IN-BAND AUCTION CAP

PROMOTING SUSTAINABLE COMPETITION IN THE CANADIAN MOBILE WIRELESS INDUSTRY THROUGH AN EQUITABLE AUCTION DESIGN

A report by:

QSI CONSULTING, INC.

www.qsiconsulting.com

April 2011

NOTE: This report was prepared by QSI Consulting, Inc. on behalf of Videotron G.P. ("Videotron"), a wholly-owned subsidiary of Quebecor Media Inc. and Shaw Communications Inc. ("Shaw"). This report expresses the views of QSI Consulting, Inc. and may not necessarily reflect the views of Videotron, Shaw or their affiliates.

QSI Consulting, Inc. is a consulting firm, headquartered near St. Louis, Missouri, specializing in utility and network industries, econometric analysis, convergence of network technologies and computer-aided modeling. QSI consultants provide services to a wide array of clients, including multi-billion dollar international communications firms, small start-up companies, lawmakers and government agencies.

QSI Contacts

Timothy Gates
Senior Vice President

Office (727) 372-5599
Mobile (727) 267-5762
tgates@qsiconsulting.com

Warren Fischer, C.P.A.
Chief Financial Officer

Office (303) 722-2684
Mobile (303) 883-9014
wfischer@qsiconsulting.com

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The framework for the upcoming auction of spectrum in the band of 698-806 MHz ("700 MHz band") in Canada will have a dramatic impact on the competitiveness and innovation in the Canadian mobile wireless industry. The exploding demand for mobile wireless services, the global scarcity of wireless spectrum, and favorable propagation characteristics of low-frequency spectrum cause the 700 MHz band to be particularly valuable to wireless service providers and consumers.

Some wireless providers in Canada currently hold low-frequency spectrum and some do not. As a result, some providers are currently better-situated than others to provide the types of mobile wireless services consumers demand, particularly in rural and/or low-density areas where the greater propagation characteristics of low-frequency spectrum are most beneficial. If the low-frequency "haves" are allowed to bolster their competitive advantage over low-frequency "have nots" due to an unrestricted 700 MHz band auction, further concentration in the Canadian wireless market will result, leading to less choice and higher prices for consumers. On the other hand, a heavy-handed regulatory approach to structuring the auction also runs the risk of stunting the competitiveness and efficiency of the Canadian wireless market. A proper auction framework must balance these industry, economic and societal considerations while understanding that efficient use of the available spectrum will be critical to addressing the global problem of spectrum scarcity no matter what framework is selected.

An in-band auction cap balances the need for sustainable competition in the mobile wireless industry without the risk of undue regulatory interference. Under the auction cap proposal described in this report, every interested wireless provider has the opportunity to obtain a block of spectrum in the coveted 700 MHz band. This holds true whether a wireless service provider currently holds no low frequency spectrum or holds a preponderance of the spectrum in lower frequency bands. The only limitations established by the auction cap are as follows: those providers who already hold low-frequency spectrum would be eligible to obtain up to one block of 700 MHz spectrum, and those who do not hold low-frequency spectrum would be eligible to obtain up to two blocks. The auction cap framework rules out auction outcomes that would result in significant concentration of 700 MHz spectrum, and low-frequency spectrum as a whole. It would also ensure that all wireless providers, whether or not they currently hold low-frequency spectrum, have the opportunity to acquire 700 MHz spectrum without being blocked by incumbents[1] who have the incentive and ability to foreclose competition through an unrestricted auction process.

The auction cap maximizes the chances that competitive forces trigger innovation and investment by those who hold low-frequency spectrum, rather than permitting the low-frequency "haves" to lock out the "have nots" and then rest on their laurels. The auction cap proposal also promotes roll-out to rural areas by fostering competition among providers in low-frequency spectrums that are ideal for serving such areas. A roll-out requirement can increase the likelihood that 700 MHz spectrum will be used to serve communities in urban and rural areas in

[1] "Incumbents," as that term is used in this report, refers to the three largest wireless service providers in Canada – Bell Mobility, Rogers and TELUS.

a timely manner, and at the same time, avoid the concerns that incumbents have ascribed to other policy levers.

Deployment of mobile broadband is not impaired by the in-band auction cap. The incumbents currently operate on the advanced High Speed Packet Access (HSPA)+ standard, which data speeds are comparable with data speeds in Long Term Evolution (LTE) standard (a standard that the incumbents associate with the 700 MHz spectrum).[2] Vendors believe that the HSPA+ standard has more than enough capacity to handle future traffic forecasts. Current networks are underutilized, and operators can improve overall capacity utilization by delivering higher data rates from existing radio spectrum by using a combination of techniques, including advanced antennas, high level signal modulation, and increasing the number of site sectors from the typical three to six sectors. Cell densification is another method of increasing network capacity. Recent developments in lightweight radios such as Alcatel-Lucent's lightRadio™ may significantly reduce capital and operating cost requirements of cell densifications. "Intelligent" radios such as Nokia Siemens' Liquid Radio, introduced in March of this year, increase capacity by directing coverage where it is needed. Another effective method of increasing network capacity and coverage is augmentation of traditional macrocells with low power nodes, such as femtocells. Femtocells (not known to be used in Canada) quickly and efficiently serve various hotspots and coverage holes. Traffic offloading to Wi-Fi routers is another effective method of relieving the capacity of macrocells. According to Cisco estimates, the amount of smartphone traffic that can be offloaded in Canada today is 23%, increasing to 34% by 2015.[3] Yet, the actual amount of traffic offloading in Canada is likely less than the potential estimated by Cisco.

Furthermore, LTE deployment is not limited to the 700 MHz spectrum. Because LTE is operationally more efficient than current technologies, industry experts view it as a technology to which all networks will migrate. The incumbents have expressed skepticism that a Canadian provider can offer LTE over spectrum bands other than those used by the big U.S. wireless providers out of fear that vendors would decline to provide an adequate ecosystem for the dominant wireless providers in Canada. LTE is being deployed or is planned to be deployed in different spectrum bands of interest to incumbents, including the 800 MHz band in Europe, South Korea and Japan. Because there is general consensus in the industry that LTE is the next generation mobile network technology, it is inevitable that a robust multi-band ecosystem will develop for this technology, and LTE handsets will be multi-band handsets, just like the present day GSM/HSPA handsets. Technological innovations that increase spectrum utilization and network speeds and capacity combined with available low-frequency spectrum will not unduly restrict wireless service providers from providing the high-quality wireless services that consumers demand throughout Canada.

Given the limited amount of spectrum available in the 700 MHz band, the auction will not solve the industry-wide problem of low-frequency spectrum scarcity. It can, however, promote a more

---

[2] See, e.g., Comments of Rogers' Communications Partnership, Gazette Notice No. SMSE-018-10 (February 28, 2011), p. 3 and Comments of Bell Mobility Inc., Canada Gazette Notice No. SMSE-018-10 (February 28, 2011) ("Bell Mobility Comments"), p. E9.

[3] Cisco, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010-2015" (February 1, 2011) ("Cisco White Paper"), p. 11, Table 7.

equitable distribution of spectrum, avoid outcomes of the auction that would lead to significantly higher concentration and market power in the Canadian mobile wireless industry, foster sustainable competition and provide incentives for spectrum holders to use existing and emerging strategies for utilizing low-frequency spectrum as efficiently as possible. The in-band auction cap proposal is the best option for meeting Industry Canada's objectives of "…encourag[ing] a competitive telecommunications marketplace…" and "…stimulat[ing] innovation and investment by the industry…"[4]

I. INTRODUCTION

The upcoming auction in the 700 MHz band represents a crossroads for the Canadian mobile wireless industry. If designed properly, the auction will foster competition in the industry and promote the roll-out of new and innovative mobile wireless services across Canada. A flawed auction design, however, could result in increased industry concentration and negative impacts on the development of competition.

The spectrum being auctioned is valuable not only because it is scarce, but also because it is low-frequency spectrum that has superior propagation characteristics and allows greater geographic coverage at lower cost. Indeed, a number of major wireless providers have announced plans to deploy Long Term Evolution or "LTE" based services over low-frequency spectrum in the 700 MHz band, and one provider, Verizon Wireless in the U.S., has started deployment of LTE in this band. For these reasons, the 700 MHz band is especially valuable to wireless service providers and consumers alike, and particularly important for deploying mobile wireless services to underserved and/or low density rural areas. Considering that only 58 MHz of this valuable spectrum will be available at auction[5] (50 MHz of which will be effectively used[6]) as well as the incumbents' incentives to foreclose competitors from acquiring 700 MHz spectrum, there is a strong chance that new entrants will bear the brunt of the scarcity dilemma absent a proper auction framework.

Industry Canada has initiated a Consultation on a policy and technical framework to auction spectrum in the 700 MHz band.[7] Commenting parties have made a number of proposals about proper auction design, which include:

---

4 Industry Canada "Consultation on a Policy and Technical Framework for the 700 MHz Band and Aspects Related to Commercial Mobile Spectrum," Canada Gazette Notice No. SMSE-018-10 (November 30, 2010) ("Consultation"), p. 1.

5 This does not include the upper D block. The upper D block is situated at 758-763 MHz / 788-793 MHz. There is currently uncertainty in the United States about whether any portion of the upper D block will be allocated for public safety purposes. As a result, commenters, including Videotron and Shaw, propose that the upper D block be held in reserve in Canada until the status of the upper D block is resolved in the United States.

6 If the 58 MHz of available 700 MHz spectrum is auctioned in five blocks as suggested in the modified U.S. band plan (by splitting the upper C block), it will involve four blocks of 6+6 and one block of 5+5. Equipment currently in this band uses 5 MHz and 10 MHz channel bandwidths. Consultation, p. 14. Therefore, 5+5 of each 6+6 block would be effectively used, or 2 MHz of each of the four 6+6 blocks (8 MHz of the total available paired spectrum) would not be effectively used.

7 See, Consultation.

- **Unrestricted auction:** The incumbent wireless providers (Bell, Rogers and TELUS) propose an unrestricted auction. Under this approach, there are no restrictions on the amount of spectrum any one provider may acquire.
- **Set-Aside:** Some new entrants propose a set-aside auction.[8] Under this approach, blocks of spectrum are set-aside for new entrants to the exclusion of incumbent providers.
- **In-Band Auction Cap:** Videotron and Shaw propose an in-band auction cap.[9] Under this approach, any provider that already holds low-frequency spectrum in a given service area may acquire up to one 700 MHz block in that service area, and any provider that does not already hold low-frequency spectrum in a given service area may acquire up to two 700 MHz blocks in that service area.[10]

QSI Consulting, Inc. has been commissioned by Videotron and Shaw to write a report commenting on the impact of the in-band auction cap on the upcoming 700 MHz spectrum auction in Canada, with a special emphasis on the claims by proponents of an unrestricted auction that any auction restrictions would impede their ability to deploy quality mobile wireless services.

Section II of this report first analyzes the differing incentives of auction participants. Understanding these incentives provides insight into how auction participants are likely to conduct themselves during the auction, as well as how that conduct may impact the outcome of the auction. The report then compares and contrasts the possible outcomes of the auction depending on whether an unrestricted auction or auction cap is adopted.[11] The differences between the possible outcomes of an unrestricted auction and the possible outcomes of an auction cap are identified to show the practical effect of adopting one framework over the other. The pros and cons are then weighed to determine which framework best promotes the public interest.

The primary concern that proponents of an unrestricted auction have ascribed to auction caps is that distributing the spectrum over more providers may not provide certain providers with the capacity they need to meet demand. These claims are examined in Section III of the report by putting the claims into context and exploring various existing and emerging methods of

---

8 Globalive Wireless Management Corp. (WIND) Comments, ¶35; Public Mobile Inc's Response to Canada Gazette, Part I, SMSE-018-10, (February 28, 2011), ¶100; Comments of Mobilicity (February 28, 2011), ¶7; and Eastlink Comments (February 28, 2011), p. 21.

9 Submission of Quebecor Media Inc., on behalf of itself and Videotron G.P. (February 28, 2011) ("Videotron Comments") and Comments of Shaw Communications Inc., Gazette Notice No. SMSE-018-10 (February 28, 2011) ("Shaw Comments").

10 Videotron and Shaw propose the use of Tier 2 service areas. Videotron proposes in its initial comments that any mismatches between Tier 2 service area boundaries and traditional cellular license boundaries in certain parts of Canada would be resolved in a straightforward manner, such as through a rule whereby a 800 MHz license holder is deemed not to hold 800 MHz spectrum in a Tier 2 service area where its cellular license area covers less than one-half of the population of the overlapping Tier 2 service area.

11 The impacts of a set-aside are not evaluated in this report.

increasing network capacity that can be used to maximize the utilization of spectrum and increase network speeds to meet growing demand for mobile data services.

Section IV of the report discusses the positive impact of the auction cap on competition and services deployment in rural areas.

Based on some estimates, about ten times more spectrum will be needed in the next few years beyond what will be available in the 700 MHz band auction.[12] Therefore, the auction of 700 MHz spectrum will not likely solve the spectrum scarcity issue regardless of the chosen design. It will, however, have a dramatic impact on the level of competition in the Canadian mobile wireless industry, and the extent to which the 700 MHz spectrum will be used to deploy services to consumers across Canada. Therefore, it is important to maximize the chance that the auction outcome promotes competition and uses available spectrum as efficiently as possible. An in-band auction cap best suits these objectives.

II. THE AUCTION CAP AVOIDS THE NEGATIVE OUTCOMES OF AN UNRESTRICTED AUCTION

A. Incumbents and New Entrants Have Differing Incentives

The significant concentration in the Canadian mobile wireless industry is undisputable. Bell Mobility, Rogers and TELUS (collectively referred to in this report as "incumbents") dominate the wireless marketplace in terms of market shares, total revenues,[13] and low-frequency spectrum holdings.[14] This concentration affects the incentives of auction participants. Since the incumbents enjoy a superior market position relative to their rivals, they possess the incentive, based on their market power, to increase barriers for new entrants so as to maintain their dominance. One way to raise barriers and foreclose new entrants from the mobile wireless market is for incumbents to acquire all available spectrum at auction so that new entrants acquire none. In other words, incumbents have the incentive to acquire spectrum not only to expand their capacity but also to preserve their dominant market position. New entrants, by contrast, acquire spectrum in order to roll-out services to consumers, but do not have the added incentive to acquire spectrum to maintain a competitive advantage because they do not have a competitive advantage in the first place. Three economists summarized this issue in a paper written for a 2007 symposium held by the Antitrust Division of the U.S. Department of Justice addressing the

[12] Bell Mobility estimates that an additional 500 MHz of spectrum beyond the Canadian 700 MHz band is required to meet demand beyond 2015. Bell Mobility Comments, p. E8.

[13] As noted in Shaw's comments, the three companies held a combined 95% share of the national market, as measured either by number of subscribers or total revenues. Shaw Comments, p. 18, ¶55 (citing Canadian Radio-television and Telecommunications Commission (CRTC) 2010 Monitoring Report, p. 158, data for year 2009). Moreover, in every province but Quebec, the top two providers hold a combined market share (as measured in subscribers) of 79% or higher (Quebec's value is 72%), suggesting they have de facto duopolies. CRTC 2010 Monitoring Report, p. 159, Table 5.5.4 ("Wireless subscriber market share, by province – 2009").

[14] Consultation, Figure 4.1, showing Rogers, Bell and TELUS holding 95% of the spectrum in the 800 MHz band.

