MFRConsulting

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Comments on "Decisions on the Transition to Broadband Radio Service (BRS) in the Band 2500-2690 MHz and Consultation on Changes Related to the Band Plan"

Summary of Key Points

1. Canada should adopt the international band plan in preference to the U.S. one because:
    - Usage of the 2.5 GHz band in the U.S. is likely to change and conform more closely to the international band plan (ITU Option 1, which is identical to Industry Canada Option 2) within the next few years
    - The international band plan is superior to the current U.S. band plan – especially if it is going to be occupied by several operators instead of essentially one operator as in the U.S. – in terms of the:
        - Economies of scale available to equipment and devices developed for it;
        - Minimization of interference issues that can cause loss of coverage and capacity and create uncertainty among bidders for spectrum that will complicate the auction process; and
        - Role in maximizing Canadian customers' ease of access to international roaming services
2. The condition that MCS and MDS licenses can be converted to BRS licenses on giving up 1/3 of the MCS and/or MDS spectrum involved means that one operator (Inukshuk, the joint venture between the two owners of the largest mobile operators Rogers Communications and Bell Mobility) will hold the majority of 2.5 GHz frequencies in the demographically and economically important Quebec-Montreal – Ottawa – Toronto-London area[1] before any auction takes place. Industry Canada may wish to consider whether for the sake of a healthy competitive market the risk of this outcome warrants the imposition of rules such as spectrum caps or set-asides or other measures in the future auction to inhibit or prevent one operator from acquiring all or a very dominant position in 2.5 GHz spectrum in this core region within Canada, comparable to or even greater than that of Clearwire in the U.S.
3. In its future Consultation about the spectrum fees for BRS licenses, Industry Canada should consider the implications of the amounts of these fees for grandfathered MCS and MDS frequencies, and the possibly much higher prices of the auctioned 2.5 GHz frequencies (if for example they are comparable to the prices paid in the 2008 auction of AWS spectrum) in comparison to existing MCS and MDS spectrum fees.
4. Wherever possible, while taking account of a policy to accommodate more than one significant operator in the band, Industry Canada should award 2.5 GHz frequencies in wider channel widths (e.g. 2x15 MHz or 2x20 MHz) than in the AWS band, to enable the deployment of new broadband technologies with the optimum cost and performance characteristics.
5. Industry Canada should consider whether it is in the interests of sustaining market competitiveness over the long term to develop rules and conditions for awarding 2.5 GHz frequencies within a multiband spectrum framework including 700 MHz and 850 MHz spectrum

[1] Includes the thirteen tier-4 areas listed in the attachment to a letter from Industry Canada to Grant Thornton and Inukshuk (http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09730.html). They are London, Brantford, Guelph/Kitchener, Alliston, Barrie, Toronto, Niagara/St. Catharines, Ottawa, St. Hyacinthe, Joliette, Montreal, Trois Rivieres and Quebec, as well as those being purchased by Inukshuk from Craig Wireless in other provinces.

- Operators lacking access to frequencies below 1 GHz, which includes all operators in Canada except two (excluding Telus's SMR spectrum), are at an intrinsic economic and operating disadvantage in deploying mobile broadband networks compared to the two operators who already hold 850 MHz spectrum

6. The evolution of broadband wireless technology over the past four years has clarified its likely configurations and upgrade path over the 20 year horizon which is the appropriate time scale that a decision on a band plan should be considering.
    - LTE is gathering momentum as a wireless broadband technology likely to become as dominant in broadband radio access networks (RANs) as Ethernet is in LANs (local area networks.
    - The expected evolution of broadband wireless deployments at 2.5 GHz in the U.S. - to include LTE - reinforces a finding that any controversy about the relative merits of the two major new broadband wireless technologies, namely WiMAX and LTE, is irrelevant to the choice of band plan in Canada

1. Introduction

I would like to support the choice in Canada, in preference to the alternative U.S. FCC Model, of the internationally harmonized band plan (ITU Option 1) for the band 2500-2690 MHz (2.5 GHz[2]). I include other comments on likely technological and competitive developments that are relevant to the use of this band. These comments and recommendations are based upon the application of basic principles and experiences in spectrum policy and allocations in the Americas as well as in Europe, Asia, and Africa.

