utilized for the benefit of Canadians.

4. Q13 – Other conditions of licence

Q13—ISED is seeking comments on proposed conditions of licence outlined in annex G that would apply to licences issued through the proposed auction process for spectrum in the 600 MHz band.

104. Shaw opposes proposed Condition 10 as set out in Annex G of the Consultation Document, relating to the minimum 2% of gross revenues to be invested by entities with revenues of over $1 billion from wireless services towards eligible research and development ("R&D") initiatives, for reasons that Shaw has previously submitted in response to other recent consultations issued by the Department.[56]

K. Auction Process

1. Q14 – Opening bids

Q14—ISED is seeking comments on the proposed opening bids as presented in table 1.

105. Shaw has no comments at this stage in the proceeding on the proposed opening bid amounts set out in table 1 of the Consultation Document.

106. However, in relation to spectrum valuations generally, and the tremendous financial and other risks involved in building new wireless networks, it is important for the Department to be mindful of the significant uncertainties in Canada's policy environment today. After several years of policy reviews and regulatory and legislative intervention, new competitors still do not have the planning certainty that we need from a CRTC decision on final regulated roaming rates. Yet, as explained above, the Wi-Fi First Review has introduced a significant, additional layer of uncertainty. A regulatory regime that positions resale-based models at an advantage over facilities-based new competitors will

[56] See Shaw Comments dated July 25, 2017,paragraph 61 regarding *Consultation on Licence Renewal Process for Advanced Wireless Services and other Spectrum,* June 2017, SLPB-002-17.

undermine the economics of facilities-based investment generally and the prospects for sustainable competition in Canada.

2. Q15 – Pre-auction deposits

Q15—ISED is seeking comments on the proposed eligibility points for spectrum licences in the 600 MHz as outlined in table 2, and pre-auction deposits as outlined above.

107. Shaw has no comments at this time on the proposed eligibility points for spectrum licences in the 600 MHz frequency band as outlined in table 2 of the Consultation Document, and the pre-auction deposits payable as a function thereof.

108. However, Shaw is proposing a change to the schedule for the payment of auction proceeds for all bidders given that the 600 MHz spectrum will likely be unusable for some time after the auction will be held. In this regard, the Department has proposed its usual schedule of the payment of 20% of the final payment within 10 business days following the publication of provisional licence winners, with the remaining portion of 80% due within 30 business days following the announcement of provisional licence winners. These payments will be non-refundable.

109. It is not yet certain when ISED will hold the auction of 600 MHz spectrum, but it could be delayed for approximately 2 years,[57] or sometime in the fall of 2019 or the winter of 2020. Shaw is concerned with this timing and would encourage the Department to hold the auction as soon as possible. Given the fundamental importance of securing sufficient low-frequency spectrum for purposes of building a network foundation to compete, as explained throughout our submission, it is essential for new competitors to know, sooner rather than later, that they will have access to sufficient 600 MHz spectrum. Even if new competitors are unable to use the spectrum for a period of time after the auction, network investments take time to plan, and the certainty of access to 600 MHz spectrum would significantly enhance the efficiency of the planning process, thereby accelerating the potential timing for new competitors to bring true choice and competition to the marketplace.

110. Shaw notes that, based on the current scheduled end dates for the transition of over-the-air television stations that currently occupy the 600 MHz band, the spectrum that is being made available for mobile terrestrial use will not be usable until late 2021 or early 2022, depending on the region in question:

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[57] Emily Jackson, "Why Canada is 'dragging its feet' on the next spectrum auction while demand keeps growing," *Financial Post,* 28 April 2017, available online at:: http://business.financialpost.com/technology/why-canada-is-dragging-its-feet-on-the-next-spectrum-auction-while-demand-keeps-growing.

Table 2 – Estimated Television Station Transition Phase End Dates, by Province[58]

Province	Phase End Date
Alberta	8/27/2021
BC	8/27/2021
Manitoba	8/27/2021
New Brunswick	1/14/2022
Nova Scotia	1/14/2022
NT	1/14/2022
Nunavut	1/14/2022
Ontario	1/14/2022
PEI	1/14/2022
Quebec	1/14/2022
Saskatchewan	8/27/2021
Yukon	1/14/2022

111. Accordingly, licence winners in the upcoming 600 MHz auction will not be able to put the spectrum licences that they have won into use for up to 2.5 years from the time when they will have to make their final payments of the auction proceeds to the Department.