Federal Communications Commission's (FCC's) then-pending auction of the 700 MHz band in the U.S.:

> Given the concentrated market structure, the participants in the auction for new spectrum have different economic incentives depending on whether they are new entrants or existing incumbents. An entrant that wins a license wants to operate so as to maximize the value of the license. In contrast, an incumbent bidding for a new license takes into account that new entrants can attract customers from its existing business and thereby jeopardize its profits and diminish the scarcity rents from its current licenses. As a result an incumbent is not neutral about how the spectrum is allocated and used, even if it does not win a new license itself. This is a major difference from auctions where all players start on equal footing. We argue that the dominant low-frequency incumbents' incentives to protect current profits are large, and could undermine the efficiency of the auction outcome. In particular, this distortion leads incumbents to value the new licenses more than the true economic value to society and thus is likely to lead to a misallocation of the scarce spectrum.[15]

The results of the unrestricted auction for 700 MHz spectrum in the U.S. support this view of the incumbents' auction incentives. By the time the U.S. auction concluded in March 2008, the two largest U.S. providers, Verizon and AT&T, had outspent all other auction participants by a ratio of greater than 6:1, and secured large new blocks of the 700 MHz spectrum. Verizon obtained a virtually nationwide footprint in the C Block (20 MHz covering 98% of pops nationwide), plus licenses for the A and B (10 MHz) Blocks covering many of the most important metropolitan areas (e.g. New York City, Los Angeles, Chicago). AT&T acquired some 227 B Block licenses (62% of pops), also covering many significant urban areas.[16] Other wireless providers participating in the auction generally acquired spectrum in second-tier areas, and none established an amount of spectrum close to a national footprint.[17] The end result was to reinforce the two largest providers' control over U.S. spectrum, as depicted by the following maps of Verizon's spectrum holdings before and after the U.S. 700 MHz auction:[18]

---

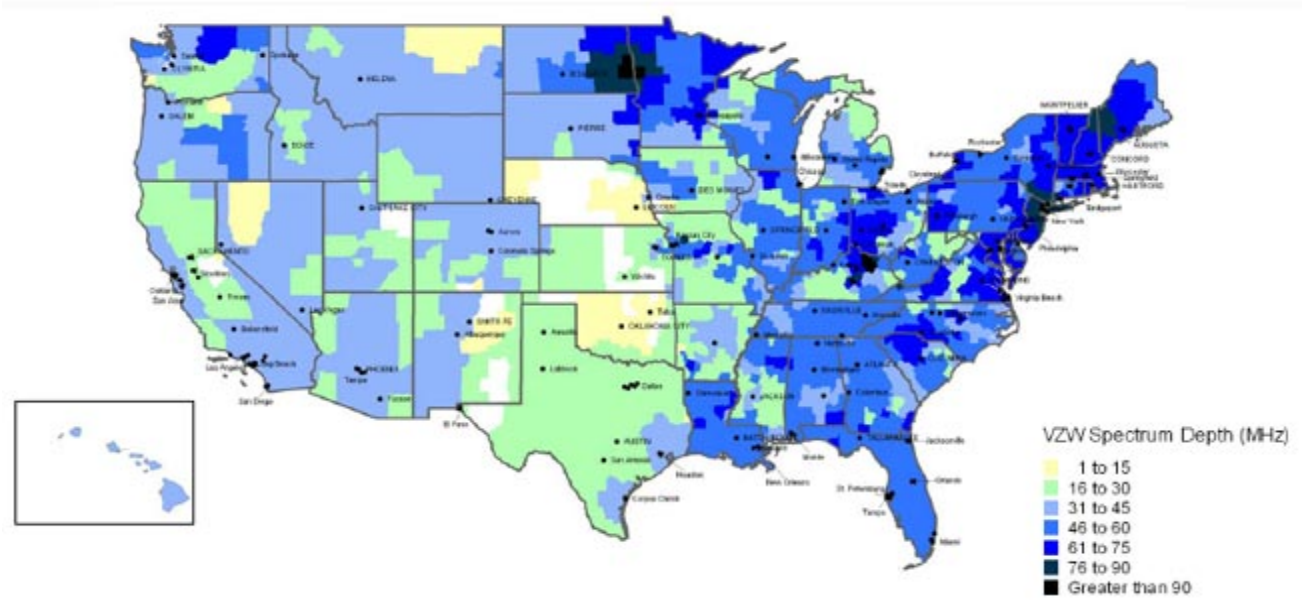
[15] Cramton, Peter, and Andrzej Skrzypacz and Robert Wilson. "The 700 MHz Spectrum Auction: An Opportunity to Protect Competition in a Consolidating Industry" (November 13, 2007), pp. 2-3. Available at: http://www.cramton.umd.edu/papers/spectrum/

[16] FCC Public Notice DA 08-595, "Auction of 700 MHz Band Licenses Closes, Winning Bidders Announced for Auction 73" (March 20, 2008). *See also*, Verizon Wireless Press Release, "Verizon Wireless Says Spectrum Additions From FCC's Auction 73 Will Further Company's Broadband Strategy" (April 4, 2008).

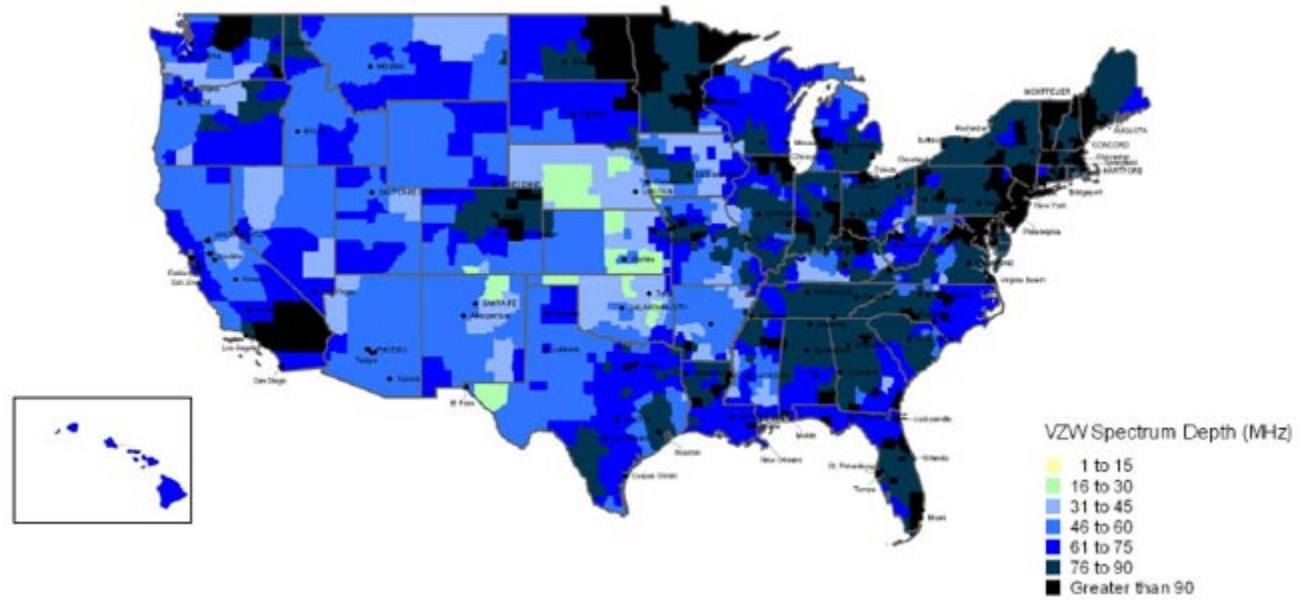
[17] Echostar's affiliate Frontier Wireless successfully bid for most of the unpaired 6Mhz lower E Block licenses nationwide, but at that time such unpaired spectrum was limited to one-way communications, so this acquisition was viewed as likely to be an adjunct to Echostar's satellite-based direct broadcast TV services rather than to support two-way mobile wireless services in competition with AT&T and Verizon Wireless. *DSLReports*, "What's Echostar Cooking? Company grabbed $700 million in spectrum for mobile TV" (March 21, 2008). Available at: http://www.dslreports.com/shownews/Whats-Echostar-Cooking-92856

[18] Source: Cellularmaps.com. Available at: http://www.cellularmaps.com/700_auction.shtml

Verizon Wireless Bandwidth Before the 700 MHz Auction:



Verizon Wireless Bandwidth After the 700 MHz Auction:



Industry Canada's existing framework for spectrum auctions relating to wireless services already acknowledges the anti-competitive nature of the incumbents' incentives.[19] The following section explains how the auction cap lessens the chances that incumbents will act on these incentives in the auction to the detriment of competitors and consumers.

B. Possible Outcomes: Unrestricted Auction Versus In-Band Auction Cap

The amount of 700 MHz spectrum that will be available for auction in Canada is limited. A total of 50 MHz of usable spectrum in the 700 MHz band will be auctioned,[20] which, according to industry consensus,[21] could properly be allocated among five, equally-sized 5+5 blocks.[22] The incumbents favor an unrestricted auction in which there are no limits placed on the amount (or number of blocks) of 700 MHz spectrum any bidder can acquire. Videotron and Shaw favor an in-band auction cap in which providers who already hold low-frequency spectrum in a service area[23] can acquire up to one block of 700 MHz spectrum and providers who do not hold low-frequency spectrum in a service area can acquire up to two blocks of 700 MHz spectrum. Under both an unrestricted auction and auction cap, there are a discrete number of possible outcomes associated with how the five blocks of spectrum may be allocated among providers. Comparing the possible outcomes of one approach versus another is instructive as it identifies the practical impact of adopting one auction framework over another.

The possible outcomes of an unrestricted auction versus an in-band auction cap differ in terms of the number of providers over which the spectrum blocks may be allocated. As the name suggests, in an "unrestricted" auction there are no limits on the number of blocks of spectrum any one provider can acquire. As such, under this auction framework, a single provider could acquire as few as zero blocks and as many as all five blocks of 700 MHz spectrum. By comparison, under the in-band auction cap, the blocks of spectrum will be allocated among as few as three providers and as many as five. These possible outcomes are illustrated below (with checks indicating the possible outcomes under each proposal):

---

19 Industry Canada, Spectrum Management and Telecommunications, Framework for Spectrum Auctions in Canada, Issue 3 (March 2011), Section 4, "Competition Principles: Promoting a Competitive Post-Auction Marketplace."

20 A total of 58 MHz will be available, of which 50 MHz will be effectively used.

21 There is wide consensus that a modified U.S. band plan has merit, in which the upper C block is split into two paired blocks, resulting in five 5+5 blocks. This is the proposal of Videotron and Shaw. Rogers states that this "variant of the U.S. band plan should be seriously considered by the Department." Rogers Comments, p. 25. The Radio Advisory Board of Canada (RABC) states that this "minor deviation from the U.S. band plan…should be considered by the Department…" Response of RABC (February 28, 2011), p. 16.

22 With the potential for a sixth block depending on whether the upper D block is part of the auction.

23 Videotron and Shaw advocate using Tier 2 service areas.

	Auction Cap	Unrestricted
Total Available Blocks	five	five
5 block holders	☑	☑
4 block holders	☑	☑
3 block holders	☑	☑
2 block holders		☑
1 block holder		☑

The unrestricted auction could result in five 700 MHz block holders (each acquiring one block) or one 700 MHz block holder (all blocks acquired by a single provider), and all combinations in between. The auction cap eliminates two of these possible outcomes: an outcome in which two providers acquire all five blocks (60/40 split between two providers) and an outcome in which one provider acquires all five blocks (100% of the 700 MHz spectrum). These two outcomes are eliminated by the auction cap because the maximum number of blocks any provider can acquire is two (40% of total 700 MHz spectrum), and as a result, the five blocks must be divided between at least three providers.

The possible outcomes of each approach also differ in terms of the amount of 700 MHz spectrum that may be concentrated among providers that already hold low-frequency spectrum. Low-frequency spectrum (below 1 GHz) is important to providers due to its superior propagation characteristics, and the existing low-frequency spectrum holdings in Canada are highly concentrated among the incumbents.[24] In recognition of these facts, the in-band auction cap turns on whether or not a bidder for 700 MHz spectrum currently holds low-frequency spectrum.

There is no limit on the amount of spectrum a low-frequency spectrum holder may acquire under the unrestricted auction; a low-frequency spectrum holder could acquire as little as 0% and as much as 100% of the available 700 MHz spectrum. Likewise, if there are two primary low-frequency spectrum holders per service area (which is the typical case in the 800 MHz band), those two providers could, together, acquire up to 100% of the available 700 MHz spectrum. By comparison, under the auction cap, each low-frequency spectrum holder may acquire up to 1 block (20% of available 700 MHz spectrum). This means that in service areas with two or three low-frequency spectrum holders, they can together acquire up to 40% and 60% of the available 700 MHz spectrum, respectively. The auction cap, therefore, eliminates the possible outcomes in which existing holders of low-frequency spectrum in a service area, either individually or as a group, acquires all or a vast bulk of the low-frequency spectrum in the 700 MHz band in the same service area.

There are six potential auction outcomes in terms of the concentration of 700 MHz spectrum among existing holders of low-frequency spectrum. Those six potential outcomes are as follows:

[24] Consultation Figure 4.1, showing Bell, Rogers and TELUS holding 95% of the 800 MHz band.

1. Zero blocks (0%) acquired by low-frequency spectrum holder(s).
2. One block (20%) acquired by low-frequency spectrum holder(s).
3. Two blocks (40%) acquired by low-frequency spectrum holder(s).
4. Three blocks (60%) acquired by low-frequency spectrum holder(s).
5. Four blocks (80%) acquired by low-frequency spectrum holder(s).
6. Five blocks (100%) acquired by low-frequency spectrum holder(s).

All six of these outcomes could occur under the unrestricted auction. Under the auction cap, outcomes 1 through 3 could occur in each Tier 2 service area because there are at least two holders of low-frequency spectrum in each Tier 2 service area.[25] These possible outcomes are illustrated below (with checks indicating the possible outcomes under each proposal):

Percent of 700 MHz Spectrum That May Be Acquired By Existing Low Frequency Spectrum Holders		
	Auction Cap	**Unrestricted**
0%	☑	☑
20%	☑	☑
40%	☑	☑
60%		☑
80%		☑
100%		☑

Outcome 4 (60%) shaded in the above table could also occur under the auction cap in service areas served by three low-frequency spectrum holders. Thus, existing holders of low-frequency spectrum can acquire up to 40% of the available 700 MHz spectrum in service areas with two holders of low-frequency spectrum, and up to 60% in service areas with three low-frequency spectrum holders. This has the effect of eliminating the outcomes associated with the unrestricted auction in which existing holders of low-frequency spectrum acquire 100%, 80% or 60% (in some instances) of the available 700 MHz spectrum.