2. Principles for Selecting a 2.5 GHz Band Plan

The considerations upon which a decision about the 2.5 GHz band plan should be reached include:

- Policies and regulations should reflect wireless realities - notably limited (scarce) spectrum resources and the need to manage interference
    - Markets can only support a limited number of efficient facilities-based national mobile operators in the long- or even medium term, especially in countries with difficult terrain and vast areas of very low population density, such as Canada
    - Nevertheless ensuring market competitiveness and pressures for continual innovations requires a minimum number of players, so that a balance must be struck between the theoretical economic advantages of maximum bandwidth per operator, and the reductions in available bandwidth per operator as their number increases
        - A range of spectrum- and non-spectrum related measures and tools can be applied to mitigate tendencies in a market with a small number of facilities-based operators to anti-competitive behavior such as, but not limited to: (i) Anti-trust regulation; (ii) Coverage obligations ("lose it or use it"); (iii) Sharing and roaming obligations; (iv) Wholesale regulation, and (v) Inhibition or prohibition of contractual terms that lead to high switching costs between operators for customers
- The high growth rate in users' access network speeds and throughputs in wired and wireless networks increases the importance of deploying systems with wide channel bandwidths,

[2] In Europe this band is sometimes called 2.6 GHz. I am aware that the Canadian MCS block has sometimes been called "2.5 GHz" and the MDS block "2.6 GHz".

while 2.5 GHz is the last remaining band below 3 GHz where this is likely to be practical on a large scale[3].

- Economies of scale and capabilities such as ease of roaming are best achieved with spectrum structures and allocations that are common across multiple countries wherever and whenever possible
    - Thanks to WRC-2000, the 2.5 GHz band has the greatest opportunity to become established as a common band for mobile broadband both within ITU Region 2 (Americas) as well as in the other ITU Regions 1 and 3[4]
    - Furthermore, mobile broadband services will be less expensive if networks are deployed in wider channel widths (e.g. 15 or 20 MHz) than those which have been the norm (such as 2x 5 MHz) in earlier generations of wireless technology[5] - reinforcing the point that the wise allocation of finite spectrum resources will only accommodate a small number of efficient operators
- Spectrum licenses run between 10 (e.g., Canada, Colombia) and 20 (e.g., Mexico) years, and are often extended
    - Hence technologies with long term road maps and substantial upgrade capabilities are preferable
        - Yet old networks take a long time to fade away, so infrastructure sharing and roaming onto old networks while new networks are only partially deployed are highly desirable
- Technology neutrality requires minimum constraints on the choice of wireless technologies, subject to dealing with interference as efficiently and effectively as possible
    - Band plans with pre-determined structures in terms of paired and unpaired frequencies impose fewer constraints on multiple operators in a band than the possible outcomes of competing bids for spectrum within "open" or flexible plans as in the U.S.
    - "Open" or flexible 2.5 GHz band plans , such as can result from the choice left to the national level in the European Commission's Decision (2008/477/EC) of where unpaired spectrum will be located within the band, fail to take account of the potential adverse economic and operational consequences of measures required to manage interference between the a priori unpredictable configurations of FDD and TDD networks that may emerge in this scenario[6], and the costs of developing equipment and devices for multiple, diverse, country- or even area-specific frequency configurations which may have limited market potential

[3] 700 MHz cellular mobile spectrum is likely to be limited. The other bands would require re-farming.

[4] See for example Global View Partners, " The 2.6 GHz Spectrum Band: Unique Opportunity to Realize Global Mobile Broadband", report prepared for the GSM Association, December, 2009, http://gsmworld.com/documents/GVP_-_GSMA_2_6_GHz_Report_-_Final_9Dec09.pdf

[5] See for example Wayne A. Leighton, "Measuring the effects of Spectrum Aggregation Limits: Three Case Studies from Latin America", October, 2009, http://ssrn.com/abstract=1494371

[6] Please see companion comments from Pacomm Consulting Group Ltd. delineating the rules, conditions and responsibilities incumbent on the TDD operator under which it may be practical to deploy TDD systems in FDD-designated spectrum. The implications and consequences of introducing TDD systems into spectrum designated as FDD are more easily managed and potentially positive, as discussed in Pacomm Consulting Group Ltd.'s comments, than those of allowing freedom of choice among competing operators as to whether the spectrum they acquire will be designated as paired or unpaired.