112. While it is reasonable for licence winners to pay an initial 50% instalment of their final payments within 10 days of the announcement of provisional licence winners, Shaw would propose that licence winners should not have to pay the remaining 50% until such time as the spectrum in the applicable Tier 2 region is fully available to be put into use for revenue-generating commercial mobile services. In order to provide the necessary assurances to ISED that payment will ultimately be received, a key component of Shaw's alternative proposal is that provisional licence winners

58 ISED, *Digital Television (DTV) Transition Schedule,* April 2017, Annex A < online: https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/DTV-transition-schedule2017.pdf/$FILE/DTV-transition-schedule2017.pdf >.

would need to secure any outstanding balance by providing ISED with an irrevocable letter of credit that covers the amount of the outstanding balance.

113. It is not appropriate in this instance to follow the Department's usual practices with respect to the payment of the auction proceeds given the fact that the spectrum being auctioned is heavily encumbered and unusable for commercial mobile services until well after the auction. This unique set of circumstances requires a modified approach to the payment of auction proceeds and spectrum licence fees, as suggested above by Shaw.

L. Q16 – Licence Renewal Process

Q16—ISED is seeking comments on the proposed renewal process for spectrum licences in the 600 MHz band.

114. Shaw has no comments on the proposed renewal process at this time.

V. CONCLUSION

115. We are at a critical juncture in the evolution of the mobile wireless market in Canada. Shaw and other new competitors are investing and innovating to catch up to the national incumbents in every aspect of the roll-out of their networks. However, sustainable competition will only be attainable if we can balance access to low-frequency spectrum that is essential for network coverage.

116. As has already been noted by the Competition Bureau, the CRTC and ISED, and as supported by empirical evidence, the benefits to consumers in terms of innovation, consumer choice and competitive prices are starting to emerge in Canada's mobile market. The fact that new facilities-based competitors have achieved this almost exclusively with higher-frequency spectrum speaks to their potential.

117. Of the many barriers to realizing the full potential of sustainable competition in the market, one of the most critical is the severe deficiency in low-frequency spectrum available to new competitors. This low-frequency spectrum is essential to efficient and cost-effective deployment by any mobile wireless carrier, particularly in a sparsely populated country like Canada, but it is especially important to new network builders, such as Shaw. Spectrum is a finite resource managed by ISED in the public interest, which demands that new competitors gain access to sufficient amounts of this valuable low-frequency spectrum to compete.

118. Enabling new competitors like Shaw to access sufficient low-frequency spectrum, through a 40 MHz set-aside with appropriate eligibility criteria, will help us reach our goal of bringing world-leading mobile connectivity to Canadians through a competitive marketplace. This auction

represents a rare opportunity to help drive a sustainable competitive dynamic that will deliver the benefits of innovation and choice at affordable prices to all Canadians for the long-term, while providing the infrastructure foundation for Canada's growth, competitiveness and the innovation economy.

*** End of document ***

The Critical Importance of the Set-aside in the Canadian 600 MHz Auction

Peter Cramton[1]

2 October 2017

Summary

I have been asked by Shaw Communications Inc., and its affiliate Freedom Mobile Inc., to comment on the use of set-asides in the upcoming 600 MHz spectrum auction to be undertaken in Canada by the Ministry of Innovation, Science and Economic Development (ISED). I focus on the rationale for set-asides, the suitability of set-asides in Canada's 600 MHz auction, and the overall experience with set-asides and other pro-competitive measures from other spectrum auctions. My comments are based on my review of Notice SLPB-005-17 in which ISED outlines the proposed auction policy framework and design. My comments are also based on twenty-five years of experience designing and implementing spectrum auctions for governments around the world, as well as my experience advising bidders in over forty major spectrum auctions. This is a topic I have studied extensively in many countries including Canada, the United Kingdom, and the United States. Indeed, this paper is based in part on a similar analysis that I did in advance of the U.S. 700 MHz auction (Cramton 2013b).

Well-crafted set-asides can increase competition both in the market for mobile broadband services and in the spectrum auctions in which they are applied. The increased competition leads to consumer benefits such as increased innovation, accelerated deployment of advanced mobile services, and expanded consumer choice. It also can lead to improved auction efficiency and higher auction revenues (Cramton 2000).

Regulators commonly use set-asides to encourage competition (Cramton et al. 2011). There are many instances where the set-asides have been effective at increasing competition in the market for mobile services and in the auction (Ayres and Cramton 1996; Arthur D. Little 2009; Cave and Web 2013). The U.S. PCS auctions of 1994-96 are a vivid example. Set-asides in these auctions led to robust competition, innovative services, and rapid price declines (FCC 1999). In recent auctions, for example in the 4G spectrum auctions in Europe, regulators have especially focused on set-asides with respect to low-band—below 1 GHz—spectrum (Cave and Webb 2013). There is little evidence that these set-asides have harmed auction revenue (Binmore and Klemperer 2001; Grimm et al. 2001).

