The Impact of Bidding Eligibility Conditions on Spectrum Auction Revenues

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Executive Summary

This research report presents evidence and findings derived from several spectrum auctions in North America and overseas demonstrating that carefully crafted bidding eligibility conditions for a spectrum auction – implemented via generally applicable spectrum caps or set-asides – do not result in lower than desirable and/or reasonable revenues as compared to so-called "open auctions" that tend to favor deep pocketed and market dominant wireless service providers.

To the contrary, the evidence indicates that if all wireless broadband operators are equally eligible to bid for all spectrum licenses on offer, then, under some circumstances, auction revenues may actually be *lower* than if such differentiating bidding eligibility conditions are imposed. This report also demonstrates that providers internationally have valued spectrum below 1 GHz substantially higher than spectrum above 1 GHz.

In the case of the planned U.S. auction for 600 MHz band licenses, there will likely be a sufficient number of financially and operationally capable bidders to ensure vigorous and healthy competition for licenses even if the two largest U.S. operators, Verizon and AT&T, are subject to restricted eligibility because of their spectrum holdings below 1 GHz or generally. Extensive evidence from recent auctions of the high value operators place on sub-1 GHz spectrum, especially when compared to valuations of high band frequencies, demonstrates that 600 MHz band spectrum licenses can be sold in well-crafted auctions for prices of $0.5-1.0 per MHz-POP (the lower limit being conservative in light of the outcomes of the auctions cited in this report).

The findings in this report have profound and direct implications for the planned auctions of the 600 MHz band in the U.S., in light of the current holdings of spectrum below 1 GHz in the hands of the two largest U.S. operators, Verizon and AT&T. Sub-1 GHz frequencies constitute a significant and particularly scarce spectrum resource, with distinctive performance characteristics and economic implications for mobile network operators that distinguish them from high band frequencies near and above the 2 GHz range. Operators' spectrum aggregation in the sub-1 GHz range should be specifically considered in determining whether and if so what bidding eligibility conditions are justified when licenses in this range are auctioned.

Introduction

Two main arguments have been raised against the imposition of bidding eligibility conditions (BECs). The first argument is based on the theory that because even generally applicable rules are likely to affect different entities differently depending on their existing spectrum holdings, the ability of some entities to bid for spectrum licenses may be restricted (at least in some markets) and thus the competition for these licenses will be reduced, and the revenues they

generate will be lower than they might or should be. A second theoretical argument against BECs is that they violate the functioning of the "free market."

As to the first argument, as we demonstrate below, it is just as likely that well designed BECs will strengthen effective competition for spectrum licenses and that their absence will result in lower competitive bids for spectrum licenses. As to the second argument, as we also demonstrate, it ignores the basic question of whether it is advisable to take steps to prevent any one or two operators from ending up with spectrum portfolios that are so much larger than those of their currently viable competitors that the latter cannot compete effectively going forward, no matter how superior or more innovative they may be in all aspects of the mobile business other than the limited size of their spectrum portfolios. Innovation and customer/consumer choice will be fostered and the public interest better served with three or four competing national providers than with two.

Hence the core issues around BECs for the upcoming 600 MHz band auction are:

- Whether BECs are necessary in the context of the U.S. mobile broadband market to promote efficient competition, and whether without BECs competition will be severely eroded; and
- If so, whether BECs can be crafted to ensure that they do not depress the revenues from the auctions.

This research report addresses both issues by reviewing and comparing the results of auctions with and without BECs in the U.S. and in other countries.

North American AWS (1.7/2.1 GHz) Spectrum Auctions

The three principal auctions of high band Advanced Wireless Service ("AWS") frequencies held in North America have been the 2006 U.S. auction, the 2008 Canadian auction, and the 2010 Mexican auction. Their outcomes are instructive since they involved three different approaches to BECs. The U.S. auction had no significant spectrum aggregation BECs on the licenses for commercial mobile service that were awarded[1]. In contrast, the Canadian and Mexican auctions both included BECs.

[1] The Upper D block license was not awarded because its reserve price was not met in the auction. This was not because of any spectrum aggregation conditions but because the license was conditioned with an obligation to negotiate with public safety representatives towards the construction by the D block licensee of a nationwide public safety network.

In the case of the Canadian auction, the auction rules included set-asides for new entrants amounting to 40 MHz of the newly available spectrum out of a total of 90 MHz[2]. Notwithstanding the imposition of BECs in Canada, substantially higher prices were paid for AWS licenses in Canada than in the U.S., i.e., $1.55 per MHz-POP compared to $0.53.[3] This example is one clear indication that the imposition of bidder-specific conditions in spectrum auctions does not necessarily lead to lower prices for spectrum licenses, provided there are other bidders who are strongly motivated to acquire spectrum licenses for which some bidders are ineligible. In the case of the AWS auction in Canada, there were two new well-financed entrants competing for the set-aside spectrum, namely Wind Mobile, backed by the Orascom media conglomerate,[4] and Videotron, the cable TV incumbent in Quebec.

In the Mexican auction, bidders were also subject to BECs, but in the form of an overall (i.e. non band-specific) spectrum cap. In a 2006 decision, the Mexican Supreme Court had emphasized the several principles and criteria that were followed by the regulator Cofetel (Comisión Federal de Telecomunicaciones) in this auction[5]:

- Avoid concentration of spectrum holdings
- Allow competitors market access
- Protect the public interest
- Place competitors on an equal footing regardless of their economic character.