- As noted by Industry Canada in its Consultation Document, one operator in the U.S. (Clearwire, majority-owned by the third largest U.S. cellular operator Sprint/Nextel) occupies almost all the 2.5 GHz band. Hence it is free to choose its mode or modes of operation without having to establish uncertain or possibly complex multi-party arrangements to manage interference between 2.5 GHz networks, which could be encountered if the U.S. band plan were adopted, unless a Clearwire-like outcome of spectrum holdings in this band also emerged in Canada.

3. Contrasts and Comparisons of the International and U.S. 2.5 GHz Band Plans

3.1 The Expected Evolution of the U.S. 2.5 GHz Band Plan

The most compelling argument against the adoption of the U.S. band plan is that it is likely to be short lived and change significantly in the next two to four years. It would make no sense to adopt a band plan in Canada for the sake of consistency with the U.S. if this consistency is at best likely to be very temporary, and to be eliminated as result of business decisions taken by one U.S. operator for whom ensuring consistency with a band plan in Canada is not a high priority.

Fortunately the U.S. band plan is likely to move towards ITU Option 1, partly if not completely. Usage of this band in the U.S. lies effectively under the control of only one operator (at least 150 MHz of spectrum in the major U.S. markets), as explained below, namely Clearwire. Commercial and financial pressures as well as the realities of technology are expected to stimulate Clearwire to introduce LTE into the band in both TDD and FDD modes, possibly as early as 2012, in addition to its initial deployment of TDD WiMAX. Clearwire is perfectly free to decide to do this – in parallel with and/or as a migration path from WiMAX – and has indicated it may do so. Indeed it recently announced trials of LTE in this band to start this year in Arizona.

The 2.5 GHz band in the U.S. is in an unusual situation. One operator occupies almost all the entire band, in contrast to the several operators holding significant 2.5 GHz bandwidth in other countries in Europe and Asia from Hong Kong to Germany, which have already held auctions assigning the majority of spectrum in this band. This situation in the U.S. arose as an outcome of a unique series of corporate maneuvers and spectrum allocations and band restructuring by the FCC going back to 1996, well before the advent of mobile broadband. Indeed Clearwire, to which Sprint transferred all its 2.5 GHz holdings, holds more spectrum in this one band than the total holdings of any other mobile operator in the U.S. in all other bands (Table 1).

Table 1:U.S. Operators' Spectrum Holdings (mid-2010)

Operator Average (Top 100 markets)	850 MHz	1900 MHz	AWS	700 MHz	2.5 GHz	**TOTAL MHz**
Verizon Wireless	25	21	13	32	0	91
AT&T	25	34	12	20	0	91
Sprint/Nextel	14 (SMR)*	36	0	0	0	50
T-Mobile	0	25	26	0	0	51
Cable MSOs	0	0	19	0**	0	19
Clearwire	0	0	0	0	150	150

Source: Yankee Group, MFRConsulting

*SMR = Specialized Mobile radio (Trunking); ** Minor amounts of 700 MHz spectrum covering about 7% of the U.S. population were acquired by one cable MSO (Cox).

Clearwire has been structuring its 2.5 GHz spectrum holdings as it chooses. So far it has been deploying WiMAX in 30 MHz of unpaired spectrum. In the case of Canada the decision to let incumbent MCS and MDS licencees retain two-thirds of their spectrum holdings upon converting these licenses to BRS means that one operator will automatically hold a significant minority, or in some areas including several of the most populous ones, even a majority of 2.5 GHz spectrum. In these circumstances a Clearwire-like outcome for the 2.5 GHz band in which one operator ends up holding 150 MHz (or even more) of this spectrum is very possible. Hence Industry Canada may wish to address the following question:

- Should the remaining 2.5 GHz spectrum not automatically awarded to MCS and MDS incumbents at their request be set aside in whole or in part for other (non-incumbent) operators, or should some other mechanism (e.g. spectrum caps) be introduced to prevent a single operator-dominated situation from arising?[7]