The market structure for mobile services in Canada, with Rogers, Bell, and Telus commanding a 90% market share of subscribers and a 92% market share of revenues (CRTC 2016), is such that, in the 600 MHz auction, ISED should include a significant set-aside for eligible carriers that are not dominant incumbents. The set-aside should exclude the major nationwide incumbents (Bell, Telus, and Rogers). As has been

[1] Professor of Economics, University of Maryland and University of Cologne, www.cramton.umd.edu. Since 1983, Peter Cramton has conducted research on market design; he has applied that research to design auction-based markets of radio spectrum, electricity, financial securities, and other products. I have written many widely-cited practical papers on spectrum auctions and competition policy available at https://goo.gl/hFbkMx. I thank Freedom Mobile for funding this research.

demonstrated repeatedly in spectrum auctions in many countries, including Canada, the United States and the United Kingdom, a set-aside is a powerful and effective instrument to encourage competition and innovation in a concentrated wireless market.

To be most effective, the set-aside should be substantial in size—ideally four of the seven 600 MHz blocks—and restricted to facilities-based bidders, excluding the major nationwide incumbents. Such a set-aside will motivate participation from smaller regional providers. This will have two important impacts: 1) it will make the auction much more competitive, thereby improving the efficiency of the auction outcome (as well as revenues), and 2) it will make the downstream market for mobile broadband more competitive. The set-aside will expand the coverage and increase the capacity of facilities-based network providers beyond those of Rogers, Bell and Telus.

A large set-aside is prudent in Canada's 600 MHz auction because:

- Mobile broadband is highly concentrated with many regions having access from only one or two networks. This absence of network competition leads to high prices and low innovation. A set-aside directly addresses the limited competition.
- The low-band spectrum is highly concentrated. Rogers, Bell and Telus hold more than 90 percent of the low-band spectrum. Low-band spectrum is critical for coverage, both within buildings and in less densely populated areas. Consumers value coverage. Thus, absent a set-aside the major incumbents may attempt to foreclose competition in the mobile broadband market by limiting the blocks won by smaller providers.
- The proposed auction design with package bidding favors those bidding for large packages of licences, making it easier for the major incumbents to foreclose competition absent a set-aside. A significant set-aside eliminates the possibility of foreclosure, and thereby improves both auction efficiency and competition in the downstream market for mobile broadband services.

Such a set-aside is consistent with ISED's design objectives. ISED's goals for the auction are: 1) to foster innovation and investment; 2) to support sustained competition, so that consumers and businesses benefit from greater choice; and 3) to facilitate deployment and timely availability of services across the country, including rural areas (ISED 2017). A 40-MHz set-aside will encourage new competitors to invest, promoting both competition and innovation for the benefit of all Canadians.

Rationale for set-asides

Spectrum is an essential input in the provision of wireless services (US DOJ 2013). Excessive concentration of this essential input undermines competition for wireless services, harming consumers. Set-asides can prevent excessive concentration of spectrum. This is the primary motivation for set-asides.

Critics of set-asides argue that the set-asides harm both auction efficiency and revenues, and ultimately are unsuccessful in promoting competition (Earle and Sosa 2013). Set-asides, if unsuited to the setting, may have these undesirable effects, but regulators can and often do design the set-asides to enhance competition and improve auction efficiency and revenues (Cramton 2002; Cramton et al. 2011).

At first glance, it may seem that a set-aside necessarily reduces auction revenues. Excluding the dominant incumbents from bidding on the set-aside block means that demand from the dominant incumbents may be reduced from what it would be absent the set-aside. Doesn't this reduced demand imply lower auction revenues? The answer would be yes, but for a countervailing force that often is decisive: the set-aside can motivate participation in the auction and thereby increase auction revenues. Auction revenues are quite sensitive to the level of competition. Adding one or more bidders can have a pronounced impact in increasing revenues.

For purposes of illustrating this dynamic, suppose there are two incumbents in a symmetric duopoly.[2] A spectrum auction creates the possibility that entry will occur and disrupt the duopoly. But the duopolists have a strong incentive to bid aggressively in the auction and acquire the entire award. Doing so prevents entry and preserves the higher duopoly profits. Potential entrants who anticipate this outcome will choose not to participate in the auction and avoid significant participation costs. As a result, only the two incumbents compete and they can coordinate to split the spectrum equally. The auction ends near the reserve price—well below the competitive price. This outcome is seen in practice, for example the 1999 German spectrum auction with two incumbents (Grimm, et al. 2003) and the 2012 Thailand 3G auction with three incumbents. In Thailand, the three incumbents each won one license and paid 2.8% above the reserve price, illustrating that the same low-price outcome may occur with three major incumbents.