The elimination of these possible outcomes, in turn, impacts how low-frequency spectrum (as a whole) may be allocated as a result of the 700 MHz auction. By way of example, Rogers and Bell (or Rogers and TELUS) split 50/50 the low-frequency spectrum in the 800 MHz band in a majority of Tier 2 service areas. If an unrestricted auction is adopted, the low-frequency incumbents in a service area (Rogers and Bell in this example), either individually or collectively, could acquire 100% of the available 700 MHz in that same service area. As a result, the low-frequency incumbents would hold all low-frequency spectrum in both the 700 MHz and 800 MHz bands. Under the auction cap, the low-frequency incumbents may acquire up to one block (20%) of 700 MHz spectrum each, resulting in total incumbent holdings of 40% of the

[25] Consultation, Figure 4.1(b), showing at least two holders of 800 MHz spectrum in each Tier 2 service area.

low-frequency spectrum in the 700 MHz band and 100% of the low-frequency spectrum in the 800 MHz band in the same service area. The auction cap has the effect of eliminating three possible outcomes in this regard. It eliminates the possible outcomes in which low-frequency incumbents hold: (1) 100% of the low-frequency spectrum in both the 700 MHz and 800 MHz bands, (2) 80% of the low-frequency in the 700 MHz band and 100% of the low-frequency in the 800 MHz band, and, in some instances, (3) 60% of the low-frequency spectrum in the 700 MHz band and 100% of the low-frequency spectrum in the 800 MHz band.

C. The Auction Cap Avoids Outcomes That Are Contrary To Sustained Competition

There are a number of key observations that can be drawn from the above comparisons:

1. There are a limited number of 700 MHz spectrum blocks (likely five) that will be available at auction. As a result, there are a limited number of ways the five blocks can be distributed among different providers and categories of providers – i.e., there are a limited number of possible auction outcomes.

2. Comparing the possible outcomes associated with an unrestricted auction versus an in-band auction cap shows that the auction cap rules out those outcomes that result in substantial concentration of 700 MHz spectrum holdings and low-frequency spectrum holdings as a whole.

3. The auction cap provides the opportunity for an additional wireless provider to acquire low-frequency spectrum in the 700 MHz band. Whereas the unrestricted auction would allow one or two providers to acquire all 700 MHz spectrum in a service area, the auction cap ensures that at least three providers have the opportunity to acquire 700 MHz spectrum.

4. The auction cap avoids outcomes in which existing holders of low-frequency spectrum acquire all or a majority of the low-frequency spectrum in the 700 MHz band.

D. The Benefits Of The Auction Cap Outweigh Any Potential Disadvantages

There are a number of benefits of the auction cap. First, it is fair and equitable to all mobile wireless providers interested in acquiring spectrum in the 700 MHz band. ***All*** wireless providers have the opportunity to acquire spectrum in the 700 MHz band. No blocks are reserved for certain groups of providers to the exclusion of others, and providers who enjoy market dominance or currently own low-frequency spectrum cannot leverage those advantages to acquire all available 700 MHz spectrum and preclude competition. The auction cap preserves the interests of all providers by ensuring that a single competitor cannot acquire all or most of the available blocks of spectrum. The in-band auction cap is a pragmatic middle ground between the unrestricted auction that could result in an effective duopoly in low-frequency spectrum throughout Canada, and other available policy levers, such as aggregate spectrum caps or set-asides, that may preclude certain providers from acquiring blocks of 700 MHz spectrum.

Second, the auction cap is the best way to promote sustainable competition for mobile wireless services in Canada. The in-band auction cap which ensures that a rival has the opportunity to compete with dominant low-frequency incumbents has a better chance than an unrestricted auction of creating an environment in which investment, innovation, efficient spectrum utilization, service deployment and lower prices result. Because access to spectrum is a major barrier to entry for new entrant wireless providers, incumbents have the incentive to not only acquire the spectrum they need, but also acquire spectrum they may not need so as to maintain barriers to entry for their competitors. This is particularly true for the auction of 700 MHz spectrum which provides low-frequency incumbents, who already own 95% of the low-frequency 800 MHz band, the opportunity to corner the market for low-frequency spectrum. The auction cap lessens the chances that incumbents will act on the incentive to hoard 700 MHz spectrum to the detriment of competition because it ensures that they cannot acquire all available 700 MHz spectrum under any auction outcome. Incumbents are less likely to acquire 700 MHz for the purposes of raising barriers to entry if they know from the outset that they cannot block new entrant access to low-frequency spectrum altogether.

Third, the auction cap holds benefits for consumers in rural areas. Absent the auction cap, there is a real possibility that incumbents will hold a vast majority of all low-frequency spectrum – spectrum best-suited for serving unserved and underserved rural areas. This places consumers in rural areas in a situation in which they must depend solely on the low-frequency incumbents, acting as duopolists, to roll-out services in their area. By preventing the incumbents from acquiring all low-frequency spectrum, the auction cap ensures that a rival has the opportunity to serve rural consumers and serve as a market disciplining check on the incumbents. To provide additional assurances that the presence of a rival will, in fact, spur service deployment using low-frequency spectrum in the 700 MHz band, the auction cap proposals are accompanied by deployment obligations for 700 MHz spectrum holders.

Fourth, the primary concerns that have been raised about other policy levers, such as aggregate spectrum caps and spectrum set-asides, do not apply to the in-band auction cap. For example, the auction cap does not permit the "gaming opportunities" that incumbents have raised about set-asides. And because the auction cap turns on whether a provider currently holds low-frequency spectrum, it avoids the dispute over the proper definition of "new entrant." Likewise, because any provider may acquire 700 MHz spectrum under the auction cap regardless of current holdings in other bands, it allows every wireless provider the opportunity to address increasing demands for network capacity by adding spectrum. And because the auction cap applies only during, and for a certain time period following, the auction, its impact is of limited duration. The 700 MHz spectrum could be re-allocated on the secondary market if market forces dictate a different distribution following the auction. For these reasons, an auction cap is the preferred policy lever of some providers whose primary recommendation is an unrestricted auction. Even though Rogers advocates for an unrestricted auction, it states a preference for an auction cap over other policy levers and recognizes that the auction cap is far less disruptive and avoids numerous concerns Rogers has with spectrum aggregation caps and set-asides.[26]

[26] Rogers Comments, pp. 86-87.

Fifth, an auction cap does not add to concerns about scarcity for low-frequency spectrum in the 700 MHz band. There will be a total of 50 MHz of usable spectrum available at auction. According to some forecasts, significantly more spectrum is needed to address future demand than will be available in the 700 MHz band. For example, Rysavy Research estimated in 2010 that in the busiest markets, an operator's spectrum requirements would increase from approximately 25MHz in 2010 to over 200 MHz in 2016.[27] If these forecasts prove accurate, the auction of 700 MHz spectrum will not solve spectrum scarcity no matter how the blocks are divvied up. Permitting low-frequency incumbents to acquire all or most of the 700 MHz spectrum may *postpone* spectrum exhaust for one or two incumbents, but it would not solve the overall spectrum scarcity issue and would negatively impact the competitiveness of the mobile wireless industry in Canada by significantly raising barriers for rivals who would have no low-frequency spectrum holdings.

In sum, the "pros" of the auction cap proposal outweigh any potential "cons" of regulatory intervention. The "pros" include the following: the auction cap proposal allocates a valuable resource in an equitable manner; promotes sustained competition for mobile wireless services, particularly in rural areas; promotes roll-out of competitive services in rural areas; promotes efficient use of assigned spectrum; avoids concerns about other types of regulatory intervention; and the impact is of limited duration. The primary "con" attributed to an auction cap by proponents of an unrestricted auction is that increased fragmentation of the available spectrum may not provide a particular wireless provider the capacity it needs to meet demand for mobile wireless data services. However, any benefits of an auction framework that permits one or two providers to corner the market for low-frequency spectrum so that those providers can accommodate increasing consumer demand to the exclusion of potential rivals are offset by the reduction in consumer welfare caused by a lack of competition. There are existing and emerging methods for maximizing the efficiency of a provider's low-frequency spectrum holdings and increasing network capacity, and the selected auction framework should provide incentives for 700 MHz spectrum holders to explore those methods as a means of addressing spectrum scarcity. These methods are discussed in the following section.

III. THE AUCTION CAP DOES NOT RESTRICT DEPLOYMENT OF MOBILE WIRELESS BROADBAND SERVICES

Proponents of an unrestricted auction claim that they will not be able to acquire the amount of spectrum they need unless the auction is unrestricted. These claims are analyzed in this section by putting the claims about spectrum scarcity in context and examining the existing and emerging strategies and technologies that can be employed to maximize the capacity of mobile networks.

[27] Rysavy Research, "Mobile Broadband Capacity Constraints and the Need for Optimization" (February 2010), chart on p. 15.

A. Putting Mobile Wireless Demand Trends and Spectrum Scarcity in Context

There has been a great deal of industry discussion in Canada, the U.S., and elsewhere concerning the ongoing rapid rise of mobile users' demand for high-speed data services in the context of LTE and other 4G network deployments, and the consequences for mobile operators' use of radiofrequency spectrum.[28] Various mobile usage statistics and demand forecasts paint an alarming picture that the spectrum available to support mobile services will be rapidly exhausted and result in a "spectrum crunch" that will adversely impact mobile services' quality and availability. Bell Mobility states that, "the industry faces a pending spectrum crunch in the very near future."[29] Rogers contends that it will need an additional 200 MHz of spectrum on top of the 100+ MHz it already possesses.[30] Likewise, Cisco Systems' latest mobile traffic forecast update reports the following trends at a global market level:[31]

- Global mobile data traffic will increase 26-fold between 2010 and 2015. Mobile data traffic will grow at a compound annual growth rate (CAGR) of 92 percent from 2010 to 2015, reaching 6.3 exabytes per month by 2015.
- Two-thirds of the world's mobile data traffic will be video by 2015. Mobile video will more than double every year between 2010 and 2015.
- Data-intensive consumer devices including smartphones, tablets, and laptops are rapidly proliferating, and they create far more demand per user than traditional cell phones. For example, in 2010, the typical smartphone generated 24 times more mobile data traffic (79 MB per month) than the typical basic-feature cell phone (which generated only 3.3 MB per month of mobile data traffic). In turn, in 2010, mobile data traffic per tablet was 405 MB per month, more than five times more traffic than the average smartphone.

Of course, the details of such forecasts can be debated, and many uncertainties exist with respect to their underlying assumptions and input parameters. The FCC's National Broadband Plan observes that most major industry participants have stated that more spectrum is needed, but that in the context of future uncertainty, their specific estimates range widely, from 40 to 150

---

[28] Consultation, p. 11. *See also*, for example: Federal Communications Commission ("FCC"), "Connecting America: The National Broadband Plan" (rel. March 16, 2010) ("FCC National Broadband Plan"), pp. 76-79 (Chapter 5.1, The Growth of Wireless Broadband), available at http://www.broadband.gov/plan/ ; FCC, "Fourteenth Commercial Mobile Radio Services (CMRS) Report" (rel. May 20, 2010) ("FCC 14th CMRS Report"), ¶¶181-184 (Chapter V.D.3, Mobile Data Traffic (Non-Messaging)), available at http://wireless.fcc.gov/index.htm?job=reports ; and Ramsay, Maisie, *Wireless Week*, "Have We Been Faking the Spectrum Crunch?" (February 4, 2011), available at http://www.wirelessweek.com/Blogs/Wireless-Week-Blog/Have-We-Been-Faking-Spectrum-Crisis/.

[29] Bell Mobility Comments, ¶ E7.

[30] Rogers Comments, pp. 23-24, ¶60.

[31] Cisco White Paper, pp. 1-2.

megahertz per operator.[32] Nevertheless, it is safe to say that Canada has been and will continue to be impacted by these industry and social trends.[33]

These demand trends, however, do not tell the entire story. If they did, then the inevitable conclusion would be that any finite amount of spectrum added to mobile wireless operators' resources would be insufficient, as they would quickly become exhausted by those exponentially-rising trends. Consider, for example, the finding by Rysavy Research that:

> With multiple users simultaneously accessing streams in the 1 to 2 Mbps range, it only takes a relatively small number of users to reach sector capacity. For example, eight users each with 2 Mbps will consume the capacity of a 10+10 MHz LTE carrier. To put this into perspective, in an urban area there may be 3,000 subscribers per cell site, translating to 1000 subscribers per sector. Eight users represent a tiny percentage of the subscribers.[34]

Taken at face value, this implies that if only half of the subscribers in the sector (i.e., 500) were to access 2 Mbps data streams at the same time, the operator would need a total spectrum bandwidth of at least 1,250 MHz.[35] This is an order of magnitude more spectrum than wireless providers typically have licensed today[36] and many times more spectrum than will be available at the 700 MHz auction. Yet, according to Cisco, Canadian mobile operators will offer average data speeds exceeding 2 Mbps in just two years' time (2.9 Mbps by 2013),[37] which means that even 1,250 MHz per provider may be insufficient to keep pace with demand if Rysavy's forecast is accurate.

This does not mean, however, that the sky is about to fall on wireless services. It is simply unreasonable to focus only on demand growth for LTE/4G-driven services without also taking into account a host of other economic, technological, and market considerations that impact those services and how the underlying networks will be implemented. These additional factors

---

32 FCC National Broadband Plan, p. 84.

33 For example, Bell Mobility has reported that the average monthly data usage by smartphone users on its network rose from 15 MB to 300 MB between 2008 and 2010, a 1900% increase. Bell Mobility Comments, p. 7, ¶19.

34 Rysavy Research, "Operator Spectrum Requirements for Mobile Broadband" (February 26, 2011), p. 13 (attached to Rogers Comments) (hereafter "Rysavy Report").

35 That is, if 8 users consume a 10+10 MHz LTE channel (i.e. 20 MHz total) as Rysavy assumes, then 500 users simultaneously accessing 2 Mbps streams will consume 500 ÷ 8 = 62.5 times as much bandwidth, i.e. 62.5 X 20 MHz = 1250 MHz.

36 SeaBoard Group, "Over the Rainbow: Thoughts on the Canadian 700 MHz Discussion" (February 2011) ("SeaBoard Report"), p. 11, Exhibit 6 ("Comparative Spectral Holdings, International Markets - Canada, by Major Markets"). It shows the dominant Canadian wireless operators holding in excess of 150 MHz total, with other countries' dominant providers holdings generally in the 60-90 MHz range. The 1250 MHz required in this example represents 20.8 times more than the lower bound 60 MHz figure (i.e., 1250 ÷ 60 = 20.83) and 8.3 times more than the upper bound 150 MHz figure (1250 ÷ 150 = 8.33).

37 Cisco White Paper, p. 13, Table 8 ("Projected Average Mobile Network Connection Speeds (in kbps) by Region and Country").

are essential to understanding what Canadian wireless providers' spectrum needs will be in the coming years. They include the following:

- More granular understanding of mobile demand characteristics, such as the distribution of data services demand across users' locations, devices, and ages;
- Available technologies for increasing efficiency of spectrum use, increasing network capacity and mitigating their spectrum requirements; and
- Canadian wireless companies' existing spectrum resources.

Each of these areas will be discussed below.

B. Countervailing Characteristics of Mobile Data Demand

When considering how wireless providers will respond to the demand trends associated with LTE/4G-driven services, it is important to recall at the outset that not all users are the same. This is a point of departure from traditional voice-oriented mobile services, for which end users were limited to largely homogeneous handsets with limited features. The advent of 3G networks and high mobile data speeds spurred the proliferation of new mobile devices including smartphones, tablets, pads, wireless-enabled laptops, and more, and the migration to LTE/4G continues this trend. The users who adopt these high-speed data-intensive devices will have distinctly different usage characteristics than other users. For example, Cisco reports that the top one percent of mobile data subscribers generate over 20 percent of mobile data traffic, and their average monthly data usage is some 24 times higher than that of the average data user.[38] The top 10 percent of mobile data subscribers generate approximately 60 percent of mobile data traffic, with monthly usage levels roughly six times higher than the average data user.[39] While these sharp peaks in usage profiles may change somewhat over time as more subscribers join the early adopters of new devices, they suggest that one strategy available to wireless providers seeking to gain control over the demands faced on the radiofrequency portion of their networks will be to apply tiered pricing plans or find other ways to encourage those subscribers to make more use of technological options that divert (offload) their data traffic from the mobile wireless network.