In accordance with these principles, a total spectrum cap of 80 MHz for all operators was applied in every one of the nine regions into which Mexico is divided for spectrum licensing purposes.

The spectrum cap of 80 MHz meant that there was strong competitive bidding over multiple rounds for many other regional licenses in both the AWS band and for the PCS (1.9 GHz) licenses that were auctioned in eight of Mexico's nine regions. The final prices for the AWS licenses ranged from premiums of about 5.5 % to over 290% over their reserve prices. On the other hand, the cap effectively disqualified all but one entity (Nextel International) to bid for

[2] The rules also limited the ability of the winners of this set-aside spectrum from later selling it to the big three incumbents for a specific period of time. These conditions are often referred to as trafficking or non-trafficking rules.

[3] Source: Industry Canada and the FCC, respectively.

[4] Wind had to overcome opposition to its market entry and post-auction attempts to have its spectrum licenses revoked on the grounds that its structure and governance violated limits on the foreign ownership of carriers in Canada.

[5] Acción de Inconstitucionalidad 26/2006, http://www.radio.uady.mx/pdf/accion_inconstitucional.pdf

the single AWS license of 2x15 MHz that was offered on a national basis. Not surprisingly, this national AWS license was awarded at the reserve price that was set.

The total spectrum holdings of the four mobile operators in Mexico before and after the auctions of the AWS band and PCS frequencies are shown in Table 1 indicating a significant post-auction reduction in the imbalances between operators' portfolios:

Table 1: Average Spectrum Holdings of Mexican Operators with National Coverage

Operator	Spectrum holdings pre-auctions, MHz	Spectrum holdings post-auctions, MHz
America Movil	53.8	77.1
Telefonica	39.1	61.3
Iusacell	43.8	53.8
Nextel International	21.9	52.6
Average	39.6	61.3

Source: Cofetel

The average price paid for PCS frequencies was $0.30 per MHz-POP, while the AWS licenses, including the national license "won" by Nextel, went for $0.24 per MHz-POP[6]. The prices paid for the AWS regional licenses alone (a total of 30 MHz divided into 2x5MHz blocks in every region) amounted to an average across all regions of about $0.32 per MHz-POP. America Movil acquired all these AWS licenses in Regions 1,5, and 8, and 20 MHz in the other regions, leaving 10 MHz for Telefonica in Regions 2, 3, 4, 6, 7, and 9. The price of Nextel's national AWS license was 60% of the average price of the regional AWS licenses.

The lesson from this outcome is that BECs are consistent with a competitive auction, provided that the rules do not result in there being only one eligible bidder. The latter outcome is highly unlikely in the U.S. 600 MHz auction. Since sub-1GHz spectrum in the U.S. is heavily concentrated in the hands of Verizon and AT&T, any reasonable sub-1 GHz spectrum cap or set-

[6] These prices are all Net Present Values (NPV) taking account of the spectrum or concession fees (*derechos)* that operators have to pay to the Government over the 20 years of the licenses that are independent of the initial license fee itself. These concession fees make much larger contributions to the NPVs than do the initial license fees. In calculating the NPVs of concession fees a weighted average cost of capital of 10.11% was used.

aside will, at most, limit the participation of only these two operators. If so much new spectrum becomes available that BECs could reduce competition for new licenses (because there is enough spectrum to enable the remaining bidders to acquire sufficient holdings without having to outbid and exclude competing bidders), then it may be appropriate to reduce or remove restrictions that limit AT&T and Verizon from bidding for the licenses on offer. One example of a technique to ensure that there is healthy competition for all new licenses on offer is described in the analysis of the recent multi-band auction in the Netherlands that is presented later in this report. Furthermore, a reserve price can be set by regulators to ensure that the public Treasury receives a fair price for the spectrum being auctioned[7].

Comment on Future 700 MHz Auction in Canada

The rules adopted by Industry Canada for its future auction of the 700 MHz band are relevant to the U.S., given that this country is the only significant market that is likely to adopt the U.S. 700 MHz band plan, with some modifications. While BECs generally produce favorable results, these rules as shown below are an illustrative example of what not to do in establishing BECs.

As in the U.S., total spectrum holdings and frequencies in the other sub-1 GHz band (850 MHz) in Canada are heavily concentrated in the hands of only a small number of operators, which for practical purposes means two in most areas since the coverage of Bell and Telus is largely non-overlapping and these two operators have an extensive network sharing agreement for their HSPA (High Speed Packet Access, the predecessor mobile broadband technology to LTE) networks. In contrast to the AWS auction, there will be no set asides in the 700 MHz auction which were replaced by band-specific spectrum caps as follows:

- A spectrum cap of two paired frequency blocks in the 700 MHz band (Lower Band blocks A, B, C, and Upper Band blocks C1 and C2[8]) is applicable to all licensees.
- A spectrum cap of one paired spectrum block from within Lower Band blocks B and C and Upper Band blocks C1 and C2 is applicable to all large wireless service providers only. Large wireless service providers are defined as companies with 10% or more of national wireless subscriber market share, or 20% or more wireless subscriber market share in the province of the relevant license area.
- Unpaired blocks D and E in the Lower 700 MHz band are not subject to a spectrum cap.
- The spectrum caps put in place for the 700 MHz auction will continue to be in place for five years following licence issuance. Therefore, no transfer of licenses or issuance of

[7] While the Spectrum Act establishes a statutory "minimum proceeds" amount for the forward auction of reclaimed broadcast frequencies, *see* 47 USC § 1452(c)(2), that does not foreclose the FCC's ability to establish a reserve price that fully accounts for the value of those frequencies.