Now suppose the regulator imposed a set-aside that prevented the duopolists from winning the entire award. This fundamentally alters the participation decision. New entrants know that at least one new entrant must be successful. This certainty motivates participation. The strongest entrants decide to participate, and the auction becomes more competitive with an expanded set of bidders.

The set-aside can also enhance auction efficiency. More societal value may come from awarding a newer entrant, rather than a dominant incumbent, a spectrum lot. Yet in an auction without set-asides, the incumbent may nevertheless win. The reason is that the incumbent's value is inflated by the benefits it enjoys from reduced competition in the wireless market in the event the entrant fails to acquire spectrum. The set-aside lets the incumbent win some spectrum, but not so much that competition for wireless services is harmed.

These arguments certainly do not imply that set-asides necessarily improve auction outcomes. Excessive set-asides without other eligibility constraints may allocate spectrum to less efficient providers who are unable to build out their spectrum, provide services, or increase competitive pressures (Cramton et al. 2011). The conclusion instead is that the regulator must carefully design set-asides to best achieve the auction objectives. Set-asides may be undesirable in settings with robust competition and little spectrum concentration; however, set-asides are desirable in settings with concentrated markets and concentrated spectrum holdings. The circumstances in which the Canadian 600 MHz spectrum auction will be held is certainly one where both market share and low-band spectrum holdings are highly concentrated.

[2] This example would also apply in other market structures exhibiting high concentration.

Set-asides in the Canadian 600 MHz auction

The Canadian mobile market consists of three national carriers (Rogers, Bell and Telus) with regional carriers serving a small segment of the market. The market is highly concentrated. Rogers, Bell and Telus have a 90% subscriber market share and a 92% revenue market share (CRTC 2016). Several regional carriers serve the remaining 10% of subscribers, who are further challenged from a lack of low-band spectrum—the dominant incumbents hold more than 90% of the low-band spectrum.

Low-band spectrum is essential for providing coverage in an economically efficient way. This is especially important in Canada, where coverage is an important challenge, given its vast geographic area. Consumers value both coverage and capacity. Coverage is what enables communications. A smart phone is an expensive paperweight in areas without coverage. Capacity is a key measure of the quality of service in areas with coverage—this is measured with data rates (megabits per second). A second measure of quality is latency (milliseconds)—how long it takes to initiate communications. In areas without coverage, latency is infinite.

Low-band (sub-1GHz) spectrum is best for coverage because of its propagation characteristics that enable signals to travel further, penetrate buildings and bend around obstructions. As a result, low-band spectrum provides the foundation of coverage on which capacity can be built. This is true regardless of wireless generation—3G, 4G, and 5G are all best-served with a foundation of low-band spectrum.

Importantly, the demand for low-band spectrum does not scale with market share. Once you have sufficient low-band spectrum to provide coverage and some minimum level of capacity, higher levels of capacity are best obtained with mid-band and high-band spectrum. This is especially true in more densely populated regions where most wireless revenues are generated. In these areas, the carrier can economically build a denser network that makes best use of mid- and high-band spectrum.

This basic result of physics and economics is why in the U.S. 600 MHz auction demand from the dominant incumbents (AT&T and Verizon) was nearly zero. Verizon never placed a bid in the auction. AT&T won little and bid in a way that suggested they did not want what they won even though prices were much lower than the prices in the earlier AWS-3 auction. Most recently, AT&T is in negotiations with Dish to transfer all its 600 MHz winnings to Dish (Piecyk 2017). This would leave both AT&T and Verizon with zero MHz from the U.S. 600 MHz auction. AT&T and Verizon's exit from the U.S. 600 MHz auction stems from the underlying economics and physics of mobile broadband and the fact that both carriers entered the auction with the substantial low-band spectrum.