Another aspect of mobile data demand that is often overlooked is that a significant portion of it is not "mobile" in the traditional sense of being incurred while physically moving. Cisco's Internet Business Solutions Group (IBSG) conducted a survey that determined that about 35% of mobile data use actually occurs while "on the move,"[40] while 40% occurs within the home (e.g., accessing the Internet from a mobile device), and the remaining 25% occurs at work.[41] This circumstance can be leveraged to reduce the burdens placed on the radiofrequency portion of wireless providers' networks, by offloading this data traffic to the fixed wireless networks in the home or office whenever high-speed data links are required.

---

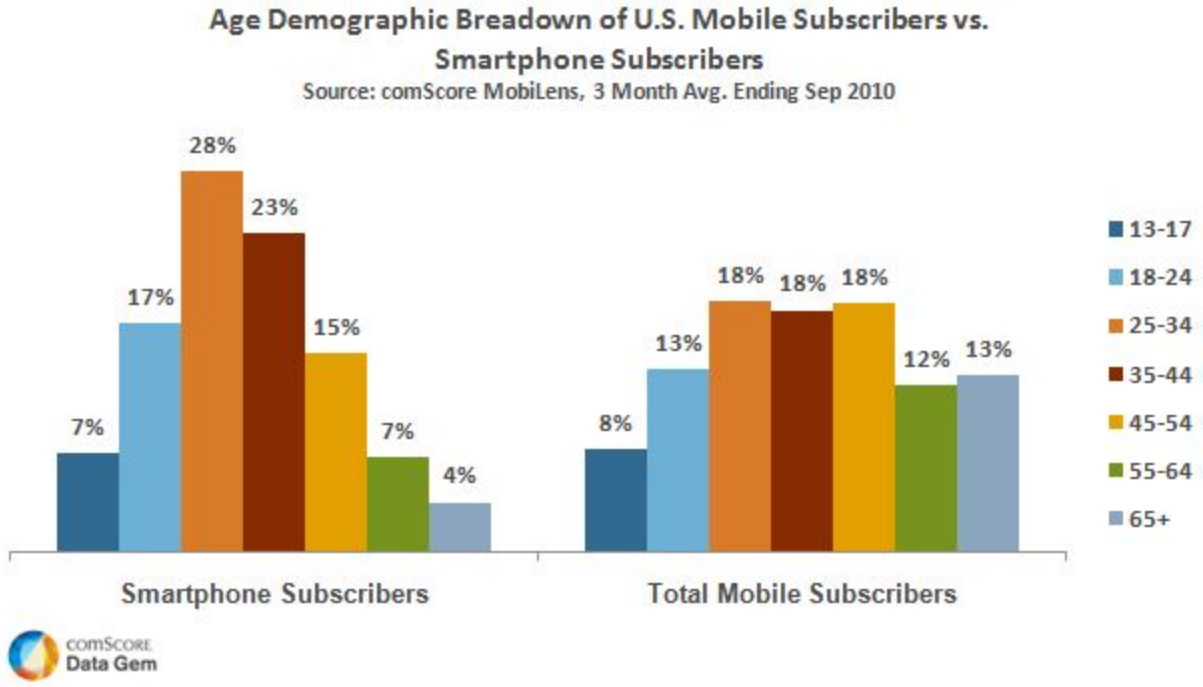
38 *Id.*, pp. 1 and 24-25.

39 *Id.*, pp. 1 and 24-25.

40 *Id.*, p. 10.

41 *Id.*, p. 10.

A final characteristic of mobile demand to consider is its "generational dimension": that a disproportionate share of data-intensive mobile devices is in the hands of younger users. For example, a recent market study by comScore found that "U.S. Smartphone subscribers skew towards persons ages 25–44," with the highest percentage of smartphone subscribers (28%) in the age 25-34 band, more than half of the total (52%) below age 35, and three-quarters (75%) below age 45. The following chart from comScore presents this data, and compares it to the much flatter age distribution found for subscribers of all mobile phone types.[42] These trends are confirmed by Nielsen's findings that 55% of Android users and 47% of iPhone users are under the age of 34.[43]

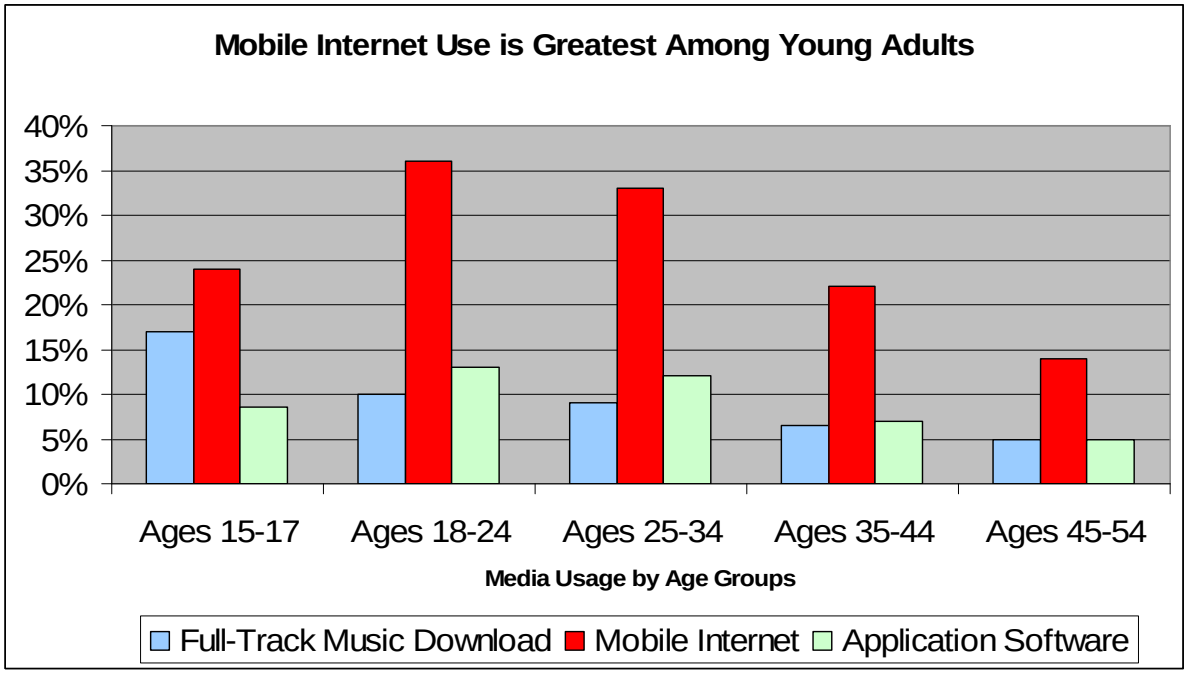


Similarly, the highest rates of mobile Internet use are for the age bands of 18-24 and 25-34 years, as shown in the following chart of Nielsen data:[44]

[42] ComScore Inc., "Age Demographic Breakdown of U.S. Mobile Subscribers vs. Smartphone Subscribers" (November 1, 2010). Available at: http://www.comscoredatamine.com/2010/11/age-demographic-breakdown-of-u-s-mobile-subscribers-vs-smartphone-subscribers/ ComScore describes its on-going consumer panel methodology at http://www.comscore.com/About_comScore/Methodology.

[43] Nielsen Company, "iPhone vs. Android" (June 4, 2010). Available at: http://blog.nielsen.com/nielsenwire/online_mobile/iphone-vs-android/

[44] "Five-minute interview: Edward Kershaw, Vice President Mobile Media, EMEA, Nielsen Online" (January 9, 2011). Available at: http://mobithinking.com/interview-transcripts/five-minute-interview-edward-kershaw-nielsen



These demand trends can have important implications for LTE/4G deployment in the rural regions of Canada. For example, Bell Mobility states that its "wireless data traffic is growing in rural and remote areas as fast as it is in urban centres."[45] However, this statement is not supported by statistics showing that young adults – the age group most likely to demand data-intensive mobile services – make up a smaller percentage of the rural population compared to the urban population. According to Statistics Canada's report entitled "Urban and Rural Canada: the Difference is Young Adults":

> In all metropolitan areas combined, more than one person in three (35.7%) was between 20 and 44 years of age in 2006, a much higher proportion than in rural areas, where young adults made up only 27.7% of the population. The difference is primarily due to internal migration of young adults, who often leave rural areas in their late teens and early twenties to pursue their education or to find a job in urban areas.
>
> Rural areas also have a higher proportion of people aged 65 and over, and that proportion is growing faster than in urban areas. Between 2001 and 2006, the proportion of seniors increased by 1.1 percentage points to 15.5% in rural areas, compared with 0.7 percentage point to 13.3% in metropolitan areas.

While there are important social and economic policy reasons to promote access to LTE/4G services in Canada's rural regions, these demographic considerations suggest that LTE/4G-driven data demand growth in many rural areas (and the associated need for network capacity) may not increase as rapidly as in urban areas. In other words, there are relatively fewer individuals demanding network capacity in rural areas compared to urban areas. This factor, as

[45] Bell Mobility Comments, p. 8, ¶22.

well as the general low population density in rural areas, suggests that the need for spectrum capacity in rural areas is not the same as in urban areas.

In addition, forecasts made by incumbents about exploding demand do not take into consideration the pricing dimensions of these services.[46] A cogent example of this occurs in the Rysavy Report attached to Rogers' Comments.[47] The Report contains a description of a "spectrum demand model"[48] and lists over 20 input variables on which the spectrum demand model is based, including such variables as the number of subscribers, the number of cell sites, monthly data consumption for smartphones, growth rate for smartphone data, spectral efficiencies of various technologies, etc.[49] Notably absent from this list is the assumed pricing of those data services. The model does not take into account the impact of tiered pricing as a variable. The economic reality is that the ostensibly limitless rise in mobile data demand will eventually meet consumers' willingness to pay thresholds and reach equilibrium, as must occur in any well-functioning market. Any spectrum demand model that fails to take this into account suffers from a fundamental defect.

C. Deployment of Mobile Broadband by Incumbents is Not Impaired by Auction Cap

Ericsson, one of the leading vendors for mobile broadband, recently noted that networks that are in operation today are built for coverage rather than capacity.[50] Ericsson observed: "[t]he vast majority of radio sites use less than 5 percent of their capacity… and typically only 4 percent of radio sites are more than 50 percent utilized, even in the most developed mobile networks."[51] In Ericsson's opinion, the HSPA standard for mobile networks has more than enough capacity not only to handle the existing volumes of mobile broadband traffic, but also the most aggressive traffic forecasts.[52]

---

[46] The pricing data in the incumbents' comments is offered only in the context of competition issues (e.g., response to Industry Canada's Question 7-1).

[47] Rysavy Report.

[48] *Id.*, pp. 23-26.

[49] *Id.*, pp. 24-25. The Report does not disclose publicly any of the values for the listed input variables, noting on p. 23 that "they represent the outcome of a considerable amount of research, and are considered proprietary." Obviously, any model is driven by its inputs, and without a disclosure of the inputs it is not possible to evaluate the merits of the model projections. Neither does the Rysavy Report provide publicly the results of the "spectrum demand model," i.e. estimates of the spectrum bandwidth required to meet growing demand. It only concludes that "the amount of spectrum that Rogers will require to meet escalating data demand depends on a number of factors including market trends such as fixed/mobile substitution and pricing" and "[t]here is a complex feedback loop from a modeling perspective between pricing and demand that the model simply cannot accurately anticipate." Instead of providing the estimates of Rogers' spectrum requirements, the public version of the Report only provides its generic projections of monthly data usage for smartphones and other mobile devices between 2010 and 2016. Rysavy Report, pp. 8-9, 14, 25-26.

[50] Ericsson White Paper, "Capacity? HSPA Has Plenty" (July 2010), p. 3 ("Ericsson White Paper"). Available at http://www.ericsson.com/res/docs/whitepapers/hspa.pdf

[51] *Id.*, p. 3.

[52] *Id.*

HSPA networks are prevalent in Canada. In fact, the five largest providers (Bell, Rogers, TELUS, SaskTel and MTS) currently operate on a more advanced HSPA+ (evolved HSPA) standard.[53] As pointed out in a recent Lemay-Yates Associates Report,[54] no country besides Canada currently has three national HSPA+ mobile broadband networks with speeds up to 21 Mbps to the majority of their customers.

Data speeds in HSPA+ networks are comparable with data speeds in LTE networks. Simulations performed by Qualcomm showed that both HSPA+ and LTE offer similar performance – similar spectral efficiency, peak data speeds and round-trip-time latency – when using the same antenna configuration and spectrum bandwidth.[55]

There are a number of techniques operators can use, individually or in combination, to improve overall capacity utilization and deliver higher data rates from existing radio spectrum. MIMO (which stands for "multiple input multiple output" and is a technology that uses multiple paths and multiple antennas to transmit and receive wireless signals) is one way to increase data throughput and signal range without additional bandwidth.[56] Signal modulation schemes, such as 64QAM (Quadrature Amplitude Modulation with 64-point grid) is another technique. It became available in HSPA+ (which is HSPA Release 7).[57] These and other enhancements increased the speeds in HSPA+ networks up to 28 Mbps downlink.[58] Rogers was the first mobile operator in North America to commercially launch HSPA+ at 21 Mbps (in July 2009), more than doubling the speeds of its HSPA network.[59]

HSPA Release 8 (published in March 2009) included a capability of simultaneous use of 64QAM in downlink and MIMO.[60] Another method, which became available in HSPA Release

---

53 4G Americas, "4G Mobile Broadband Evolution: 3GPP Release 10 and Beyond" (February 2011) ("4G Americas February 2011 Paper"), p. 185. MTS launched its HSPA+ network on March 31, 2011. "MTS Launches HSPA+ Network on March 31" (February 7, 2011). Available at: http://news.softpedia.com/news/MTS-Launches-HSPA-Network-on-March-31-182913.shtml . *See also*, MTS News Room, "Manitoba's new high-speed 4G wireless network" (March 31, 2011). Available at: http://www.mts.ca/portal/site/mts/menuitem.0290497802902f369e5e921031248a0c/?vgnextoid=beba250301c0f210VgnVCM1000002a040f0aRCRD&vgnextchannel=ed7c8dca20041110VgnVCM1000001342a8c0RCRD

54 Lemay-Yates, Associates Inc., "The Impact of 700 MHz Spectrum on LTE Deployment and Broadband in Canada" (February 28, 2011), pp. 57-58 (attached to Rogers' Comments).

55 Qualcomm, "How to Meet Spectrum Demand" (February 2011), p. 9. Available at: http://www.qualcomm.com/documents/how-meet-data-demand

56 Sharony, Dr. Jacob. "Introduction to Wireless MIMO – Theory and Applications" (November 15, 2006) Available at: http://www.ieee.li/pdf/viewgraphs/wireless_mimo.pdf . *See also*, Bergman, Johan and Dirk Gerstenberger, Fredrik Gunnarsson and Stefan Ström (Bergman *et al.*). Ericsson Review, "Continued HSPA Evolution Of Mobile Broadband" (2009), Issue 1, p 9. Available at http://www.ericsson.com/ericsson/corpinfo/publications/review/2009_01/files/HSPA.pdf

57 *See, e.g.*, Rysavy Research, "Transition to 4G. 3GPP Broadband Evolution to IMT Advanced." (September 2010), p. 20.