[8] In the Canadian modification of the U.S. 700 MHz band plan the Upper Band C block (that was acquired in the U.S. by Verizon) is divided into two blocks C1 and C2.

new licenses will be authorized if it allows a licensee to exceed the spectrum cap during this period.

The most prominent new entrant in the AWS auction in Canada – Wind Mobile – has stated that it may decide not to bid in the scheduled 700 MHz auction in Canada since there are no set aside rules in this case[9] and as a result its ability to become a national competitor will be unreasonably hampered. One of the authors of this report has analyzed the possible outcomes of the 700 MHz auction in Canada and concluded that in the absence of set asides for this auction it is highly unlikely that any new entrant will be able to acquire sufficient spectrum, i.e. at least 2x10 MHz for a competitive LTE deployment.[10] In this case, BECs could be more helpful if set-asides were to be included as well.

The prospects for the 700 MHz auction in Canada illustrate how BECs, if poorly crafted, may have no impact in terms of enhancing downstream competition. They may not enable newcomers to mitigate the imbalance inherent in their much smaller spectrum portfolios compared to those of much larger incumbents and may even lead to a greater spectrum imbalance post- than pre-auction. Ineffective BECs may also decrease the competitive intensity of bidding if the effect is to leave the field free for the largest incumbent operators with the greatest existing spectrum portfolios. These incumbents may be able to tacitly carve up the spectrum licenses on offer between them at relatively low bid prices if entrants (or other smaller carriers) are discouraged from bidding against the incumbents' much larger financial resources and their unrestrained motivations to sustain, or even enhance, their superiority with respect to the sizes of their spectrum portfolios.

Recent European Spectrum Auctions

A number of auctions of the European digital dividend band, i.e., spectrum at 800 MHz, have been held in Europe since 2010. The 800 MHz band plan in Europe includes 2x30 MHz of spectrum available in 5 MHz blocks (791-821 MHz paired with 832-862 MHz), with some national variations in the structure of the licenses offered, along with other conditions such as coverage obligations. The bulk of these auctions were multi-band, e.g., Germany, Italy, Spain, Portugal, and most recently the Netherlands, including high frequency bands as well as 800 MHz. Their outcomes provide direct evidence of the very large discrepancies in, or much higher values operators place on, low band as compared to high band, spectrum, whether they already hold sub-1 GHz frequencies or not, when they have the opportunity to acquire either or both of

[9] "Wind still cloudy on auction," http://www.itworldcanada.com/news/wind-still-cloudy-on-auction/146115

[10] "Consequences of Industry Canada's Policy and Technical Framework for the 700 MHz Band," unpublished draft by Martyn Roetter, September 22, 2012.

them simultaneously. The prices for high band spectrum licenses awarded in simultaneous auctions with sub-1 GHz frequencies fell in the range of just over 3% to about 33% of the prices paid for the sub-1GHz licenses.

Regulators' objectives in these auctions have varied, which has influenced the rules and conditions that they imposed. In some cases, the primary concern of the regulator has been to sustain or enhance competition at a network or facilities-based level, and in the case of the digital dividend spectrum to provide mobile broadband coverage to rural communities and smaller towns. In other cases, regulators appear to have focused on raising as much cash for the government as possible. The latter point is best illustrated by the high reserve prices set by some regulators, for example in France and Italy. It is obviously essential not to set reserve prices so high that the licenses on offer attract no bids[11].

It is often asserted that circumstances such as total market sizes, geographies and population densities of some, if not all, European countries are so different from the U.S. that any insights from these countries about the values of different frequencies, along with the economics of network deployments and competitive viability, are simply not applicable or transferable across the Atlantic. In fact, the U.S. and European markets are more similar than they are different:

- Most Americans, like most Europeans, live in cities and suburbs. The challenges of how to deploy efficient and effective mobile networks that can generate revenues from urban and suburban customers (business and consumer) in comparable economic circumstances (ability and willingness to pay) are similar, including the values that mobile operators tend to place on spectrum in different bands to support their business models and plans.
- It is increasingly inappropriate to consider individual national European markets as independent from each other in terms of the economics and structure of the provision of mobile services, or to consider that a small country, such as the Netherlands, should only support one or two mobile operators. Common technical standards, the influence of Directives of the European Commission, and the establishment of multinational operators with networks in several European countries, e.g., Vodafone, Orange,

[11] A recent striking example of unreasonable price expectations can be found in the failed November 2012 2G spectrum auction in India, which as a result of very high reserve prices did not attract any bids for the most lucrative license areas (known as "circles") in Delhi and Mumbai, as well as in Karnataka and Rajasthan. These reserve prices were multiples of the prices paid per MHz-POP for spectrum licenses in much wealthier countries from Germany and the U.S. to Singapore. As another example two major operators in Australia (Vodafone and Optus) have announced they will not bid for 700 MHz spectrum in 2013 for which the Government has set a reserve price equal to $1.36 per MHz-POP.