Given this near-zero economic demand for the U.S. 600 MHz spectrum, why then did the dominant carriers lobby so strenuously against a set-aside for non-dominant incumbents? Because absent a set-aside AT&T and Verizon could have foreclosed competition. T-Mobile was desperate for low-band spectrum to overcome the large coverage advantage enjoyed by AT&T and Verizon. AT&T and Verizon were desperate to avoid competition from the disruptive T-Mobile, who already was making large inroads in acquiring subscribers at the expense of the Big Two. Thus, although the use-value of the 600 MHz spectrum was low for the Big Two, the foreclosure-value of the spectrum was high. This is why AT&T and Verizon feigned great interest in the 600 MHz spectrum only to effectively not show up at the auction. The FCC's wise decision to include a set-aside for non-dominant bidders prevented the foreclosure of

competition by pushing T-Mobile aside in the auction. Because of the set-aside, T-Mobile and many others came to the auction loaded for bear and indeed won over 95% (price-weighted) of the spectrum. The set-aside played an essential role in preventing foreclosure by the dominant incumbents and thereby motivated much stronger participation from T-Mobile and others.

The economic setting of the Canadian 600 MHz auction is similar, with the exception that the competition problem is more severe in Canada, since the dominant incumbents command an even more dominant position in Canada both in terms of market share and low-band spectrum holdings. Absent a significant set-aside, foreclosure of competition would be likely—causing tremendous long-term harm to consumers.

The 600 MHz auction is a critical opportunity to strengthen competition, especially the relative disparity in newer entrants' low-band holdings. To avoid excessive concentration of low-band spectrum and motivate participation in the auction from the newer rivals, a significant set-aside is essential.

Well-crafted set-asides can enhance competition for wireless services and increase competition in the auction. The U.S. experience demonstrates these benefits. The PCS auction was a success in bringing fresh competition and innovation to the mobile marketplace. In its 1997 Report to Congress (FCC 1997) on the results of the PCS auctions, the FCC observed that fifty-three percent of the licenses awarded went to new entrants, which had the result of "improving wireless service at lower prices." The FCC also noted that because of the auctions, capital investment in wireless networks increased to $26.7 billion in 1996, up from just $12.8 billion in 1993, while the average cellular subscriber bill decreased 27 percent during the same period. By 1999, the date of the Commission's Fourth Report on Commercial Services (FCC 1999), PCS deployment had resulted in the expansion of the mobile market to include at least five mobile telephone providers in each of the thirty-five largest regions of the U.S., and at least three mobile providers in 97 of the 100 largest regions. Even a casual student of today's mobile marketplace can observe that the wireless providers born of the PCS auction, such as Sprint, Leap, MetroPCS, and T-Mobile remain active competitors today.

Well-crafted set-asides can enhance competition for wireless services and increase competition in the auction while generating little risk that the set-asides would adversely impact the auction outcome. In the Canadian setting, the potential regulatory risk comes from too small a set-aside that does not adequately motivate participation.

A set-aside of 40 MHz (four of the seven blocks) would be ideal in the Canadian 600 MHz auction. A 40-MHz set-aside maximizes participation and competition among non-dominant facilities-based carriers. It guarantees that at least one facilities-based carrier in each service area can obtain the spectrum needed to compete against the dominant incumbents. Such disruptive competition would create enormous social value.

A key advantage of the 40-MHz, rather than 30-MHz, set-aside is that it prevents the dominant incumbents from splitting the non-set-aside blocks, (2-2 between Rogers on the one hand and Bell/Telus, who have an extensive spectrum sharing agreement, on the other hand), at low prices, as we have observed in other auctions (Ausubel et al.; Grimm et al. 2003). With only 30-MHz available for the dominant incumbents, if they choose to compete for more low-band spectrum, they must fight to

determine who gets more, since the only possibilities for the dominant incumbents is 2-1, 2-0, 1-1, 1-0, 0-0, and the reverse.

Experience with set-asides

The regulator faces difficult tradeoffs in designing set-asides. Fortunately, the regulator can draw on experience with set-asides over the last twenty years in spectrum auctions worldwide.

One of the important early uses of set-asides was in the U.S. PCS auctions from 1994 to 1996 (Arthur D. Little (2009). At the time of the first PCS spectrum auction, the market structure was quite close to the duopoly example above—in every region of the country there were two cellular carriers, each with one-half of the available spectrum (Cramton 1997). Were the PCS auctions conducted without set-asides, the outcome likely would have been much less competitive. The set-aside implied that there would be at least five spectrum holders in each market. The set-aside motivated robust competition both in the auctions and in the market for wireless services (Cramton et al. 2011). The market experienced rapid innovation and U.S. consumers enjoyed better services and lower prices. This progress is well-documented in the FCC's annual reports on wireless competition from 1995 to 2003. However, since the elimination of spectrum caps in 2003—which ended effective set-asides—market concentration has increased (Cramton et al. 2007).