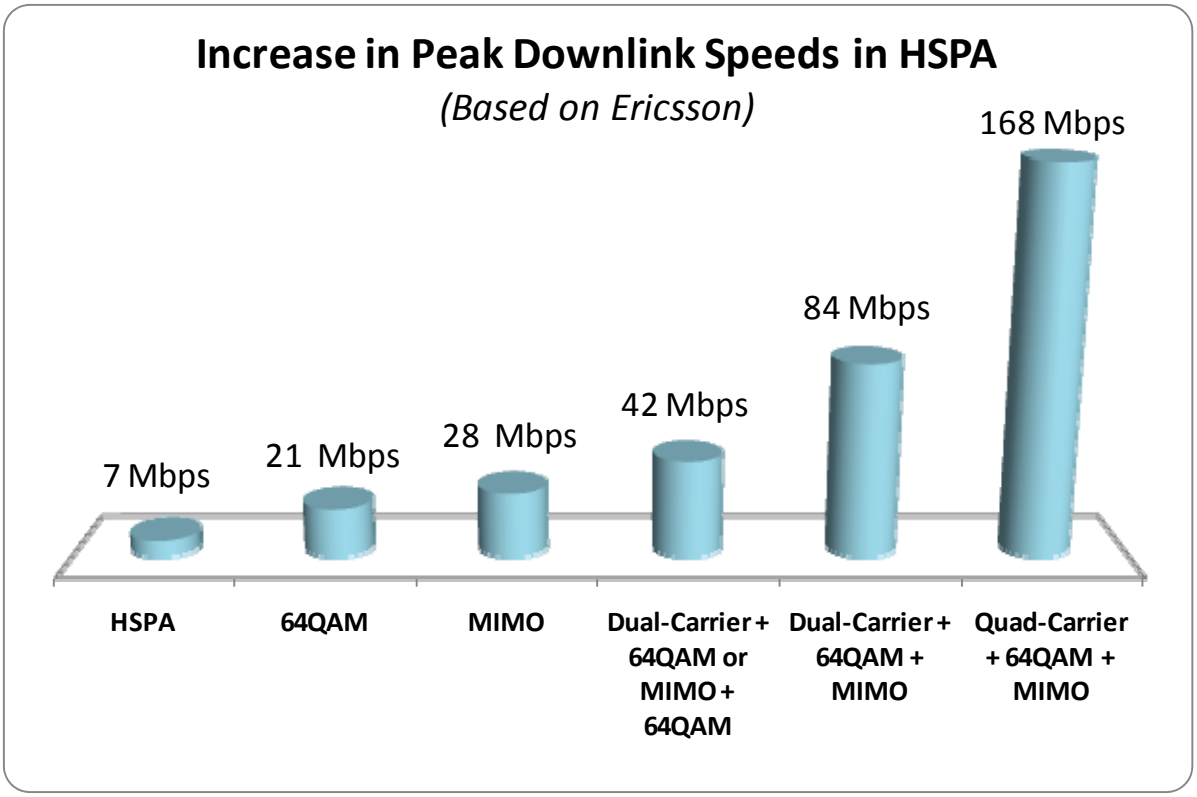
58 Bergman *et al*, Issue 1, p 7.

59 4G Americas February 2011 Paper, p. 15.

60 *Id.*, p. 9. *See also*, Rysavy Research, "Transition to 4G. 3GPP Broadband Evolution to IMT Advanced" (September 2010), p. 20.

8 is the use of dual carriers (referred to as dual-carrier or dual-cell), meaning that two 5MHz radio channels are combined to double the speeds. HSPA Release 9 (completed in March 2010) introduced the capability of downlink dual-cell deployments across non-contiguous frequency bands and the support of simultaneous MIMO and dual-cell operation.[61] For example, it is possible to combine two 5 MHz carriers from different frequency bands, such as one carrier on 2100 MHz and another on 900 MHz. Release 10 (under development)[62] extends this concept further, allowing the aggregation of up to four carriers from two separate frequency bands, such as carriers from bands 1900 MHz and 800 MHz in North America.[63]

Downlink speeds achievable using the above discussed enhancements are captured in the following chart based on Ericsson:[64]



61 4G Americas February 2011 Paper, p. 11.

62 3rd Generation Partnership Project (3GPP) website. Available at: http://www.3gpp.org/Release-10

63 4G Americas February 2011 Paper, pp. 63 and 65. *See also*, Nokia Siemens Networks White Paper, "Long Term HSPA Evolution Mobile Broadband Evolution Beyond 3GPP Release 10" (2010), p. 3.

64 Ericsson White Paper, p. 8.

Ericsson demonstrated the downlink speed of 168 Mbps in HSPA+ using a prototype consumer device and commercial network equipment in January 2011.[65] At the same time, Ericsson also demonstrated that speeds of 42Mbps can be achieved by using a single carrier.[66] There is clearly significant room for improvement in spectrum utilization because HSPA operators today achieve slower speeds (42Mbps) using twice as much spectrum relative to the speeds and spectrum utilization that were shown to be achievable in Ericsson's demonstration.

As discussed above, one of the methods of increasing speeds in HSPA networks is the use of multiple carriers, including the commercially available dual-carrier. Because the dominant wireless providers in Canada own very large "chunks" of spectrum compared to new players or U.S. providers,[67] they are well positioned to use this method of increasing speeds. Incidentally, Bell and TELUS announced plans to deploy dual-carrier HSPA in the second part of 2010, ahead of the U.S. HSPA providers AT&T and T-Mobile.[68]

D. Additional Measures To Address Mobile Broadband Capacity Exist

The above discussion of the evolution of HSPA illustrates the continuity of technology improvements. These improvements have been increasing spectral efficiency (throughput per unit of spectrum), as illustrated by the following chart (based on a chart in a recent 4G Americas' Report[69]).

---

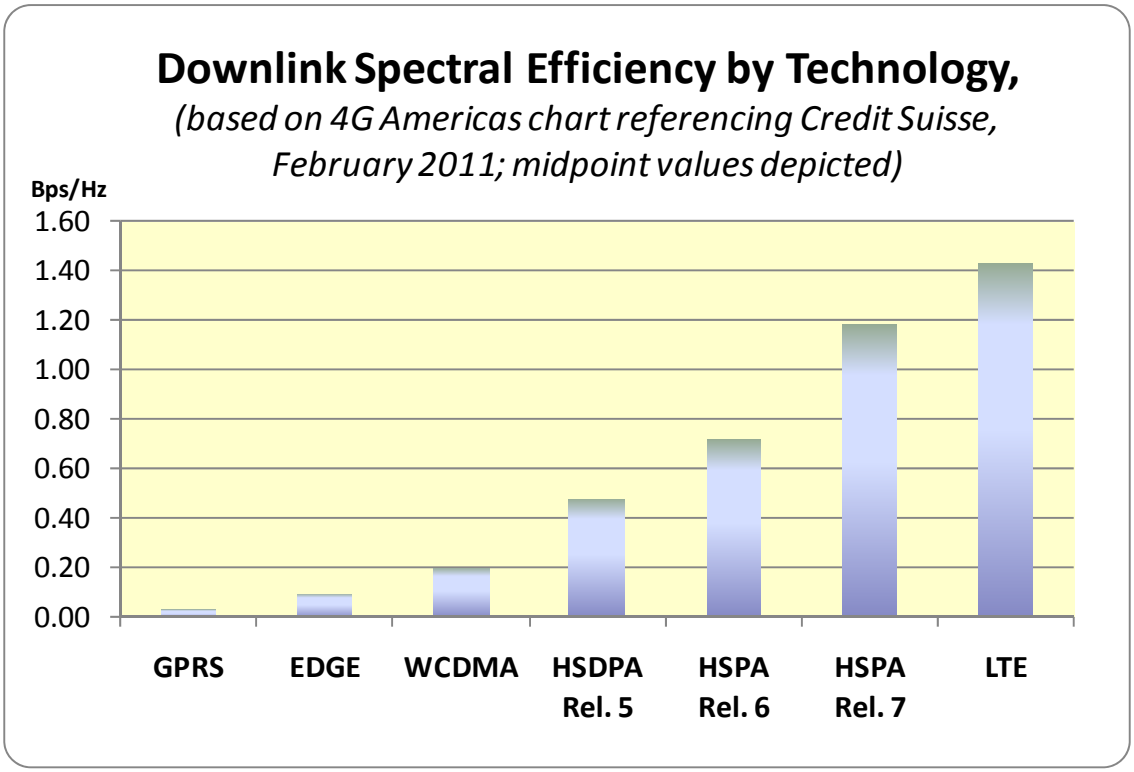
65 Ricknäs, Mikael. *PC World*, "Ericsson Demonstrates HSPA at 168 Mbps" (January 30, 2011). Available at: http://www.pcworld.com/businesscenter/article/218257/ericsson_demonstrates_hspa_at_168m_bps.html

66 *Id.*

67 Videotron Comments, p. 11 and Shaw Comments, p. 8.

68 Nguyen, Hubert. "Dual-cell HSPA networks deployed in Canada: why are they cool?" (August 4, 2010). Available at: http://www.ubergizmo.com/2010/08/dual-cell-hspa-networks-deployed-in-canada-why-are-they-cool/ *See also*, Bell Canada, "Bell doubling data speeds on world-leading HSPA+ wireless network" (November 18, 2010). Available at : http://www.bce.ca/en/news/releases/bm/2010/11/18/76761.html?feedt=rss&feeds=News+Release&utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+BCE-NewsRelease_rss+%28BCE.ca+-+Prod+-+EN+-+RSS+-+Ne T-Mobile announced deployment of dual-cell carriers in March 2011. *See*, "T-Mobile Makes America's Largest 4G Network Even Faster by Lighting Up 42 Mbps Speed in Las Vegas, New York and Orlando" (March 24, 2011). Available at: http://www.fierceiptv.com/press-releases/t-mobile-makes-americas-largest-4g-network-even-faster-lighting-42-mbps-spe

69 4G Americas, "Sustaining the Mobile Miracle. A 4G Americas Blueprint for Securing Mobile Broadband Spectrum in this Decade" (March 2011), ("4G Americas March 2011 Report") p. 23.



Another method of increasing capacity in mobile networks is cell densification – building additional (infill) cell sites within the existing network area. While traditionally this method of expanding network capacity is considered capital-intensive, recent developments in lightweight radios may reduce capital and operating cost requirements of cell densifications significantly. Earlier this year, Alcatel-Lucent, followed by Ericsson, introduced their versions of lightweight radios: lightRadio™ by Alcatel-Lucent[70]and AIR by Ericsson.[71] Alcatel-Lucent describes its lightRadio™ as "a groundbreaking antenna, capable of 2G, 3G, and 4G, small enough to fit in your hand, that promises to radically streamline and simplify mobile networks."[72]

[70] Alcatel-Lucent, "LightRadio: Evolve your wireless broadband network for the new generation of application and users." ("Alcatel-Lucent lightRadio web site") Available at :http://www.alcatel-lucent.com/features/light_radio/index.html

[71] Ricknäs, Mikael. *PC World*, "Ericsson Airs Smaller Mobile Base Stations" (February 8, 2011). Available at: http://www.pcworld.com/businesscenter/article/219053/ericsson_airs_smaller_mobile_base_stations.html

[72] Comments of Alcatel-Lucent, Gazette Notice No. SMSE-018-10 (February 28, 2011), p. 2.

Picture. Alcatel-Lucent's lightRadio™ Cube[73]

Below are some excerpts from the description of lightRadio™ on Alcatel-Lucent's web site:[74]

> a new architecture where the base station, typically located at the base of each cell tower, is broken into its component elements and distributed through the network or 'carrier cloud.' Additionally the various cell tower antennas are combined and shrunk into a single powerful, Bell Labs-pioneered multi frequency, multi standard (2G, 3G, LTE) device that can be mounted on poles, sides of buildings or anywhere else there is power and a broadband connection.
>
> **Addresses digital divide:** By reducing the cell site to just the antenna and leveraging future advances in microwave backhaul and compression techniques, this technology will eventually enable the easy creation of broadband coverage virtually anywhere there is power (electricity, sun, wind) by using microwave to connect back to the network.

According to Alcatel-Lucent,[75] lightRadio™ can simultaneously support 2G, 3G and LTE networks and various spectrum bands (as opposed to present day mobile radio systems that require separate remote radio heads for each band). It reduces total cost of network ownership (capital and operating cost) up to 50% and can be used in various situations, including small cells and replacement for macrocells.

In March 2011, Nokia Siemens introduced Liquid Radio,[76] which it calls an "intelligent radio."[77] According to Nokia Siemens, Liquid Radio "adapts the capacity and coverage of networks to

---

73 Alcatel-Lucent lightRadio web site.

74 *Id.*

75 *Id.*

76 Ramsay, Maisie. *Wireless Week*, "Nokia Siemens Counters ALU with Liquid Radio Tech" (March 21, 2011). Available at: http://www.wirelessweek.com/News/2011/03/Technologies-Nokia-Siemens-ALU-Liquid-Radio-Tech-Wireless-Networks/

77 Nokia Siemens Networks, "Nokia Siemens Networks Liquid Radio." Available at: http://www.nokiasiemensnetworks.com/sites/default/files/document/Nokia_Siemens_Networks_Liquid_Radio_Executive_Summary_lore_17-03-11.pdf

match this fluctuating user demand."[78] Below are additional excerpts from Nokia Siemens description of the Liquid Radio technology:

> Nokia Siemens Networks Liquid Radio architecture removes the highly structured constraints of traditional mobile broadband networks. This allows the 'ebb and flow' of network traffic to be addressed as users move across the network. The result is a network that operates fluidly to meet waves of demand that change constantly with location and time.
>
> Baseband pooling centralizes the digital signal processing typically done at base station sites and shares it with several sites to ensure that capacity is dynamically used where needed. This enables the network to always match the actual capacity needs of end users as they change during the day or over longer periods...
>
> The Nokia Siemens Networks Flexi Multiradio Antenna System introduces a new way of providing highly targeted additional capacity with beamforming. Beamforming allows coverage to be directed exactly where it is needed in concert with the other layers of coverage from macro, pico and micro site configurations. It is an effective tool for providing liquid capacity – capacity exactly where users need it. In addition, Flexi Multiradio Antenna System can be combined with baseband pooling, further increasing the efficiency of network and spectrum assets. [79]

Cell densification increases total capacity of the network, just like an addition of new bandwidth. According to Ericsson, both methods of increasing capacity have similar effects on downlink capacity, but cell densification is a better method of increasing uplink capacity.[80] For example, in HSPA networks, doubling the spectrum from 10 MHz to 20 MHz roughly doubles downlink capacity, but barely increases uplink capacity because of power limitation.[81] Increasing inter-site distance from 425 meters to 300 meters similarly doubles downlink capacity, but the uplink capacity is more than doubled.[82]

Cell densification comes in several forms. The example of cell densification discussed above is a situation where new "regular" sites (macrocells) are added. Recently, many operators have begun to deploy low power nodes, such as femtocells, picocells and microcells, to serve various hotspots and coverage holes (including indoor, home or enterprise coverage). Femtocells are very low power small cellular base stations that are typically deployed in residential or enterprise settings (typically covering less than 50 meters). Femtocells are typically sold to end-users and

---

78 Nokia Siemens Liquid Radio product description. Available at: http://www.nokiasiemensnetworks.com/pt/portfolio/products/mobile-broadband/liquid-radio

79 *Id.*

80 Landström, Sara and Anders Furuskär, Klas Johansson, Laetitia Falconetti and Fredric Kronestedt. Ericsson Review, "Heterogeneous networks – increasing cellular capacity" (2011), Issue 1 ("Landström *et al*."). Available at http://www.ericsson.com/res/thecompany/docs/publications/ericsson_review/2011/heterogeneous_networks.pdf

81 *Id.*

82 *Id.*

utilize the end-user broadband connection to serve end user-specified mobile phone numbers.[83] Picocells are essentially higher power femtocells, typically deployed indoors for larger businesses or public access at shopping malls (typically covering less than 200 meters). Microcells typically have much lower power than macrocells but higher power than picocells (typically covering about 1 km), which can be used for providing either indoor coverage or for filling holes in macrocell coverage.[84]

Low-power cells are deployed to increase coverage and/or capacity. To continue Ericsson's example discussed above, [85] deploying 12 picocells has approximately the same doubling effect on downlink capacity as increasing spectrum from 10 MHz to 20 MHz or macro cell densification (an increase of inter-site distance from 425 meters to 300 meters). However, picocells have a significantly more profound effect on uplink capacity than the increase of spectrum or even macro cell densification. Another study by NEC Europe[86] found that LTE picocells are able to deliver 200 times the traffic density of LTE macrocells.