Deutsche Telekom (T-Mobile), Telefonica, Telenor, etc., which in some cases also have mobile activities outside Europe, means that several of them are perfectly able to compete in small national markets drawing upon their global or continental resources, just as Verizon and AT&T compete in small license areas within their national footprints[12]. These operators are also making more substantial use of network sharing arrangements than the two largest U.S. operators in order to minimize their capital expenditures (capex) and operational expenses (opex). These arrangements are subject to scrutiny and approval by regulators in order to avoid anti-competitive consequences. This approach further improves the economic viability of having three (or four) competitive mobile operators even within the smaller national markets in Europe. ***Hence, any implications of, and legitimate policy and regulatory concerns about, unequal spectrum portfolios are similar in Europe and the U.S.***

- While rural areas in Europe, or at least Western Europe, do not contain wide open sparsely populated areas that are fully comparable in their extent to those encountered in the U.S., there are some remote areas, e.g., in Sweden, as well as topology (forests, mountains) and severe climatic conditions, that pose similar challenges for achieving economical network coverage in sparsely populated areas[13].
- The suppliers of technology (network equipment and devices) in both Europe and the U.S. belong to the same global ecosystem of equipment and device supply on which all operators depend, and compete fiercely with each other on both continents.[14]
- Contrary to Verizon's assertion in its recent filing[15] in FCC Docket 12-269 (Policies Regarding Mobile Spectrum Holdings), it is not the case that European regulators "tie a particular technology to a specific spectrum band" and that only in the U.S. can "[w]ireless operators . . . choose to deploy whatever technology they want in whatever band they hold." While European policy may have previously tied a specific mobile technology to a particular band (GSM Directive of 1987) that policy was changed in 2009 (DIRECTIVE 2009/114/EC).[16] Thus, the principle of technology neutrality is now widely accepted in Europe and operators have the freedom of choice to deploy broadband systems in spectrum originally allocated to 2G, e.g., LTE in the GSM band at 1800 MHz.

[12] Several Europe-based mobile operators with multinational reach serve a substantially larger number of subscribers than Verizon and AT&T.

[13] The average population density in Sweden is lower than in the U.S.at about 60 per square mile compared to 89 for the U.S.

[14] In the U.S. Chinese vendors are for now prevented from full market participation by concerns about their connections to the Chinese Government.

[15] "Comments of Verizon Wireless," http://apps.fcc.gov/ecfs/document/view?id=7022067974

[16] This Directive can be found at http://www.etsi.org/index.php/about/our-role-in-europe/public-policy/ec-directives.

> The mix of mobile technologies of various generations and capabilities that AT&T and T-Mobile are operating and planning to deploy in the U.S. [(GSM, HSPA (High Speed Packet Access), and LTE)] are also the same as the technologies being exploited by European operators. The TD-LTE (time division duplex) variant of LTE for unpaired spectrum will also play a role in Europe as it will with Sprint/Clearwire in the U.S. along with the more popular FDD (frequency division duplex) version for paired spectrum that Verizon has been deploying.[17] The two continents will become even closer in the future as Verizon and Sprint have now abandoned the alternative technology roadmap of 3GPP2 (originally CDMA) and begun to follow the more globally accepted 3GPP path.

Given the similarities between the U.S. and Europe, the results of digital dividend auctions in Europe are relevant to an evaluation of the potential use of BECs in the U.S. As is evident from Tables 2 and 3, ***spectrum prices with BECs that affect operators' eligibility to bid differentially are not necessarily lower than in auctions without these distinctions***. It is particularly noteworthy that the price paid by Verizon for its Upper C Block license in an auction, with no BECs, was lower than the prices paid for 800 MHz spectrum licenses in the German auction in which operator- and band-specific caps were in effect.

Comparisons of the prices of 800 MHz digital dividend licenses within Europe present a varied picture in terms of outcomes that reflect several factors in addition to BECs that influence and may have a greater impact in some cases than BECs on the prices of spectrum licenses. [18] This varied picture demonstrates that there is no credible basis for the claim that BECs, which differentially limit the bidding eligibility for new spectrum of the largest current holders of spectrum, must lead to lower prices for these licenses than in auctions where there is no distinction made in the bidding eligibility of operators by taking account of their existing

[17] "Hi3G brings TD-LTE to Europe," http://www.telecomasia.net/content/hi3g-brings-td-lte-europe; "NSN Partners with COTA for Spanish TD-LTE Deployment," http://www.telegeography.com/products/commsupdate/articles/2012/10/17/nsn-partners-with-cota-for-spanish-td-lte-deployment

[18] Examples of factors independent of BECs that influence spectrum prices include: (i) The current state of competition and the strengths and weaknesses, i.e., market shares, profits, existing network facilities and coverage, financial capacities, etc., of actual and potential competitors and bidders for new spectrum licenses in the mobile market; (ii) The design of the band plan or plans and structure (by channel bandwidth, duplex mode, geography, etc.) of the spectrum licenses that are on offer; (iii) The perceptions and assumptions of the potential for growth in mobile market revenues which is related to GDP/capita; (iv) The economics and capabilities of the technologies and equipment (both network and customer devices) available for use in the frequencies on offer; and (v) The potential impact of regulations and policies that affect the prospects and economics of competitors and market growth, such as limits on foreign ownership, and coverage, roaming and sharing obligations, associated with spectrum licenses.

frequency holdings. To the contrary, the results of the auctions in Germany and the Netherlands refute the proposition that restrictions on bidding eligibility are bound to lead to low auction revenues.