The PCS auctions also revealed that some policies distinct from the set-asides were mistakes. The largest mistake was providing small businesses with excessively attractive installment payment terms (Cramton 2000). This policy led to rampant speculative bidding. Most of the winners defaulted on payments and many of the spectrum licenses got tied up in bankruptcy court. The FCC learned from this mistake. Installment payments to encourage small players to participate in auctions were dropped from consideration in future auctions. Some critics point to this experience as a reason to avoid set-asides (Earle and Sosa 2013), but the mistake with installment payments has nothing to do with the successful policy of set-asides.

Nearly all the European spectrum auctions had set-asides or spectrum caps (Cave and Web 2013). My overall assessment is that the set-asides often were effective in promoting competition both in the auction and in the market for wireless services. I discuss below some relevant examples.

The United Kingdom 3G auction of 2000 illustrates well how the auction framework can enhance competition (Börgers and Dustmann 2002). The regulator packaged the 3G spectrum into five licenses, two large licenses and three smaller licenses. No bidder could win more than one license (Cramton et al. 2011). The incentive for entry was further strengthened by designating one of the two large licenses for a new entrant (Binmore and Klemperer 2001). This structure provided strong motivation for new entrants to participate. In fact, thirteen bidders including nine potential entrants competed in the auction.

Strictly in terms of revenues produced, the U.K. 3G auction experience contradicts claims that pro-competitive instruments reduce auction revenues. On the contrary, the U.K. case illustrates the role that these instruments can play in enhancing revenues by motivating participation and thereby encouraging auction competition. Had the regulator instead designed the auction without such instruments, then I would expect the outcome to be dramatically different, including a significant possibility of no

participation by newer players and the auction quickly concluding at low prices with the two large carriers each winning a large license and the two smaller carriers each winning a smaller license, much like in the duopoly example. In this low-revenue outcome, the ability of the large incumbents to bid for multiple licenses is what can keep the smaller incumbents from bidding on the large licenses, since the smaller incumbents are then vulnerable to retaliation should they bid for the large licenses.

In addition to the record-setting auction revenues, the U.K. 3G auction gave rise to the operator "3," which has had a disruptive influence on pricing, service, and innovation in the market (Cave and Webb 2013). 3UK was the first operator to roll out 3G in the U.K. and it pioneered video telephony and video download. It was also the first operator to offer unlimited data and the first to offer MiFi capability.

The German 3G auction came shortly after the U.K. 3G auction. The regulator chose the same 2x15 MHz in-auction-spectrum-cap, but the available spectrum was split into twelve 2x5 MHz lots. A bidder could win either two or three lots, which meant that there would be between four and six winners. Two outcomes appeared especially likely: (1) five winners with the two larger incumbents each winning three lots and (2) six winners with each winning two lots, including two new entrants (Grimm et al. 2001). In the case of this German auction, the pro-competitive instrument likely motivated the participation of three strong new entrants and that participation made for a highly competitive auction. The prices paid in the auction, and the ultimate failure of the new entrants that won licenses in this this auction, have been used to criticize pro-competitive measures in auction design (Earle and Sosa 2013). However, this criticism is flawed. The ultimate failure of the new entrants from Germany's 3G auction rested on the entrants assigning too high a value to be a new entrant in a six-carrier German market, in part because of continued fallout from the dot com bubble, not from the fact that a pro-competitive measure was used.[3]

In the Canadian AWS-1 auction of 2008, Industry Canada set aside 40 MHz of AWS-1 spectrum exclusively for new entrants. Critically, the Canadian AWS-1 auction has resulted in reinvigorated challengers, Freedom Mobile—formerly Wind Mobile—Eastlink and Videotron, to the three Canadian incumbents. Together, these competitors have over two million subscribers, serving a small but significant share of Canadians and starting to provide disruptive competition. (Disclosure: Freedom Mobile funded this research.)

Furthermore, the set-asides motivated several new entrants to participate in the auction. The result was a highly competitive auction that generated $4.25 billion in revenue, nearly three times initial revenue expectations. Canada represents another clear case where the set-aside for new entrants can increase auction revenues (Hyndman and Parmeter 2015).

[3] Given the experience of the German 3G auction and the subsequent bursting of the dot com bubble, it is not surprising that the Austrian 3G auction had a much different outcome despite having essentially the same market and auction structure (12 lots with a 3-lot limit). The government set a low reserve price that was one-eighth of the reserve set in the German auction, and the auction ended quickly with each of the six bidders winning two lots (Klemperer 2002). With only six bidders, this low-price equilibrium was focal. The two strongest incumbents knew that they could end the auction quickly by reducing demand from three lots to two lots early in the auction, while trying for a third lot would require much higher bidding to drive out another bidder. The incumbents therefore did not bid at their limits and so this low-price outcome with six winners had nothing to do with the set-asides.