A further question which is likely to be brought to the attention of Industry Canada is the very large possible disparity between current licence fees for MCS and MDS spectrum converted to BRS licences, and costs for the remaining 2.5 GHz spectrum including the prices that may be paid by winning bidders in an auction, if these turn out to be comparable to the prices paid for AWS spectrum in 2008. Industry Canada has announced its intention to launch a Public Consultation into the matter of fees for BRS licences, and the question that can be anticipated in this context, given the interests of non-incumbent (in the 2.5 GHz band) operators who win or wish to acquire 2.5 GHz spectrum is the following:

- Should the future annual fees for MCS and MDS spectrum converted to BRS licences be established taking into account the spectrum prices paid in an eventual 2.5 GHz auction, so as not to create an unreasonable financial disparity between MCS/MDS incumbents and other eventual 2.5 GHz mobile operators?

The ultimate configuration of the 2.5 GHz band, in terms of the amounts and locations of the bandwidth held by various operators, will have significant economic and competitive consequences. Hence Industry Canada should consider very carefully the conditions under which MCS and MDS incumbents and other parties interested in these frequencies should be eligible to bid for the 2.5 GHz bandwidth that eventually becomes available for this auction, to ensure that they are consistent with public policy and regulatory goals.

3.1.1 ITU Option 1 Will Support Lower Costs and Easier Roaming than the U.S. Band Plan

In both the Americas and elsewhere (e.g., Europe) the momentum towards the adoption of ITU Option 1 for the 2.5 GHz band is growing. Among the countries that have or plan to choose this band plan are such key markets as Brazil (as reported recently by the regulator Anatel www.anatel.gov.br: “Anatel aprova alterações de uso do espectro”; 06 de August de 2010), Chile, Scandinavia, Germany, France, and Spain.

The more widely ITU Option 1 is adopted, the greater the economies of scale which equipment (network and devices) developed for this band will enjoy, and the more reluctant vendors and components suppliers will be to develop equipment in a timely fashion or to offer it at equal prices to ITU Option 1-

[7] I present this as a question for consideration, not as a recommendation. Presumably alert non-incumbent operators will make this same point for competitive reasons, particularly since the major 2.5 GHz incumbent (Inukshuk) is a joint venture of the two largest cellular operators in Canada, who between them already control much more spectrum than any other competitor in other bands. Non-incumbent operators may also raise the question of the competitive impact of potentially huge disparities in spectrum costs within the 2.5 GHz band, as discussed in the following paragraph.

compatible equipment for different and especially country-specific band structures. As noted by Industry Canada the U.S. band plan is very specific to the U.S. context not only in its indifference to the use of TDD and/or FDD, but also in its structure of a mix of channel widths that are not compatible with the 5 MHz channel blocks for which IMT 2000 and IMT Advanced equipment for mobile broadband networks are being designed and manufactured globally. Additional filters that may be needed to implement equipment for country-specific frequency configurations, such as could result from adoption of the current U.S. band plan, might increase the costs of base stations by a few thousand dollars each, amounting to a total of multiple tens of millions of dollars in a network with several tens of thousands of base stations.

3.1.2 ITU Option 1 Is Less Restrictive for Operators than the U.S. Band Plan

The principle of technology neutrality is a worthy one. It is aimed at ensuring that operators and wireless technology developers are able and stimulated to seek out and implement innovations in wireless technologies for the ultimate benefit of the users of these networks with as few restrictions as possible. However flexible spectrum allocations in which each bidder can choose how it wishes to operate the licenses it bids for (in paired or unpaired spectrum) actually create more restrictions on the collective freedom of maneuver of network operators than an alternative band structure with pre-determined paired and unpaired spectrum blocks which is harmonized to the greatest extent possible across national and regional borders. Harmonization is accomplished when operators have to acquire frequencies and then deploy networks in paired and unpaired frequency blocks that are pre-determined by spectrum authorities with uniform configurations (locations and widths) throughout a country and internationally. In this situation, for example both across and within countries which adopt the international 2.5 GHz band plan ITU Option 1 throughout their territories, there will be no risk of having networks deployed in adjacent areas in TDD and FDD modes using the same frequencies in configurations that are unpredictable, and for which conditions for interference management cannot be clearly established before spectrum is awarded. This outcome could easily arise in countries adopting open band plans[8].