The outcomes of these European auctions also demonstrate that the use of BECs will not undermine the goal of high or reasonable prices in spectrum auctions as long as (i) there is competitively intense bidding (the number of financially capable bidders exceeds the number of licenses that are being competed for) and/or (ii) reserve prices are set at levels that are based on realistic market valuations and are not burdensome to the bidders so they will be prepared to pay them, even if the number of bidders is no greater than the number of licenses on offer.

Table 2: Digital Dividend Auction Prices in Europe

Country	Date of Auction	Price per MHz-POP, $
Germany	May, 2010	0.95
Sweden	March, 2011	0.536
Spain	July, 2011	0.361
Italy	September, 2011	1.06
Portugal	December, 2011	0.543
France	December, 2011	0.875
Netherlands	December, 2012	0.626
U.S. 700 MHz auction	*March, 2008*	*0.76 (Verizon Upper C Block)*

Source: Regulators' websites and IAE Analysis

The conditions or rules of the European auctions for 800 MHz varied with respect to the imposition of BECs as shown in Table 3.

Table 3: Digital Dividend Auction Conditions in Europe

The seven countries covered can be divided into those in which spectrum caps had no differentiating effects on operators (France, Sweden, Portugal) because they only applied to new spectrum, and those (Germany, Spain, Italy, the Netherlands) in which either spectrum

caps (because they took account of existing as well as new frequency holdings) or set-asides were designed to limit the bidding eligibilities of a subset of operators.[19]

Country	Bidding Eligibility Conditions	Goals of Regulator	Comments
Germany	2x10 MHz cap at 800 MHz for Vodafone and T-Mobile	Coverage of rural areas (800 MHz licensees have to cover rural areas first before urban areas)	Only the four existing operators bid, and one (E-Plus[20]) did not win any 800 MHz licenses; Vodafone and T-Mobile acquired 2 x10 MHz licenses at 800 MHz as well as additional frequencies in high bands; prices paid for paired high band frequencies in this multiband auction were only about 3% to 14% of the prices paid for 800 MHz

[19] Italy, Germany and the Netherlands in the latter group with differentiating BECs recorded the highest, second highest and fourth highest spectrum prices among these seven countries, but Spain the lowest. In the former group in which all operators were on an equal footing with respect to bidding eligibility France achieved the third highest prices while Sweden and Portugal recorded the second and third lowest respectively (these two prices were very close, even though Sweden's GDP/capita is more than 2.5 times larger than Portugal's). The high price paid in France can be ascribed to the circumstance that four operators were competing to acquire enough bandwidth (2x10 MHz) for efficient LTE deployment whereas at most three such 800 MHz licenses were available. The French regulator had required the three incumbents to return some of their 900 MHz spectrum to be used by the entrant Free, and as a consequence did not need to reserve or set aside 800 MHz frequencies to ensure that Free had access to sub 1 GHz spectrum. Moreover as noted in Table 3 above Free's subscribers have access to an 800 MHz network though a national roaming obligation imposed on one of the 800 MHz license holders. The French regulator was clearly sensitive to the importance of access to sub 1 GHz spectrum for all national operators if their ability to be effectively competitive was not to be severely compromised by inadequate spectrum portfolios. The Portuguese price was higher than in Spain, although its GDP per capita is only about two-thirds that of its neighbor, because in Portugal a reserve price was set.

[20] E-Plus does hold a 2x5 MHz block at 900 MHz, as does O2 (owned by Telefonica), which acquired the third 2x10 MHz license at 800 MHz, while both Vodafone and T-Mobile hold 2 x12.4 MHz at 900 MHz.

Sweden	Band-specific cap of 2x10 MHz	Prevent spectrum concentration defined as dominance in both 800 and 900 MHz bands; Generate funds to provide broadband to unserved locations	5 bidders competed and three won licenses – all were incumbents of which there are four, but two (Tele2 and Telenor Sweden) formed a joint venture in 2009 for the deployment of LTE networks which was a winning bidder
Spain	Cap of 2x20 MHz for sub 1 GHz spectrum	Prevent spectrum concentration	Prices paid for paired high band frequencies in this multiband auction were only about 5-15% of the prices paid for 800 MHz
Italy	2x25 MHz cap for sub 1 GHz spectrum	Efficient allocation; Prevent spectrum concentration	Prices paid for paired high band frequencies in this multiband auction were only about 6%-33% of the prices paid for 800 MHz
Portugal	Band-specific 2x10 MHz cap	Increase spectrum available for mobile services; Generate substantial revenues from spectrum licenses	Auction was uncompetitive and significant amounts of spectrum in this multiband auction were unsold[21] although all 800 MHz spectrum was awarded (in three 2x10 MHz licenses) at