The most recent wave of spectrum auctions was the 4G auctions in Europe and elsewhere beginning in Germany in 2010. These typically were multiband auctions involving both low-band (below 1 GHz) and high-band (above 1 GHz) spectrum (GSMA 2012).

To provide service in a market, carriers require a portfolio of spectrum together with network infrastructure (cell sites, backhaul, etc.) that provides both coverage and capacity. Low-band spectrum has propagation characteristics that make it ideally suited to provide coverage in less populated areas as well as within buildings. High-band spectrum is better suited to provide capacity in more densely populated areas.

Low-band spectrum is especially scarce and as such regulators are concerned that excessive concentration of the low-band spectrum may adversely impact competition for wireless services (Cave and Web 2013). For this reason, regulators typically have in-auction-spectrum-caps or set-asides for low-band spectrum in the recent auctions. Low-band auction prices were high in several countries despite these pro-competition instruments, for example in Germany and Italy. In many countries, a combinatorial clock auction was used, which does not give prices for individual lots. The U.K. 4G auction included both low-band in-auction-spectrum-caps and a spectrum floor that guaranteed that at least four companies would win a sufficient portfolio of spectrum for effective operation in the U.K. wireless market (Myers 2013).

Earle and Sosa (2013) argue that set-asides ultimately have been ineffective in increasing the number of competitors in a market and therefore set-asides are both ineffective and costly. I disagree. Set-asides have played an essential role in creating competition and fostering innovation in wireless communication. Moreover, the evidence suggests that the impact on auction revenues has generally been positive, not negative. While it is true that there has been some consolidation in recent years as the wireless industry has matured, this is a natural tendency in most industries. The process of competition inevitably involves entry of some companies who succeed and grow and other companies who fail and exit or merge with successful rivals. As the industry matures, entry and exit become less common. The competition shifts to fights over market share. In these more mature markets, set-asides still have a role in avoiding excessive concentration.

Conclusion

Recognizing market concentration in the mobile wireless marketplace, ISED has recommended a set-aside for eligible carriers that are not dominant incumbents. Such a set-aside is essential to the success of the auction, especially one that utilizes package bidding. A package auction without a set-aside would let the dominant incumbents foreclose competition; indeed, I would be shocked if such an outcome did not occur. By contrast, a package auction with a significant set aside prevents the foreclosure of competition, and thereby improves auction efficiency and promotes long-run facilities-based competition, consistent with ISED objectives.

A set-aside of 40 MHz (four of the seven blocks) would be ideal in the setting of the Canadian 600 MHz auction. A 40-MHz set-aside maximizes participation and competition among non-dominant facilities-based carriers. It guarantees that at least one new facilities-based carrier in each service area can obtain the spectrum necessary to compete against the dominant incumbents. A key advantage of the 40-MHz

set-aside is that it prevents the dominant incumbents from splitting the non-set-aside blocks, 2-2 (Rogers-Bell/Telus), at low prices.

Experience from around the world shows that set-asides, when properly applied, are an effective tool for promoting competition and social welfare. In the Canadian 600 MHz auction, a significant set-aside is essential. Encouraging participation with a significant set-aside, ideally 40 MHz—four of the seven blocks—is by far the most important design feature of the 600 MHz auction in achieving ISED goals for the benefit of Canadians.

References

Arthur D. Little (2009), "Mobile Broadband, Competition and Spectrum Caps," paper prepared for the GSM Association, January. Available at https://goo.gl/W2AKvi.

Ausubel, Lawrence M., Peter Cramton, Marek Pycia, Marzena Rostek, and Marek Weretka, "Demand Reduction and Inefficiency in Multi-Unit Auctions," *Review of Economic Studies*, 81(4), 1366-1400, October 2014.

Ayres, Ian and Peter Cramton (1996), "Deficit Reduction Through Diversity: How Affirmative Action at the FCC Increased Auction Competition," *Stanford Law Review*, 48:4, 761-815.

Binmore, Ken and Paul Klemperer (2001), "The Biggest Auction Ever: The Sale of the British 3G Telecom Licenses," *Economic Journal*, 112, C74, C90.

Börgers, Tilman and Christian Dustmann (2002), "Rationalizing the UMTS Spectrum Bids: The Case of the UK Auction," *Ifo Studien*, 48, 77-109.

Bundesnetzagentur (German Regulatory Authority for Telecommunications and Posts) (2004), *Annual Report 2004*. Available at https://goo.gl/S9tJ7o.