Furthermore, in the international band plan the number of TDD/FDD interfaces within the band that will require guard bands is limited to two. The minimization of the number of these interfaces is significant for both economic and operational reasons. Interference problems are most problematical between FDD and TDD systems operating at adjacent frequencies or even at the same frequencies in neighboring regions within a country such as Canada which awards spectrum on a regional basis, as well as in the border regions between countries. Yet these situations are more likely to arise as a result of open band structures than a pre-determined one such as ITU Option 1, for whose two FDD/TDD interfaces interference management requirements are already well defined and understood.

In contrast the adverse consequences of the possible outcomes of “open” band plans may include: (i) a greater number of FDD/TDD interfaces, and (ii) simultaneous use of the same frequencies for TDD and FDD modes in adjacent geographies, resulting in reductions in network coverage and capacity and the introduction of more complex and unpredictable limits on authorized power levels in base stations[9]. The

[8] See accompanying comments from Pacomm Consulting Group Ltd. concerning the conditions to be established in order for TDD operation in designated FDD spectrum to be possible and potentially beneficial in some instances, while staying within a pre-determined regime for interference management.

[9] See for example Analysys Mason, Final Report for the WiMAX Forum, “Cross Border Trigger Limits and Case Study for TDD/FDD Border Coordination in Europe,” 14 April 2009 http://www.wimaxforum.org/sites/wimaxforum.org/files/cross_border_trigger_limits_and_case_Study_for_tddfdd_border_coordination_in_europe.pdf; and ibid, Global View Partners (2009)

coverage and capacity of networks deployed under these conditions are likely to be lower. In addition their costs may be higher as vendors have to make special arrangements, such as additional or customized filters in their equipment and devices, in order to meet the demands of the associated requirements for interference management.

A greater number of TDD/FDD interfaces than two may be introduced in an "open" band plan if multiple winners of frequency request and are awarded non-contiguous TDD blocks within the band separated by FDD blocks. In addition to the implications just discussed for lower capacity and coverage and higher costs, the process of awarding spectrum in this circumstance may be confused by the need to arrange or re-arrange the frequencies requested by winning bidders to minimize the number of TDD/FDD interfaces, and to agree on the appropriate rules to manage interference, e.g. from whose spectrum or which operators any guard bands will be taken. This added uncertainty as potential bidders contemplate their bidding tactics, or even bid/no bid decisions - with respect to how much usable spectrum they will finally receive in a winning bid, and where within the band it will be located - may lead to lower bids than would otherwise be the case. It may even result in fewer bidders being willing to participate in the spectrum competition than is desirable.

Of course it is also possible to envisage that there may be only one or no TDD/FDD interfaces in an "open" 2.5 GHz band plan, if all winning bidders were to request only unpaired spectrum[10]. However, this outcome is almost impossible to imagine, based on the evidence of the substantial demand for paired spectrum in this band (and in other bands) from major cellular operators around the world, and the generally higher prices, with few exceptions, that have been paid for paired than unpaired spectrum in the 2.5 GHz auctions held to date. Furthermore, multiple TDD networks within the band would also require guard bands between them, except in the very unlikely event that the various operators agreed to synchronize their networks and maintain equal uplink and down link ratios at all times, which would be another source of restrictions on their freedom to innovate.

4. Broadband Wireless Technologies and the 2.5 GHz Band

4.1 Overview of Broadband Wireless

There has been considerable uncertainty and controversy about broadband wireless technologies in recent years, notably regarding the respective merits and roles of LTE, HSPA and mobile WiMAX.

Fortunately at this point the technological environment for broadband wireless and the consequences of various conditions of spectrum allocations have become clearer than they were a few years ago when Sprint/Nextel decided in mid-2006 to deploy TDD WiMAX in its 2.5 GHz spectrum in the U.S. These developments offer Industry Canada the opportunity to adopt a band plan and other conditions for deployment of BRS networks in the 2.5 GHz band that will avoid the disadvantages of the U.S. situation in this band, and enable Canadian operators to deliver these services at minimum costs and maximum capability to the benefit of their customers.