[21] In the 450, 900, and 1800 MHz as well as in the 2.1 and 2.6 GHz bands – all lots sold were at their reserve prices.

			the reserve price
France	Band-specific cap of 2x15 MHz for all operators (also separately a 2x5 MHz block at 900 MHz has been refarmed to be transferred to the 4th operator Free[22])	To enable the market entry of a 4th operator which has been tied to refarming existing 900 and 1800 MHz licenses (this goal is not specific to the 800 MHz auction)	4th operator Free failed to acquire any 800 MHz licenses that were won by the three incumbents; Free did win significant spectrum in a 2.6 GHz auction held in September 2011. However one 800 MHz license holder is obliged to provide Free with national roaming once Free's own network coverage reaches 25% of the population
Netherlands	Flexible set asides of two 2x5 MHz blocks at 800 MHz and one 2x5 MHz block at 900 MHz for newcomers; any newcomer was subject to a 2x10 MHz cap combined at 800 and 900 MHz	Enable market entrants to acquire enough low band frequencies for efficient LTE deployment to complement their earlier acquisitions of 2.5 GHz band licenses, so as to strengthen competition in the mobile market	Two existing operators (out of 3) and one newcomer won 800 MHz licenses (2x10 MHz), while 3rd existing operator won 2x15 MHz at 900 MHz including 5 MHz block initially set aside for newcomers once the second newcomer

[22] "900 MHz and 1800 MHz band refarming case study France 30 November 2011," http://www.gsma.com/spectrum/wp-content/uploads/2012/04/refarmingcasestudyfrance20111130.pdf - 2x5 MHz available to Free in all areas except high density areas from 13 July 2011; and in high density areas from 1st January 2013. In the 2.6 GHz auction of 2x70 MHz in September 2011 a band cap of 2 x30 MHz for all operators was imposed in the auction of a total of 140 MHz.

			bidder dropped out of the auction[23]
U.S. 700 MHz auction	*None*	*Make more sub 1 GHz spectrum available for mobile broadband service*	*Since the auction Verizon has expanded its 700 MHz Upper C block licenses to cover all areas except the Gulf of Mexico and islands[24].*

Source: Regulators' websites and IAE analysis

The total bandwidth available in the European or ITU Region 1 800 MHz band plan allows only a maximum of three operators to obtain licenses of at least 2X10 MHz for efficient LTE deployment. The effect of the operator and band-specific spectrum caps imposed in Germany at 800 MHz was to leave the two operators with the least amount of sub-1 GHz (900 MHz band) spectrum [(O2 and E-Plus (owned by the Dutch incumbent KPN)] competing for one license for which T-Mobile (the mobile arm of Deutsche Telekom) and Vodafone were ineligible. T-Mobile and Vodafone, in turn, were not excluded from the 800 MHz band, but they were limited in how much spectrum they could acquire. Each acquired 2x10 MHz licenses in this band.

The most recently completed auction in the Netherlands, which included set asides in the highly valued sub-1 GHz spectrum, generated substantially larger revenues for the Government than expected.[25]

Additional Insights from Europe

Other relevant evidence for consideration in the context of future 600 MHz band auctions can be found in research reports commissioned by European regulators. For example, the Irish regulator has commissioned benchmarking exercises to set reserve prices for both low and high

[23] The Dutch regulator introduced flexibility into the set asides by allowing one or more, and even all of them, to be included in the pool of licenses for which all bidders were eligible, if there were no or insufficient bids in the auction from operators for whom these licenses were initially reserved.

[24] Verizon also plans to sell all its Lower 700 MHz band licenses by auction (some have already been divested in secondary market transactions). In December 2012 Verizon applied for assignment of the 700 MHz Upper C Block license for the Gulf of Mexico from Small Ventures USA, LP to CELLCO PARTNERSHIP d/b/a VERIZON WIRELESS further reinforcing its sole control of Band Class 13.

[25] "Dutch 4G frequency auction raises more than expected," http://www.reuters.com/article/2012/12/14/dutch-telco-auction-idUSL5E8NED2H20121214

frequency bands in future auctions. The most recent recommendations for reserve prices in future spectrum auctions in Ireland fell in the ranges of[26]:

- $0.433-0.751 per MHz-POP for 800 MHz
- $0.195-0.451 per MHz-POP for 1800 MHz

The Irish regulator, the Commission for Communications Regulation (ComReg), has since decided to set reserve prices of $0.577 per MHz-POP for 800 MHz licenses and half that ($0.289) for licenses in the 1800 MHz band. The introduction of these prices illustrates current expectations of the relative and absolute values of sub-1 GHz and high band frequencies to operators.

The Ministry for Economic Affairs in the Netherlands commissioned a study prior to its multi-band auction on the comparability of frequency bands in different business models.[27] This study concluded, among other findings, that:

"In today's market, access to sub-1 GHz spectrum may be essential to the success of a mobile telecommunications service provider with a nationwide mass-market ambition. Lack of access to sub-1 GHz spectrum will result in a material competitive disadvantage to a mobile operator with national mass market ambitions. It is most unlikely to be cost effective to roll out a national network with supra 1GHz spectrum in contrast with operators that have access to sub-1 GHz. This is one of the main reasons that new entrants operating at 2100 MHz today are typically compelled to enter into roaming agreements to achieve national coverage rather than embark on national build out programmes."