Complementing macro cells with low-power pico cells is a particularly attractive approach for areas where users are highly clustered.[87] This strategy of deploying two or more overlaying cell layers is referred to as heterogeneous deployment or heterogeneous networks ("hetnets") and depicted in the following chart by Ericsson:

[83] Some QSI consultants have femtocells that significantly increase wireless capabilities in their offices.

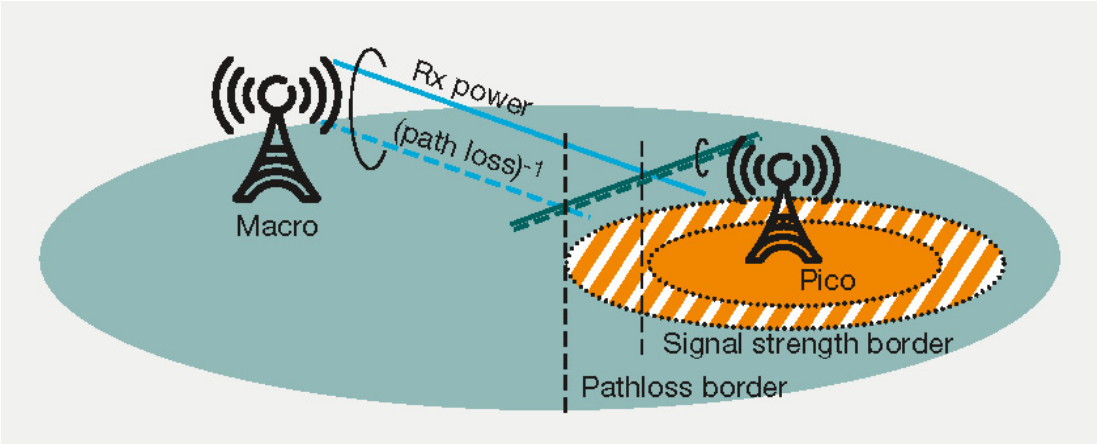
[84] The descriptions of femto, pico and microcells are based on 4G Americas, "4G Mobile Broadband Evolution: 3GPP Release 10 and Beyond" (February 2011), p. 40. In the U.S., AT&T's brand 3G MicroCell™ meets the definition of a femtocell.

[85] Landström *et al.*

[86] Femtoforum, "Femtocells – A Natural Solution to Offload" (June 2010), p. 3. Available at: http://www.3gamericas.org/documents/016+Femtocells+Natural+Solution+for+Offload%5B1%5D.pdf . This report references a Simulation Study to Examine Various Deployment Scenarios for LTE by Dr. Hamid Falaki, Sr. Product Manager, LTE/SAE Strategy & Solution, NEC Europe.

[87] Parkvall, Stefan and Anders Furuskär and Erik Dahlman. Ericsson Review, "Next Generation LTE, LTE-Advanced" (2010), Issue 2, p. 24. ("Parkvall *et al.*") Available at http://www.ericsson.com/res/thecompany/docs/publications/ericsson_review/2010/Ericsson-Review-2010-2.pdf

Chart. Heterogeneous Deployment with a Macro Cell Overlaying Multiple Pico Cells:[88]



Heterogeneous deployments are possible with LTE Rel-8 and Rel-9, and LTE Rel-10 provides additional features that improve the support for this type of deployment.

Cell densification (whether it relates to building a new macro site or deploying femtocells, which require femtocell-related core network infrastructure such as femtocells gateways) requires capital investment. Accordingly, this method of expanding network capacity works better for large wireless companies that enjoy scale economies and can spread costs over a large number of subscribers.

The number of providers offering femtocells is growing fast. According to Informa Telecom & Media's "Femtocell Market Status" report,[89] as of February 2011, nineteen operators in 13 countries have commercially deployed femtocells (up from nine operators in 2009), including three U.S. operators (Sprint, Verizon and AT&T) and no Canadian operators.[90]

According to a recent 4G Americas report, "[t]he trend toward more and more cells with diminishing cell radii is forecast to continue in the near term."[91]

An operator may deploy femtocells to extremely heavy users in order to reduce the load on the macro-cellular network. In other cases, femtocells can be used in an area with poor cellular signal to improve coverage. The idea behind femtocells is that they increase coverage or/and performance by offloading mobile traffic to the end-user broadband wireline connection, which serves as wireless backhaul. More generally, traffic offload can happen not only via a femtocell,

---

88 Reproduced from Parkvall *et al.*, p. 24, Figure 2.

89 Informa Telecom & Media's Femtocell Market Status Report, Issue 6 (February 2011), p. 8. Available at: http://www.femtoforum.org/femto/pdfs01.php

90 Rogers offers a somewhat related service called Talkspot, which works only on a limited number of mobile devices. Rogers markets Talkspot as a replacement for wireline service and a way to make and receive unlimited calls without using wireless minutes, rather than a method of increasing capacity and coverage. *See*, https://www.rogers.com/web/content/wireless-products/talkspot

91 4G Americas March 2011 Report, p. 25.

but also a Wi-Fi router, with the latter approach requiring a handset with Wi-Fi connectivity (often present in smartphones). In both cases, a device other than the macrocell site carries mobile traffic over an alternative network to the mobile operator or another Internet destination.

Traffic offloading is a natural strategy when dealing with mobile data traffic because a large portion of mobile data usage takes place indoors in areas where wireline broadband is often available. For example, as discussed above, a recent Cisco's survey found that out of total time spent on mobile usage, 40% of time is spent at home, 35% "on the move," and the remaining 25% of mobile Internet use occurs at work.[92] In addition, mobile broadband traffic "on the move" often takes place in areas such as airports and downtown locations that already have Wi-Fi hot spots. As noted by an AT&T executive, "Wi-Fi provides critical coverage and capacity where most needed."[93] According to industry analysts, AT&T is continually expanding its Wi-Fi network and building a dedicated Wi-Fi network as a capacity relief valve for its mobile broadband network.[94]

Another reason why traffic offloading is a "natural" strategy for mobile data usage is that indoor traffic demands greater radio resources from the macro-cellular network than outdoor traffic because the signal must penetrate walls to reach the indoor subscriber. Therefore, the benefit to the macro network goes beyond the sheer fact that traffic is offloaded because those subscribers whose data is offloaded are all sitting behind radio-wave absorbing walls.[95]

Cisco has estimated the amount of smartphone traffic that potentially can be offloaded through dual-mode devices or femtocells for different countries. Cisco's offload factor for each country is a combination of smartphone penetration, the share of smartphones of Wi-Fi mode, percentage of home-based mobile Internet use, and percentage of dual-mode smartphone owners with Wi-Fi fixed Internet access at home. Cisco's estimates for Canada are presented in the following chart.[96]

---

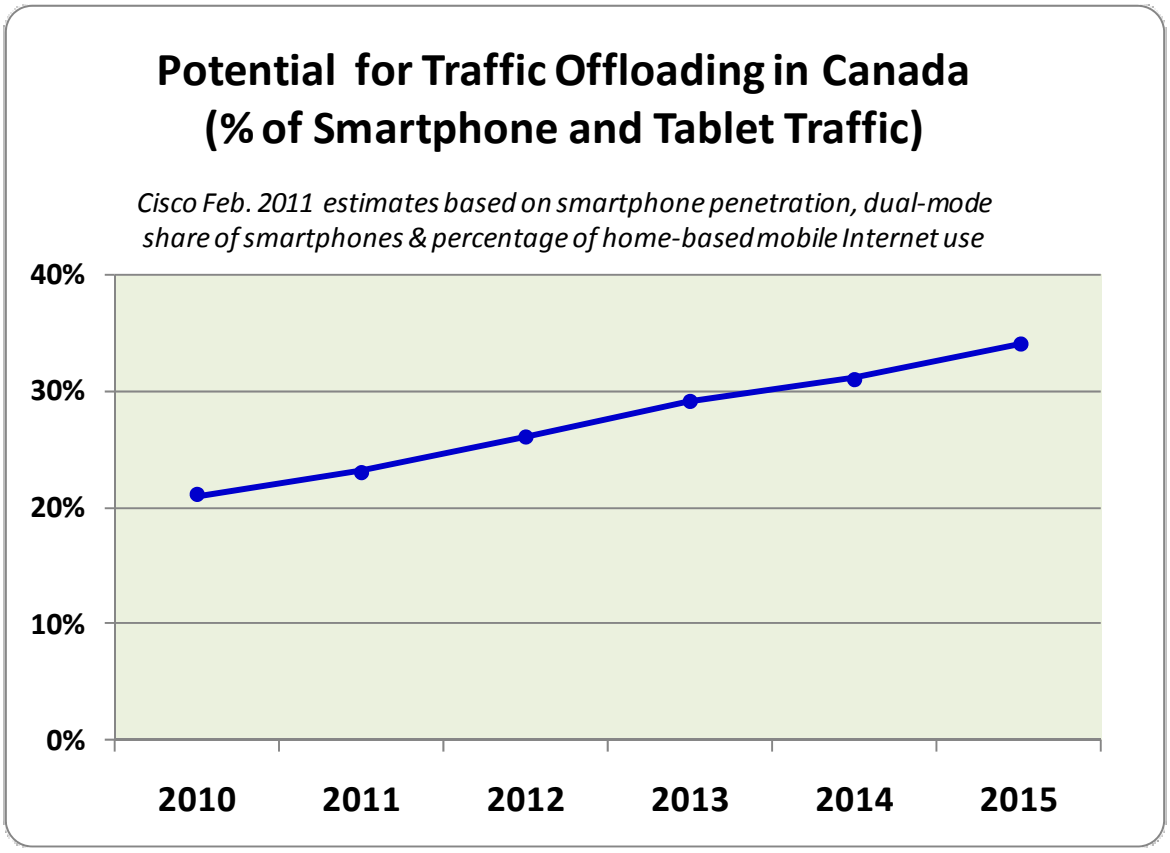
92 Cisco White Paper, p. 10.

93 PrepaidMVNO, "As Mobile Data Demand Spikes, Can Wi-Fi Come to 3G's Rescue?" (September 30, 2010). Available at: http://www.prepaidmvno.com/2010/09/30/as-mobile-data-demand-spikes-can-wi-fi-come-to-3g%E2%80%99s-rescue/ This report cites to Dennis Whiteside, assistant Vice President for AT&T Wi-Fi service.

94 *Id.*

95 Femtoforum, "Femtocells – A Natural Solution to Offload" (June 2010), p. 12. Available at: http://www.3gamericas.org/documents/016+Femtocells+Natural+Solution+for+Offload%5B1%5D.pdf

96 Cisco White Paper, Table 7, p. 11.



As shown, Cisco estimates that the current potential for traffic offloading in Canada is 23% of smartphone and tablet traffic (for 2011), increasing to 34% by 2015. The latter figure is greater than the corresponding estimates for the U.S. (30%) and Japan (28%).[97] It appears that actual rates of traffic offloading are uneven among various operators. For example, in the U.S., AT&T, which owns thousands of Wi-Fi hot spots nationwide, has been aggressively pursuing a Wi-Fi offloading strategy. AT&T smartphones come with auto-authentication at AT&T Wi-Fi hot spots, and Wi-Fi usage is not counted towards total smartphone usage. In contrast, Verizon and Sprint do not have similar marketing and pricing plans that encourage Wi-Fi offloading.[98] In Canada, Rogers launched Canada's first special pricing plan designed to encourage Wi-Fi offloading for business customers in March 2011.[99] The plan is called "Wi-Fi Calling for

---

97 *Id.*

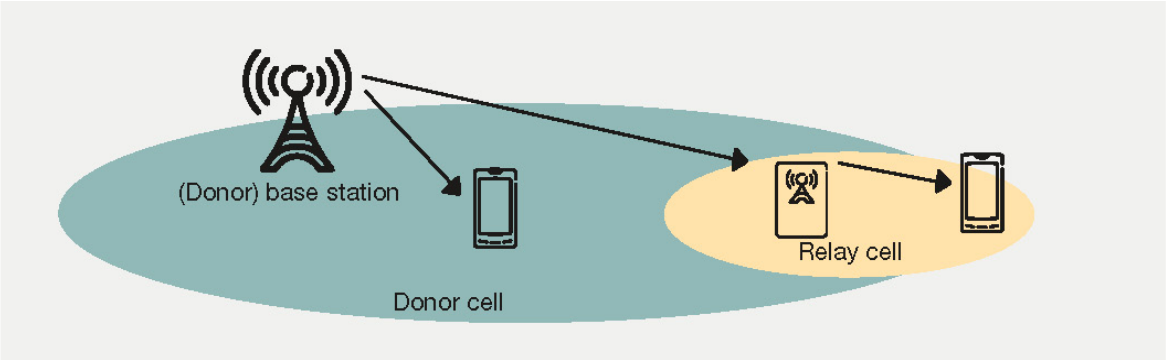
98 Luna, Lynnette. "Wi-Fi Offload for Mobile Networks: 20% of Traffic and Counting" (February 25, 2011). Available at: http://www.fiercebroadbandwireless.com/special-reports/wi-fi-offload-mobile-networks-20-traffic-and-counting

99 Rogers New Release, "Mar 11, 2011 - Rogers launches Canada's First Wi-Fi Smartphone Service for Business." Available at: http://www.rogers.com/web/Rogers.portal?_nfpb=true&_windowLabel=investor_1_1&investor_1_1_actionOverride=%2Fportlets%2Fconsumer%2Finvestor%2FshowNewsDetail&investor_1_1yearInSelection=2011&investor_1_1BusiUnit=RCI&investor_1_1NewsID=1903118235&investor_1_1selectedPageIndex=0&investor_1_1fromNewReleasePage=RCI&_pageLabel=IR_LANDING