Among the points to note are:

- The choice between mobile WiMAX and LTE is not equivalent to the choice between TDD and FDD respectively, since LTE is already available in FDD mode at 2.5 GHz (e.g. in

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[10] The alternative of paired spectrum only would require allocation of spectrum for one of the directions of transmission outside the 2.5 GHz frequencies, as in ITU Option 2 plan for this band, which is not being considered as a reasonable approach in any country.

Scandinavian networks) and will soon be available in TDD mode backed by powerful supporters from China to India, including North American and European as well as Chinese vendors. Some winners of TDD spectrum in the recent auction of 2.3 GHz frequencies in India have already chosen TDD LTE as their network technology (entrants including the joint venture between Qualcomm and its Indian partners Global Holding Corporation Pvt. Ltd. and Tulip Telecom Ltd, as well as Infotel/Reliance Industries).

- Although all mobile WiMAX deployments to date have been in TDD, profiles for FDD WiMAX have been defined and it is up to vendors to decide whether to commit resources to their commercialization.

Hence there is no reason or justification to let any consideration of the relative merits or timetables for deployments of mobile WiMAX or of LTE influence the choice of band plan in Canada. Both will be available for deployment. Any limitation is likely to be more significant for WiMAX if FDD profiles for WiMAX do not become available to complement its TDD mode, as TDD LTE becomes commercially available to complement and exploit maximum commonality with FDD LTE. The finding about the irrelevance of the LTE/WiMAX controversy to the choice of 2.5 GHz band plan in Canada in light of the current state and likely evolution of wireless technology is reinforced by the expected introduction of TDD and FDD LTE into the 2.5 GHz band in the U.S. (in addition to its initial deployments at 700 MHz in 2010) within the next few years.

Nevertheless, for the sake of the long term perspective which adoption of a band plan with long term consequences (at least 20 years) requires, it is important to consider the special role and uniquely extensive capabilities which LTE is building up with considerable momentum, including its suitability for deployment within the international 2.5 GHz band plan. Canadian operators and consumers will benefit from access to the wide range of capabilities and costs which LTE will deliver, based upon its future in which:

- LTE has established a path to offer a unique combination of flexible deployment configurations, interoperability, and global support
    - LTE is already available for FDD deployment at 2.5 GHz, and will also be available for TDD networks in this band, with interoperability between FDD and TDD, when this spectrum becomes widely available for mobile services in Canada
    - LTE will become available for deployment in all existing and new spectrum bands, in both FDD and TDD modes, and in multiple channel widths from 1.4 to 20 MHz, thereby achieving a quasi-universal role in broadband RANs comparable to that of Ethernet in local area networks. Furthermore by deployment of LTE the use of unpaired spectrum, including still unused unpaired spectrum in the 1900 MHz band as well as in new spectrum, can play a relatively larger role in future mobile broadband networks than it has for 2G and 3G systems, helping to reduce the risk of future spectrum shortages
    - Operators and consumers in Canada will benefit the most from the largest and fiercely competitive global system of supply of LTE equipment, devices and components if its networks are deployed in conformity with the international plan for the 2.5 GHz band
    - Operators will be delivering services over multiple wireless technologies (e.g. GSM, CDMA2000, HSPA/HSPA+, LTE) for many years, so that backwards compatibility or roaming capability onto different networks, for which LTE is the

best placed next generation technology, will be very valuable to protect current assets and enable wide coverage of services to customers of latest generation networks while they are being built out.

4.2 Impact of Channel Widths

A general issue faced by spectrum policy is how to achieve a reasonable balance between the number of authorized operators (i.e. spectrum licensees) to ensure healthy competition, and the techno-economic reality that finite spectrum resources will only support a limited number of efficient operators. At some point fragmentation of spectrum among many operators means that the costs and capacities of any radio access network will be significantly higher than in an efficient network, which will reduce the affordability and capabilities of the services to which customers have access.[11]

The impact of spectrum depth is enhanced for mobile broadband networks compared to preceding generations of mobile networks because new OFDMA-based broadband wireless systems can achieve substantially higher efficiencies in wider channel widths (such as 2x 15 or 2x20 MHz for paired and 20-30 MHz for unpaired operation) than have been prevalent in earlier allocations of spectrum (such as 2x5 MHz). Table 2 shows the results of one example of this phenomenon:

Table 2: Costs of LTE Service as a Function of Channel Width

Minimum Monthly Cost of FDD LTE Service in Selected Major Metro Areas in South America				
Spectrum Allocation	2x20 MHz	2x15 MHz	2x10 MHz	2x5 MHz
Relative Cost	1	1.3	2	4

Source: ibid, Wayne A. Leighton (2009)

This observation reinforces the significance of the finding noted earlier concerning the potential domination of the band by one operator. In some key areas in Canada there may only be 2x30 MHz available for auction. This situation suggests that to avoid uneconomic spectrum fragmentation there should be room made for no more than two operators in addition to the major MCS/MDS incumbent. If this incumbent wins even one out of the two blocks for auction under this circumstance then it will occupy 150 MHz out of the band's total 190 MHz, which is the same level of band dominance that Clearwire enjoys in the U.S.

4.3 Value of a Diverse Spectrum Portfolio

The importance of the 2.5 GHz band for mobile broadband services should not be considered in isolation. Growing demands for mobile broadband services and hence traffic are likely to require capacity from as much spectrum as possible for mobile services in the ideal frequency range up to 3

[11] See for example: Thomas W. Hazlett and Roberto E. Muñoz: "Spectrum Allocation in Latin America: An economic analysis", Information Economics and Policy, (21), Issue 4, November 2009, http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V8J-4WKK1G4-1&_user=10&_coverDate=11%2F30%2F2009&_rdoc=4&_fmt=high&_orig=browse&_srch=doc-info%28%23toc%235872%232009%23999789995%231528422%23FLA%23display%23Volume%29&_cdi=5872&_sort=d&_docanchor=&_ct=7&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=bbd83fbf02edbd254741e4bc765d2291; and "What Really Matters in Spectrum Allocation Design," April 2010, http://businessinnovation.berkeley.edu/Mobile_Impact/Hazlett-Munoz_Spectrum_Matters.pdf

GHz. At the same time the 2.5 GHz band is not well suited to providing economical broadband coverage in rural areas.

Hence for a mobile broadband operator to be competitive with respects to the costs (capital and operating) of its networks with wide area coverage it will ideally have access to a diverse portfolio of spectrum both below and above 1 GHz. Frequencies below 1 GHz allow for substantially fewer base stations in networks deployed in coverage-limited areas thanks to their longer propagation ranges. These lower frequencies also offer superior in-building penetration than frequencies near, at, and above 2 GHz. In-building penetration is significant since a large proportion (up to over one-half)[12] of traffic originating and terminating on devices using mobile networks is actually generated in fixed or nomadic usage environments within buildings. At the same time higher frequencies with shorter propagation ranges such as 2.5 GHz offer greater capacities within the small, capacity-limited cells required in urban and dense urban areas. Frequencies below 1 GHz are thus valuable to operators both to cover less dense areas economically, and to supplement higher frequency network capacity in urban areas with the highest traffic volumes thanks to their superior in-building penetration.[13]

Hence Industry Canada should investigate and determine whether operators lacking access to frequencies below 1 GHz[14] are at an unreasonable economic and operational disadvantage compared to major incumbents who already enjoy spectrum holdings at both low and high frequencies. If this disadvantage is judged to be unreasonable for the competitive health of the mobile market Industry Canada would be justified to assess whether it should take steps, and if so which ones, within a multi-band spectrum planning framework to ensure that these disadvantaged operators also gain reasonable access to frequencies below 1 GHz. These frequencies are in principle available to them for mobile services at 850 or 700 MHz. The justification for such steps would be reinforced to the extent that the current holders of 850 MHz spectrum, which they have been able to refarm for broadband, acquired it historically under very attractive and relatively non-competitive conditions.