On this basis, the rules adopted for the recently completed (December 14th 2012) multi-band auction by the Netherlands regulator included a set-aside of lower band spectrum for newcomers: "*Low frequencies are much scarcer than high frequencies. The quantity of the frequency spectrum in relation to the low spectrum is limited to such a degree and newcomers are so behind with regard to existing players that it cannot be excluded that the existing players may obtain all available low frequencies if threshold lowering measures are not implemented. It is important that sufficient players have access to low frequencies to also retain the effective competition goal in the long term. It has, therefore, been determined in the*

[26] DotEcon Ltd., "Award of 800MHz, 900MHz and 1800MHz – Fifth Benchmarking Report, A report for ComReg." http://www.comreg.ie/_fileupload/publications/ComReg1223.pdf

[27] "Study on comparability of frequency bands in different business models," PA Consulting, London, 2010.

strategic policy documents that 2 x 10 MHz in the frequency spectrum in the 800 MHz band shall be reserved for newcomers in the auction.
"In consultation with the Dutch House of Representatives, it has, subsequently, been determined that this reservation in itself is insufficient to achieve the goals. It has, therefore, been decided to also reserve 2 x 5 MHz in the frequency spectrum in the 900 MHz band for newcomers.[28]"

The British regulator, Ofcom, likewise recently announced that it would impose the following spectrum caps in its forthcoming auctions in 2013 of 800 MHz and 2.6 GHz frequencies:

- A cap of 2 x 27.5 MHz in sub-1 GHz spectrum, and
- An overall spectrum cap of 2 x 105 MHz

Ofcom states that it considers these particular caps to be the minimum necessary to avoid asymmetric distributions of spectrum, **taking account of existing spectrum holdings** *(emphasis added)*[29].

This is an impressive body of findings about policies and regulations related to spectrum portfolios and issues of spectrum concentration or aggregation that have been introduced after thorough investigations and consultations by regulators in which operators, among other stakeholders, have had ample opportunities to express their opinions and present their findings, along with data from actual outcomes of recent European spectrum auctions. Together they demonstrate the significant competitive impact of both the sizes and the compositions (in terms of low and high bands) of operators' spectrum portfolios, and the different values that European providers and regulators place on spectrum above and below 1 GHz. This evidence supports the conclusion that, in order to sustain competition in mobile broadband markets, it is essential to prevent highly asymmetric spectrum holdings both overall and within sub-1 GHz spectrum.

[28] http://www.agentschaptelecom.nl/binaries/content/assets/agentschaptelecom/Mobiele-communicatie/multibandveiling/courtesy-translation-auction-rules
[29] "Statement on the making of regulations in connection with the award of the 800 MHz and 2.6 GHz spectrum bands," Ofcom, http://stakeholders.ofcom.org.uk/binaries/consultations/regs-800mhz/statement/statement.pdf

Evidence from Other Continents

Continents other than North America and Europe provide further evidence of the role and impact of BECs on the outcomes of, and revenues generated by, spectrum auctions. Japan is one example of the particular and critical competitive value operators attribute to sub-1 GHz frequencies, and their priority for gaining access to them, if their spectrum portfolio only includes high bands. The 700 MHz and 900 MHz bands are known collectively as the "Platinum Band" in Japan, which indicates how they are viewed by Japanese operators. The relative mobile newcomer, SoftBank, now the #3 operator after NTT DoCoMo and KDDI (which operates the au brand), but poised to become #2 overtaking KDDI following its acquisition of the # 4 operator eAccess, lobbied to obtain 900 MHz spectrum in order to be competitive with its rivals which held sub-1 GHz spectrum, and to improve its network coverage in response to complaints from customers.

SoftBank's position with respect to the value of the Platinum Band was presented in a press conference by the Chairman Masayoshi Son, given on March 1st, 2012 in which he identified this operator's lack of frequencies in this range until its allocation in Q1 2012 as its "greatest weakness."[30] Since then, in June 2012 NTT DoCoMo, KDDI and eAccess have been awarded spectrum in the 700 MHz band, while in early October SoftBank's acquisition of eAccess was announced.

In Australia, the Department of Broadband Communications and the Digital Economy commissioned studies on the valuation of public mobile spectrum at 825-845 MHz and 870-890 MHz and the 1800 MHz bands.[31] The context for these studies was the reissue of spectrum licenses in these two bands. They will be reissued upon their expiry in 2013, either through renewal at an administratively determined price, or through price-based reallocation, e.g., auction. The aim of the studies was to value licenses for the purposes of setting government expectations with regard to license reissue prices. If current licensees fail to meet the government's price expectations, the spectrum will be auctioned; therefore the value of spectrum yielded by an auction sets a lower bound on value. It was stated that current licensees should be prepared to pay a premium for license reissue because this removes the costs and uncertainty of engaging in an auction.