Canadian Radio-television and Telecommunications Commission (2016), "2016 Communications Monitoring Report." Available at https://goo.gl/Dx69zD.

Cave, Martin and William Webb (2013), "Set-asides and Auction Revenue: the European Experience," (hereinafter "Cave & Webb") attached to *Ex Parte* Presentation of Sprint Corporation, GN Docket No. 12-268 & WT Docket No. 12-269, July 29.

Cramton, Peter (1995), "Money Out of Thin Air: The Nationwide Narrowband PCS Auction," *Journal of Economics and Management Strategy*, 4, 267-343.

Cramton, Peter (1997), "The FCC Spectrum Auctions: An Early Assessment," *Journal of Economics and Management Strategy*, 6:3, 431-495.

Cramton, Peter (2000), "Lessons from the United States Spectrum Auctions: Testimony Before the United States Senate Budget Committee," February 10. Available at https://goo.gl/VH4HLU.

Cramton, Peter (2002), "Spectrum Auctions," in Martin Cave, Sumit Majumdar, and Ingo Vogelsang (eds.) *Handbook of Telecommunications Economics*, Amsterdam: Elsevier Science B.V., Chapter 14, 605-639.

Cramton, Peter (2013a), "Spectrum Auction Design," *Review of Industrial Organization*, 42:2, 161-190, March.

Cramton, Peter (2013b), "The Rationale for Spectrum Limits and Their Impact on Auction Outcomes," filed on behalf of T-Mobile USA in the U.S. 700 MHz auction rule-making, August. Available at https://goo.gl/xHXif7.

Cramton, Peter, Evan Kwerel, Gregory Rosston, and Andrzej Skrzypacz (2011), "Using Spectrum Auctions to Enhance Competition in Wireless Services," *Journal of Law and Economics*, 54, 2011.

Cramton, Peter, Andrzej Skrzypacz, and Robert Wilson (2007), "The 700 MHz Spectrum Auction: An Opportunity to Protect Competition in a Consolidating Industry," submitted to the U.S. Department of Justice, Antitrust Division, November 13. Available at https://goo.gl/xub7kF.

Earle, Robert and David Sosa (2013), "Spectrum Auctions Around the World: An Assessment of International Experiences with Auction Restrictions," Analysis Group, Inc. Attached to *Ex Parte* Presentation of Mobile Future, GN Docket No. 12-268 and WT Docket No. 12-269, July 31. Available at https://goo.gl/wcr1HD.

Federal Communications Commission (1997), *The FCC Report to Congress on Spectrum Auctions*, WT Docket No. 97-150, Report, FCC 97-353, 23-24, October 9.

Federal Communications Commission (1999), *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services*, Fourth Report, FCC 99-136, June 24. Available at https://goo.gl/gtusS4.

Federal Communications Commission (2016), *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services*, Nineteenth Report, DA 16-1061, September 23. Available at https://goo.gl/ty8445.

Grimm, Veronika, Frank Riedel, and Elmar Wolfstetter (2001), "The Third Generation (UMTS) Spectrum Auction in Germany," CESifo Working Paper Series, October. Available at https://goo.gl/cnGdQp.

Grimm, Veronika, Frank Riedel, and Elmar Wolfstetter (2003), "Low Price Equilibrium in Multi-Unit Auctions: the GSM Spectrum Auction in Germany," *International Journal of Industrial Organization*, 21:10, December, 1557-1569.

GSMA (2012), "Auctions Summary," *Digital Dividend*, Section 1.4, Page 4. Available at https://goo.gl/ctNA4d.

Hyndman, Kyle and Christopher F. Parmeter (2015), "Efficiency or Competition? A Structural Econometric Analysis of Canada's AWS Auction and the Set-Aside Provision," *Production and Operations Management*, 24:5, 821-839.

Innovation, Science and Economic Development Canada (2017), "Consultation on a Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band," Notice SLPB-005-17, August.

Klemperer, Paul (2002), "How (not) to run auctions: The European 3G telecom auctions," *European Economic Review*, 46:4-5, 829-845.

Myers, Geoffrey (2013), "Spectrum Floors in the UK 4G Auction: An Innovation in Regulatory Design," The 41st Research Conference on Communication, Information and Internet Policy. Available at https://goo.gl/u5arUJ.

Piecyk, Walter (2017), "AT&T Quietly Deploying Band 29 for LTE and Why That is Positive for Dish," BTIG Research, September 22. Available at https://goo.gl/UF46Sg.

U.S. Department of Justice (2013), "*Ex Parte* Submission of the United States Department of Justice," WT Docket No. 12-269, April 11. Available at https://goo.gl/NZNpWF.