In this context I submit to your attention the recent proposals (Table 3) regarding spectrum refarming and the allocation of new spectrum by the Ministry of Industry, Tourism, and Commerce in Spain, which are the subject of a public consultation in that country. The translation from Spanish is mine and hence not official, nor are some or even any of the details of these proposals necessarily appropriate to the very different market, competitive, and regulatory circumstances of Canada. Nevertheless they do explicitly link refarming of existing spectrum to the allocation of new spectrum. They illustrate questions with which Industry Canada should be concerned and address in the context of future allocations of 2.5 GHz spectrum in a multiband spectrum planning framework, namely:

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[12] Estimates range as high as 80% (Instat, http://www.instat.com/mp/09/IN0904558CWW_Mktg_Pkt.pdf) and 70% (Huawei, http://www.huawei.com/publications/view.do?id=6027&cid=11309&pid=61)

[13] See for example *for network cost savings*: "UMTS900 - A Case Study Optus," June 2009, http://www.gsacom.com/downloads/pdf/GSA_Optus_UMTS900_June_2009.php4; and *for in-building penetration*: Nokia Siemens Networks White Paper, "WCDMA Frequency Refarming", - http://w3.nokiasiemensnetworks.com/NR/rdonlyres/822AB956-2775-41BB-AEE3-9A67C895316C/9126/WCDMA_Frequency_Refarming___White_Paper.pdf

[14] According to Optus in Australia (ibid. "UMTS900 - A Case Study Optus," June 2009), the deployment of its 3G network at 2100 MHz only would have required an investment of at least A$800 million, as compared to under A$500 million with a combination of 900 and 2100 MHz frequencies.

- Should the current holders of 850 MHz spectrum have their licenses automatically renewed, when they can and already have been refarming them for broadband deployments, or should they have to return or give up some of their frequencies in this band for others to bid for, and
- What conditions of eligibility if any should be imposed for the future allocation of new 700 MHz spectrum to ensure that all operators have a reasonable opportunity to acquire spectrum below 1 GHz, especially if it turns out that it is unreasonable and impractical to require current 850 MHz operators to return some of this spectrum, given that they have already made substantial investments in refarming it for broadband?

Table 3: Proposals by the Ministry of Industry, Tourism, and Trade (Spain)

Frequency	Proposals
900 MHz	Refarming of this band will be permitted, in connection with spectrum being returned in mid 2011 (Telefonica 2.2 MHz, Vodafone and Orange 1 MHz) with a 5MHz block (including 0.8 MHz not allocated) to be auctioned in 2011, from which Vodafone and Telefonica will be excluded; in exchange licenses expiring in 2025 will be extended to 2030. Furthermore Vodafone will have to return another 1 MHz in 2015, and Telefonica's license for 1 MHz that expires in 2015 will be extended to 2030. Telefonica and Vodafone, the only operators who have a 5MHz carrier for UMTS at 900 MHz will have to offer national roaming to other mobile operators who cannot refarm at 900 MHz. A second auction will take place after February 2015 for two blocks (5MHZ and 4.8MHz, based on the 8.8MHz of Telefonica's expiring license plus the second returned 1 MHz from Vodafone) in which all operators can participate.
1800 MHz	An operator wishing to refarm this spectrum will have to return a 5MHz block to the Ministry; this spectrum will be auctioned to operators not holding spectrum in this band
2600 MHz[15]	Spectrum will be auctioned according to ITU Option 1 - 2x 70MHz (paired) and 50 MHz (unpaired) - with national licenses for four 2x10 MHz, three 2x5MHz and five unpaired 10MHz blocks, and regional licenses for one 2x10 MHz and one 2x5 MHz block[16]
"Digital Dividend" 800 MHz[17]	The 2x 30 MHz of spectrum expected to be available for mobile services after January 1st, 2015 will be auctioned in 6 blocks of 2x5MHz
Other Conditions on Operators	A combined spectrum cap of 2x 55 MHz will be established for paired spectrum in the bands of 1.8, 2.1, and 2.5 GHz A combined spectrum cap of 2x 20MHz will be applied to frequencies below 1 GHz (900 MHz and 800 MHz)

5. Conclusion

I would like to express my thanks for this opportunity to comment on the proposals for the 2.5 GHz band and welcome Industry Canada's initiatives in this regard. I am submitting this material on my own initiative and at my own cost, and am not acting on behalf of any other interests in this matter, apart from my association with the Pacomm Consulting Group Ltd. I would be happy to answer any questions which Industry Canada and other interested parties may have about the issues and findings presented in these comments.

[15] The 2500-2690 MHz band is often called "2600 MHz" or "2.6 GHz" in Europe.
[16] I do not support such small blocks, but rather blocks that support channel widths of at least 15 and preferably 20 MHz as discussed earlier above.
[17] Comparable to 700 MHz in Canada.

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