Business" and allows business customers to place mobile calls from their smartphones over Wi-Fi networks registered on their devices. With the $10 per month add-on, customers can make calls over the Wi-Fi network that do not count towards monthly voice plan minutes. Rogers also currently offers Wi-Fi calling for residential customers for a fee.[100] Yet, in the U.S. T- Mobile has been offering a similar service without additional fees[101] since 2007, and currently its subscribers place around 40 million calls per month over Wi-Fi.[102]

Another enhancement related to the notion of heterogeneous networks is the use of relay nodes, which are supported in LTE.[103] Like femto and other low powered cells, relay nodes are placed at problematic locations (such as indoor environments) to improve coverage. The difference between relay nodes and femtocells is that relay nodes are connected to the network (the donor cell) wirelessly using the LTE radio interface technology, rather than via an Internet wireline connection. Relay nodes enable the deployment of small cells at locations where conventional wireline or microwave backhaul is not possible or commercially viable. Relaying is depicted in the following diagram by Ericsson:

Chart. Relaying:[104]



Yet another means of capacity enhancement involves increased cell-site sectorization. A typical cell site is composed of three sectors (directions). Increasing the number of sectors to six almost doubles the capacity: equipment manufacturer trials showed that this method increases capacity

100 Rogers Calling Services description. Available at: http://www.rogers.com/web/content/add-ons/callingservices?tab1_content&submenu5

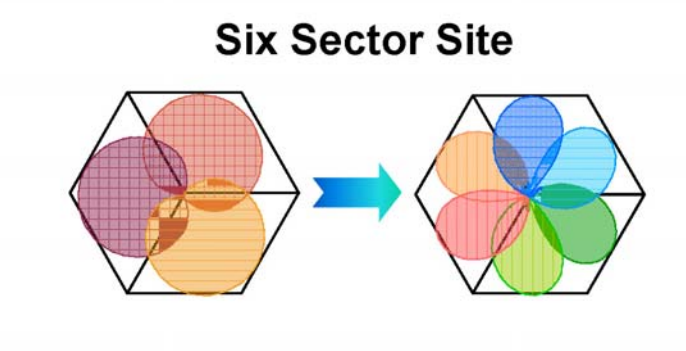
101 T-Mobile Wi-Fi Calling FAQs. Available at: http://support.t-mobile.com/doc/tm24195.xml

102 Dano, Mike. "T-Mobile USA offloads 5M Wi-Fi callers" (February 16, 2011). Available at: http://www.fiercewireless.com/story/t-mobile-usa-offloads-5m-wi-fi-callers/2011-02-16#ixzz1IIcUXk2T

103 Parkvall *et al*., pp. 25-26. *See also,* Nokia Siemens Networks Technical White Paper, "LTE-Advanced. The advanced LTE Toolbox for More Efficient Delivery of Better User Experience" (2011) ("Nokia Siemens LTE White Paper"), p. 10. Available at http://www.nokiasiemensnetworks.com/portfolio/products/mobile-broadband/long-term-evolution-lte

104 Reproduced from Parkvall *et al.*, p. 26, Figure 3.

by 80% and also increases in-building penetration.[105] The following diagram[106] illustrates this technology:



This method of increasing capacity is commercially available and is being used in dense areas. For example, South Korea's biggest mobile operator, SK Telecom, announced last summer that in preparation for its unlimited data offering, the company is increasing its network capacity by using a combination of the six-sector approach, femtocells and Wi-Fi offloading.[107] As noted in the recent SeaBoard report,[108] Canadian incumbents use predominantly three-sector antennas.

Another recent enhancement that improves spectral efficiency and coverage is a set of optimizing technologies referred to as Self Organizing Networks (SON),[109] which were introduced as part of the 3GPP LTE standard. These technologies dynamically optimize radio network performance during operation, such as optimization of handovers and capacity-based optimization in situations of traffic congestion. For example, SON can change an antenna tilt to improve coverage or distribute bandwidth equitably among users and minimize overloads that deprive each user of bandwidth.[110] Similarly, when one cell is overloaded, SON can hand over users at the cell's edge to a neighboring cell.[111]

---

105 Linehan, Kevin. 4G Americas, "Smart Antennas and SON," presentation at 4GWorld, Chicago (October 18-21, 2010) ("Smart Antennas and SON"). Available at: http://www.3gamericas.org/UserFiles/file/4G%20Americas%20at%204G%20World/Kevin%20Linehan,%20Andrew,%20Smart%20Antennas%20and%20SON.pdf

106 Reproduced from "Smart Antennas and SON," p. 5.

107 Ji-hyun, Cho. *The Korean Herald*, "SKT Ups Ante in Network Competition" (August 19, 2010). Available at: http://www.koreaherald.com/national/Detail.jsp?newsMLId=20100819000804

108 SeaBoard Report, p. 15.

109 Nokia Siemens LTE White Paper, pp. 12 and 14.

110 Nokia Siemens Networks White Paper, "Self-Organizing Network (SON) Introducing the Nokia Siemens Networks SON Suite – an efficient, future-proof platform for SON" (2009) ("Nokia Siemens SON White Paper"), p. 10. Available at http://www.nokiasiemensnetworks.com/portfolio/products/self-organizing-networks-suite/son-suite

111 Nokia Siemens SON White Paper, p. 10.

E. LTE Deployment is not Limited to 700 MHz Spectrum

Long Term Evolution or "LTE" is the latest standard in mobile technology that provides downlink peak rates of at least 100 Mbps and uplink speeds of at least 50 Mbps. It is an all-IP technology that is characterized by better performance (higher radio network efficiency, lower latency) than current technologies.[112] Industry analysts estimate that the cost per megabyte for LTE services will be 83% lower than Wideband Code Division Multiple Access (W-CDMA) and 66% lower than High-Speed Downlink Packet Access (HSDPA).[113]

Because LTE is operationally more efficient than current technologies, industry experts view it as a technology to which all networks would migrate. For example, Ovum forecasts that "[b]y 2020, LTE is expected to be the dominant mobile technology…"[114] Rogers states that it, "is using all of its available mobile spectrum to implement Long Term Evolution (LTE) technology in Canada's top markets."[115] Alcatel-Lucent notes that "LTE [is] deployable in any of the "3GPP" [3rd Generation Mobile System] bands,…(and more)," including the 800 MHz (the cellular band), 1800 MHz, 1900 MHz (PCS), and 1700/2100 MHz (AWS) bands.[116] A recent 4G Americas Report notes that "over 30 frequency bands are supported in the standards for LTE[.]"[117] Industry analysts also predict that while initial deployments of LTE would happen in the more recently licensed (and therefore, often unused) bands such as the North American bands 700 MHz and AWS, eventually other bands will be re-farmed to LTE such as the cellular and PCS bands.[118]

A U.S. provider, MetroPCS, was the first North American operator to launch an LTE network in September 2010 (in Las Vegas, Nevada), and this launch was based on AWS spectrum.[119] According to Tom Keys, chief operating officer for MetroPCS, the provider will manage its spectrum on a market-by-market basis, deploying both in the PCS and AWS bands.[120] The only other U.S. provider that has launched LTE in the U.S., Verizon, deployed it in the 700 MHz band. The third U.S. operator expected to launch LTE in 2011, AT&T, is deploying LTE over

---

112 Motorola Technical White Paper, "Long Term Evolution (LTE): A Technical Overview," p. 3. Available at http://www.motorola.com/web/Business/Solutions/Industry%20Solutions/Service%20Providers/Wireless%20Operators/LTE/_Document/Static%20Files/6834_MotDoc_New.pdf

113 UMTS Forum Report 42, Ovum, "LTE Mobile Broadband Ecosystem: the Global Opportunity" (May 2009), p. 2, referencing report published by the UMTS Forum "Global Mobile Broadband: Market potential for 3G LTE."

114 *Id.*, p. 5.

115 Rogers Comments, p. 3.

116 Palamara, Maria E. Alcatel-Lucent, "Realizing LTE: Understanding the Challenges and Planning for LTE Introduction" (January 2009), p. 11.

117 4G Americas March 2011 Report, p. 33.

118 Palamara, Maria E. Alcatel-Lucent, "Realizing LTE: Understanding the Challenges and Planning for LTE Introduction" (January 2009), p. 11. *See also*, Nokia Siemens LTE White Paper, p. 10.

119 Fitchard, Kevin. "LTE launches in the U.S. — MetroPCS Style" (September 21, 2010). Available at: http://connectedplanetonline.com/3g4g/news/metropcs-launches-lte-092110/index.html

120 *Id.*

700 MHz and the AWS bands.[121] One of the themes in AT&T's recent announcement about purchasing T-Mobile was the ability to free T-Mobile's AWS spectrum for LTE offerings.[122] In Canada, Rogers announced LTE trials in October 2010 based on the AWS band.[123] Notably, Canadian incumbents currently hold 95% of the 800 MHz spectrum as well as unused AWS spectrum, and have the option of deploying LTE over these spectrum bands.

Further, as discussed above, one of the newest advancements in mobile broadband technologies (HSPA and LTE) is the capability to aggregate carriers (spectrum) from different spectrum bands, including non-contiguous bands. Aggregation from non-contiguous "pipes" results in the creation of a "virtual pipe" that allows speeds not achievable with smaller bandwidths. For example, in February 2011, Nokia Siemens Networks conducted the world's first successful demonstration of LTE-Advanced carrier aggregation on commercial equipment – the company's Flexi Multiradio Base Station – using a combination of 800 MHz and 2.6 GHz bands.[124] The capability of aggregating various bands to produce bigger (and faster) broadband pipes favors the dominant wireless providers, which hold large amounts of spectrum in cellular, PCS, AWS and BRS bands. As a hypothetical example, under the auction cap proposal, Rogers (a 800 MHz license holder in each service area) may obtain in a given service area up to 10MHz of spectrum in the 700 MHz band. However, Rogers owns at least 125 MHz of spectrum in each market, including 20 MHz of unused AWS spectrum. Therefore, by utilizing the multi-carrier aggregation technology, Rogers can aggregate its 700 MHz and other spectrum holdings to offer very high speed LTE over a bandwidth of 20, 30 or 40 MHz, and still have 75 to 95 MHz bandwidth to offer non-LTE services. Because under the multi-carrier technology more spectrum translates into higher speeds, a large player like Rogers can always match or exceed mobile broadband speeds that a smaller player can achieve.

The incumbents have expressed skepticism that a Canadian provider can offer LTE over spectrum bands other than those used by the big U.S. providers out of fear that vendors would

---

121 Fitchard, Kevin. "MWC: NSN mixing and maxing LTE frequencies" (February 9, 2011). Available at: http://connectedplanetonline.com/3g4g/news/MWC-NSN-mixing-and-maxing-LTE-frequencies-0209/index.html *See also*, Lawson, Stephen. "AT&T's T-Mobile Deal Shows Importance of Spectrum" (March 21, 2011). Available at: http://www.cio.com/article/677703/AT_T_s_T_Mobile_Deal_Shows_Importance_of_Spectrum?page=2&taxonomyId=3061

122 Lawson, Stephen. "AT&T's T-Mobile Deal Shows Importance of Spectrum" (March 21, 2011). Available at: http://www.cio.com/article/677703/AT_T_s_T_Mobile_Deal_Shows_Importance_of_Spectrum?page=2&taxonomyId=3061 *See also,* AT&T Presentation, dated March 21, 2011. Available at: http://www.att.com/Common/about_us/pdf/INV_PRES_3-21-11_FINAL.pdf

123 Rogers News Release, dated, October 6, 2010, "Rogers Announces First LTE Technical Trial In Canada." Available at: http://www.rogers.com/web/Rogers.portal?_nfpb=true&_windowLabel=investor_1_1&investor_1_1_actionOverride=%2Fportlets%2Fconsumer%2Finvestor%2FshowNewsDetail&investor_1_1yearInSelection=2010&investor_1_1BusiUnit=Wireless&investor_1_1NewsID=1810068753&investor_1_1selectedPageIndex=0&investor_1_1fromNewReleasePage=Wireless&_pageLabel=IR_LANDING

124 Nokia Siemens Networks Press Release, "LTE-Advanced 'carrier aggregation' on commercial equipment a world first #MWC11" (February 9, 2011). Available at: http://www.nokiasiemensnetworks.com/news-events/press-room/press-releases/lte-advanced-carrier-aggregation-on-commercial-equipment-a-wor

decline to provide an adequate ecosystem for the dominant wireless providers in Canada.[125] The example of the U.S. provider MetroPCS suggests that these fears are exaggerated. MetroPCS, a provider of approximately the same size as TELUS,[126] managed to secure equipment vendors and device manufacturers for its LTE network. Similarly, in the recent past, MetroPCS and another U.S. operator, Leap Wireless, persuaded major vendors to build them CDMA equipment in the AWS spectrum that these two providers acquired in 2006.[127] At the time, MetroPCS had less than 3 million subscribers, and Leap Wireless had slightly over 2 million subscribers, meaning that both operators were smaller than the Canadian incumbents today.[128] Besides company size, another factor that makes the task of securing vendors easier for the Canadian incumbents compared to the case of MetroPCS and Leap Wireless is the expected revenue: LTE deployment is associated with much higher average revenue per unit than the case of voice-centric business plans of the U.S. providers in 2006.

More generally, because there is an agreement in the industry that LTE is the next generation mobile network technology, it is inevitable that a robust ecosystem will develop for this technology.[129] Given that LTE is being deployed in different spectrum bands, it is reasonable to expect that LTE handsets will be multi-band handsets, just like the present day GSM/HSPA handsets offered by the incumbents which simultaneously support four GSM bands (800/900/1800/1900 MHz) and three HSPA bands (800/1900/2100 MHz) to permit global roaming.[130] The 800 MHz LTE band is very likely to be accommodated in future LTE handsets for global roaming because this band is being used to deploy LTE in a number of countries.

Specifically, in Europe, the 800 MHz spectrum is being freed-up by the digital television switch-over and has been reserved by the European Commission for LTE and WiMAX.[131] In Germany, Vodafone has launched LTE over the 800 MHz spectrum, and two other German operators, T-

---

125 Rogers Comments, p. 16, ¶36.

126 According to the FCC 14th Report on Wireless Competition, released on May 20, 2010 (at p. 10), MetroPCS had 6.6 million subscribers at the end of 2009 (a year before LTE was deployed). TELUS had slightly over 6.9 million subscribers at the end of 2010 (*see* TELUS Corporation, Management's Review of Operation 4Q 2010, p. 18).

127 Fitchard, Kevin. "Alltel looks to LTE, but over which spectrum?" (May 15, 2008). Available at: http://connectedplanetonline.com/wireless/news/alltel-lte-spectrum-0515/

128 FCC, 13th Report on Wireless Competition, p. 138, Table A-4 (data for the end of 2006).

129 Alcatel-Lucent Strategic White Paper, "CDMA and LTE: Making the most of wireless broadband, An overview of strategies, issues and opportunities" (May 2009), p. 2. Available at http://webform.alcatel-lucent.com/res/alu/survey/alu2CustomForm.jsp?cw=alu2CorpDocDownload&LMSG_CABINET=Docs_and_Resource_Ctr&LMSG_CONTENT_FILE=White_Papers/cdma_lte_SWP.pdf&lu_lang_code=en_WW

130 See, e.g., specifications for the following sample smartphones: Samsung Focus by Rogers (http://www.rogers.com/web/link/wirelessBuyFlow?forwardTo=PhoneThenPlan&productType=normal&productId_Detailed=I917BLKR&N=52+11), Motorola Atrix by Bell Canada (http://www.bell.ca/shopping/en_CA_ON.MOTOROLA-ATRIX/71866.details?contractId=term36m#tabCont1-tabs) and HTC 7 Surround by TELUS (http://www.telusmobility.com/en/ON/htc_7_surround/index.shtml).

131 Davies, Simon. "Europe to Reserve 800Mhz Bands for LTE and WiMAX Networks" (May 6, 2010). Available at: http://www.cellular-news.com/story/43196.php The European "digital dividend" spectrum is the 790-862 MHz band.

Mobile (Deutsche Telekom) and O2 also plan to deploy LTE over the 800 MHz spectrum.[132] An auction of the 800 MHz band was completed in Sweden in early March of this year, and winners in that auction already indicated that they plan to deploy LTE over that band.[133] British operators have been conducting LTE trials over the 800 MHz band in rural areas of the U.K,[134] and the 800 MHz spectrum will be auctioned in the U.K. in 2012.[135] According to 4G Americas, France's largest mobile operator, Orange, plans to deploy LTE in 800 MHz and 2.6 MHz bands.[136] Croatian operator, Vip, has trialed LTE in the 800 MHz spectrum and plans to launch LTE commercially later in 2011.[137] Nokia Siemens will be upgrading Telecom Italia's network with LTE base stations that will allow implementation of LTE in 800 MHz and 2.6 GHz bands.[138] In South Korea, the largest wireless provider, SK Telecom, indicated that it also plans on using 800 MHz spectrum for the LTE services (to be launched later in 2011), for which it is currently awaiting governmental approval.[139] In Japan, the second largest provider, KDDI (au),

---

[132] Donegan, Michelle. "Vodafone Beats Deutsche Telekom to LTE Launch" (November 29, 2010). Available at: http://www.lightreading.com/document.asp?doc_id=201103 *See also*, "Deutsche Telekom launches LTE via 800 MHz with Nokia Siemens" (October 22, 2010). Available at: http://www.telecompaper.com/news/deutsche-telekom-launches-lte-via-800-mhz-with-nokia-siemens *See also* 4G Americas, "Global 3G Status HSPA / HSPA+ / LTE" (March 24, 2011). Available at: http://www.4gamericas.org/UserFiles/file/Global%20Status%20Updates/Global%20Status%20Update%20March%2024%202011.pdf

[133] Ricknäs, Mikael. *IDG News*, "Spectrum for Rural 4G Auctioned off in Sweden" (March 4, 2011). Available at: http://www.pcworld.com/businesscenter/article/221386/spectrum_for_rural_4g_auctioned_off_in_sweden.html

[134] "O2 UK to trial LTE at 800 MHz" (May 22, 2010). Available at: http://www.intomobile.com/2010/05/22/o2-uk-to-trial-lte-at-800mhz/ *See also*, "Clear Mobitel announces UK LTE trial in 800MHz 'Digital Dividend' Spectrum in Cornwall" (July 17, 2010). Available at: http://blog.epn-online.com/rfwirelessblog/2010/07/clear-mobitel-announces-uk-lte-trial-in-800mhz-digital-dividend-spectrum-in-cornwall.html *See also*, "Nokia Siemens Looking for Rural 800MHz LTE Trial Location in UK" (March 11, 2011) (discussing Nokia Siemens LTE trials in partnership with operator Cambridge Wireless). Available at: http://www.mobileeurope.co.uk/news/blog/8645-nokia-siemens-looking-for-rural-800mhz-lte-trial-location-in-uk

[135] Parker, Andrew. *Financial Times*, "Ofcom Outlines Auction Rules for 4G Spectrum" (March 22, 2011). Available at: http://www.ft.com/cms/s/0/48117eb0-545a-11e0-979a-00144feab49a.html#axzz1IVmHJopV

[136] 4G Americas, "Global 3G Status HSPA / HSPA+ / LTE" (March 24, 2011) ("4G Americas Global Status HSPA / HSPA+ / LTE"). Available at: http://www.4gamericas.org/UserFiles/file/Global%20Status%20Updates/Global%20Status%20Update%20March%2024%202011.pdf

[137] Mansfield, Ian. "LTE Trials at 800 MHz in Croatia" (March 24, 2011). Available at: http://www.cellular-news.com/story/48462.php

[138] "NSN Upgrades Telecom Italia" (March 28, 2011). Available at: http://www.lightreading.com/document.asp?doc_id=206116

[139] Meyer, Dan. *RCR Wireless News*, "SK Telecom Sets Partners for LTE Launch" (January 27, 2011). Available at: http://www.rcrwireless.com/article/20110127/CARRIERS/110129958/-1/sk-telecom-sets-partners-for-lte-launch SK Telecom is awaiting approval from the Korea Communications Commission to utilize the 800 MHz bandwidth for LTE service.

plans to deploy LTE initially in the 800MHz band and later using 1.5GHz spectrum.[140] The company says that the 800MHz band will be used for nationwide coverage, while 1.5GHz will be used only in densely populated areas. According to 4G Americas,[141] Vodafone Qatar is conducting LTE trials in the 800 MHz band. Given the number of planned LTE deployments in the 800 MHz spectrum across the globe, as well as the general trend towards LTE technology, it is likely that the 800 MHz band will be supported in handsets designed for global roaming.

An example showing that LTE ecosystems are moving towards multi-band equipment is the recent announcement that equipment manufacturer ZTE has developed for Swedish operator TeliaSonera an LTE modem that supports multiple bands.[142] This modem can access LTE networks in the 800MHz, 1.8GHz and 2.6GHz bands, or use HSPA+. Industry analysts observe that "[t]he arrival of modems that can access LTE networks on multiple spectrum bands is also a sign that the technology is maturing."[143]

IV. THE AUCTION CAP PROMOTES COMPETITION FOR MOBILE WIRELESS SERVICES IN LOW DENSITY AND RURAL AREAS

The superior propagation characteristics of low-frequency spectrum make it ideal for deploying mobile wireless services to rural areas.[144] The low-frequency spectrum allows providers to extend coverage to a larger geographic region at lower cost compared to higher frequency spectrums. Accordingly, low-frequency spectrum "haves" enjoy a significant competitive cost advantage over low-frequency spectrum "have nots," particularly in rural areas.[145]

The Consultation notes that Canada's geography and widely-dispersed population can render it difficult to make a business case for the deployment of advanced, innovative services in some parts of the country.[146] This must be considered when encouraging the deployment of alternative networks and services. Most countries, including Canada, have a governmental mandate to

---

140 Zander, Jens. "Neither LTE nor 800 MHz is enough" (November 24, 2010). Available at: http://theunwiredpeople.org/neither-lte-nor-800-mhz-is-enough/. *See also*, "KDDI Confirms LTE Migration Plan; But Will Use WiMAX/Wi-Fi Too" (November 17, 2010). Available at http://www.telegeography.com/cu/article.php?article_id=35225.

141 4G Americas Global 3G Status HSPA / HSPA+ / LTE.

142 Ricknäs, Mikael. *IDG News*, "TeliaSonera, ZTE Readies First Multimode LTE Modem" (March 7, 2011). Available at: http://www.pcworld.com/businesscenter/article/221498/teliasonera_zte_readies_first_multimode_lte_modem.html#tk.mod_rel

143 *Id.*

144 The Consultation outlines the superior characteristics and benefits of the 700 MHz spectrum at pages 2 and 42.

145 It is obvious that not having low-frequency spectrum will either prevent competitive entry in rural areas or severely limit the new entrants' ability to compete because their cost structure will be less efficient than the incumbent. In the U.S., the Government Accountability Office (GAO) has observed that new entrants are limited in their ability to compete in rural areas because of insufficient amounts of spectrum. (GAO-10-779; dated July 2010).

146 Consultation, p. 40.

provide advanced services to all consumers in all regions of the country. Communities in rural and low-density areas should not be left behind and indeed a case could be made that they require advanced services, including wireless services, to a greater degree than urban communities. The fact remains, however, that certain factors – population density, terrain, backhaul requirements, lack of existing infrastructure (power sources and wireline infrastructure) – have limited the deployment of wireless to these areas.[147] While it is widely recognized that competition will develop in urban areas and then, as economics permit, expand to more rural areas, the availability of low-frequency spectrum will impact that process directly and dramatically.

The incumbents hold 95% of the existing low-frequency spectrum in the 800 MHz band today.[148] Allowing them to acquire all or a vast majority of 700 MHz spectrum at an unrestricted auction will create a wide chasm between the incumbents (as low-frequency spectrum "haves") and other wireless providers (as "have nots.") This would raise serious concerns for consumers in rural areas that would be forced to rely solely on the incumbents, acting as an effective duopoly, to roll out services to underserved areas. This lack of competition would negatively impact the rate of deployment, the quality of services deployed and the prices in rural and low-density areas where the incumbents have "significant market power."[149] In short, all Canadians, including those in rural, remote and low-density areas should be able to participate in the global information society, and an in-band auction cap will assist in that important goal.

In the AWS Consultation it was noted that "[n]ew facilities-based wireless operators have several barriers to market entry. Spectrum is a finite resource that can only be accessed periodically subject to changes in international and national allocation plans and technical standards." And "…the economies of scale that a wireless incumbent enjoys, may prevent a competitive entrant from being able to match the incumbent's incremental costs of serving each additional subscriber."[150] These economies of scale combined with sole access to low-frequency spectrum would create an insurmountable barrier to entry for any wireless provider attempting to compete with the incumbents in rural or low-density areas. In the alternative, the proposed in-band auction cap would allow providers other than the incumbents to offer services with spectrum that is equally efficient. It would also be consistent with the Canadian Telecommunications Act requirement "…to render reliable and affordable telecommunications services of high quality accessible to Canadians in both urban and rural areas in all regions of Canada."

The importance of mobile broadband services and access to low-frequency spectrum to rural areas is well-recognized. In the U.S., the FCC's National Broadband Plan specifically recognizes the importance of wireless and low-frequency spectrum for rural areas, noting that "especially for highly propagating lower bands, increased availability of spectrum provides

---

147 GAO-06-426; "Broadband Deployment is Extensive Throughout the United States, But it is Difficult to Assess the Extent of Deployment Gaps in Rural Areas" (May 5, 2006), pp. 19-20. *See also*, GAO-10-779, p. 39.

148 Consultation, Figure 4.1.

149 Telecommunications Policy Review Panel (TPRP) Final Report 2006, Executive Summary, p. 5.

150 AWS Consultation at 2.5.

sufficient capacity to serve very large rural areas with a single cell, thereby further reducing the cost of rural deployments."[151]

Mobile broadband providers in the U.S. have also argued for more loans and spending on mobile broadband in rural areas because of the importance of mobile broadband to all consumers. For instance, Crossroads Wireless Holdings LLC made the following comments to the Rural Utilities Service of the U.S. Department of Agriculture on rural broadband loans and guarantees:

> Mobile broadband could transform rural development throughout the country. In America, business is becoming increasingly dependent on mobile technology; and rural areas should not be left behind. Rural health care and education will benefit from the range, low cost, and mobility that typify today's mobile networks. Rural mobile broadband means that individuals in rural areas who need to consult with medical specialists in the larger cities do not necessarily need to travel long distances but can connect with the medical specialists wherever they are on their family farms or ranches via mobile broadband service. New mobile broadband connections will benefit rural Americans who otherwise might have to travel hundreds of miles to gain access to the information, expertise, and markets they need. Finally, rural communities require mobile broadband to meet their essential homeland security needs. Mobile networks will allow rural first responders to communicate with law enforcement – and enable people to get help when and where they need it.[152]

These same arguments are just as pertinent to the rural areas of Canada. Indeed, the TPRP Report identified many of the same kinds of benefits associated with broadband to rural parts of Canada, noting "[a]s well as offering improved education, health care and economic opportunities, access to broadband in unserved areas of the country will help ensure all Canadians have the opportunity to participate in the 'global information society.'"[153] The need for mobile broadband access is universal and allocating the 700 MHz spectrum in an equitable manner that promotes competition will be key to meeting this need. Allowing the incumbents to acquire all, or virtually all, of the spectrum through an unrestricted auction runs counter to this objective.

All parties recognize the need for 700MHz spectrum and all parties should have the opportunity to acquire low-frequency spectrum. Since low-frequency spectrum is needed to efficiently deploy mobile broadband to rural areas, a company without low-frequency spectrum cannot cost-effectively enter rural markets to provide mobile broadband. Therefore, in order to create competition for mobile broadband in rural areas, it is particularly important for the auction to provide equitable access to 700 MHz spectrum to operators that currently do not hold any low-frequency spectrum. That is the goal and effect of the in-band spectrum auction cap.

---

[151] "Connecting America: The National Broadband Plan" (rel. March 17, 2010), p. 85.

[152] Comments of Crossroads Wireless Holdings LLC in Docket No. RUS-06-Agency-0052 (July 10, 2007).

[153] TPRP Final Report 2006, pp. 8-3 through 8-5.

By preventing the incumbents from acquiring all low-frequency spectrum, the auction cap ensures that a rival to the incumbent has the opportunity to serve rural consumers in remote and low-density areas thereby providing a market disciplining check on the incumbents. To provide additional assurances that the presence of a rival will, in fact, spur service deployment using low-frequency spectrum in the 700 MHz band, the auction cap proposals are accompanied by deployment obligations for 700 MHz spectrum holders. The in-band auction cap promotes competition, the sustainability of competition, and provides opportunities for competition in rural areas that would not exist otherwise.

V. CONCLUSION

An in-band auction cap should be employed when auctioning spectrum in the 700 MHz band in Canada. This framework abounds with benefits. It will distribute 700 MHz spectrum on an equitable basis, allowing each wireless provider the opportunity to bid on 700 MHz spectrum. It will promote sustainable competition by allowing at least one competitor to acquire 700 MHz spectrum, rather than allowing further concentration in low-frequency spectrum holdings and a resulting increase in incumbent market power. It will provide incentives for spectrum holders to use their spectrum as efficiently as possible by making it less likely that incumbents will acquire 700 MHz spectrum for the purposes of thwarting competition and more likely that spectrum holders employ spectral efficiency strategies. And it will produce benefits for consumers in rural areas by spurring competitive roll-out and investment in these areas, rather than relying solely on incumbent companies which have already shown a reluctance to use existing low-frequency spectrum to serve these areas. As an added benefit, the auction cap avoids most of the criticisms incumbents have ascribed to other auction frameworks, thus making the auction cap a reasonable "middle ground" position between parties advocating for an unrestricted auction and parties advocating for a set-aside.

While the auction of 700 MHz spectrum will make much-needed additional capacity available, it will not solve the "spectrum crunch" according to current traffic forecasts regardless of which auction framework is adopted. As a result, it will be critical for all spectrum holders to use spectrum as efficiently as possible. Fortunately, there are numerous existing and emerging methods and technologies that can be used to increase spectral efficiency. The potential for these strategies – most of which have yet to be deployed in Canada – to alleviate spectrum shortage is promising. Notably, the incumbents have the most to gain from these strategies because of their significant economies of scale and vast holdings of existing spectrum. The auction cap will promote the use of these spectral efficiency strategies as a means of spectrum management, without placing undue restrictions on any provider's ability to provide quality mobile wireless services.

Because no auction framework will completely solve the spectrum scarcity issue that faces the global wireless industry, the framework that best promotes competition and the most efficient use of spectrum should be utilized. That framework is the in-band auction cap.