The spectrum licenses in Australia involved are currently used to provide public mobile services (voice and data). It is assumed that the licenses will continue to be used for these applications

[30] http://www.softbankmobile.co.jp/en/news/info/2012/20120301_01/

[31] http://www.dbcde.gov.au/__data/assets/pdf_file/0013/144220/Plum-Consulting-Valuation-of-public-mobile-spectrum-at-825-845-MHz-and-870-890-MHz.pdf; http://www.dbcde.gov.au/__data/assets/pdf_file/0015/144222/Plum-Consulting-Valuation-of-public-mobile-spectrum-at-1710-1785-MHz-and-1805-1880-MHz.pdf

over the next license period of 15 years as these bands are used internationally for these applications[32]. The studies included: (i) A review of international evidence on the value of spectrum licenses in the same or similar frequency bands as revealed in auctions and license renewal processes elsewhere; and (ii) Modeling of values based on the projected revenues and costs of a hypothetical operator. The valuations produced in these studies are shown in Table 4, taken from the two studies by Plum Consulting (U.K.) cited in footnote 32.

Table 4: Valuations of 800 MHz and 1800 MHz Licenses in Australia

Frequency Band	International Benchmarking Valuation, $ per MHz-POP	Modeling: Cost Reduction Valuation, $ per MHz-POP	Modeling: Full Enterprise Valuation, $ per MHz-POP
850 MHz	0.53-1.26	1.02	3.36
1800 MHz	0.24	0.16	0.49

Source: Plum Consulting

The cost reduction valuation for the 850 MHz band includes benefits from the ability to provide more cost effective in-building coverage in urban and suburban areas. The analyses in these two studies are further confirmation of the substantially higher value that mobile operators place on sub-1 GHz spectrum as they strive to acquire more bandwidth within which to deploy mobile broadband networks that can meet rapidly rising demands for capacity.

History and Status of Sub-1 GHz Spectrum in the U.S.

The current sub-1 GHz frequencies usable for mobile broadband services in the U.S. include the cellular band (850 MHz), part of the 700 MHz band, and the SMR (Specialized Mobile Radio) frequencies at 800 MHz held by Sprint Nextel. The 850 and 700 MHz bands are both dominated by AT&T and Verizon. Much of their holdings in the former band are inherited legacies of frequencies initially awarded at no cost to their direct predecessors (the Regional Bell Operating Companies (RBOCs)) and now being re-farmed for modern mobile broadband systems, a process that has already started with the deployment of HSPA systems in this band. [33] Their competitors, who had to acquire all of their spectrum holdings at often significant expense, do not enjoy this inherited advantage.

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[32] The low band known as 800 MHz in Australia almost completely overlaps with the 850 MHz cellular band in the U.S. and many other countries in the Americas, while the 1800 MHz band is commonly used initially for 2G networks and now beginning with LTE in Europe and Asia.

[33] AT&T recently announced that it will shut down its 2G systems completely by 2017. "AT&T plans to shut down entire 2G network by 2017," http://www.engadget.com/2012/08/03/att-plans-to-shut-down-entire-2g-network-by-2017/

The dominant positions of AT&T and Verizon in the 700 MHz band are the outcome of the 700 MHz FCC Auction 73 held in 2008, and subsequent secondary market transactions.

Both Verizon[34] and AT&T[35] have argued in FCC Docket 12-269 that all frequencies or bands should be treated equally in spectrum screens. They claim that there is no reason to distinguish sub-1 GHz spectrum for special treatment since, according to AT&T, every MHz has the same capacity independently of its band, and operators without sub-1 GHz spectrum will prefer to acquire spectrum in or near to the bands they already occupy (ideally contiguous to their existing frequencies). According to Verizon, higher frequencies have advantages in greater capacity (since more bandwidth is available in higher frequency bands) that offset the advantages of lower frequencies, such as greater propagation range and superior indoor penetration. Hence low and high frequencies are, and should be, regarded as equally valuable and not distinguished from each other.

These arguments are not supported by the experience in other countries and by the valuations in the U.S., including license acquisitions by Verizon and AT&T themselves. Evidence from the auctions in North America and overseas referred to earlier, demonstrates and proves that operators with no or very little spectrum below 1 GHz are willing to bid much higher prices for sub-1 GHz spectrum, when it becomes available, than they are for higher frequencies closer to their existing portfolio of spectrum. Furthermore, the capacity per MHz available at a location is significantly dependent in the real world of cellular networks upon its frequency band. The capacity of one MHz at a location within a cell is dependent, among other factors, on the path loss from the transmitter, which is frequency dependent both outdoors and even more significantly if the signal has to penetrate indoors.

Evidence from other countries also confirms that while both low and high frequencies are valuable, they are also both essential, and non-substitutable for each other. Verizon's FCC filing acknowledges that operators often seek a mix of both high and low band spectrum to meet the widely varying topographies and population densities that characterize the U.S.[36] The same observation is true for all other countries, except perhaps for urban-only city states, where the value of the low frequencies' longer propagation range is much less relevant. It is precisely this observation about the most useful spectrum portfolio, comprising a mix of high and low band frequencies, that is the nub of the justification for considering sub-1 GHz spectrum holdings separately from total spectrum holdings as a potential source of inescapable severe erosion of robust and publicly beneficial competition.

[34] ibid. "Comments of Verizon Wireless."
[35] "Comments of AT&T Inc." http://apps.fcc.gov/ecfs/document/view?id=7022068061

As demonstrated above, this conclusion has been reached in several countries across the world with varied demographics and geographies, and steps have been taken to avoid excessive concentration of sub-1 GHz spectrum in the hands of one or two operators. Such concentration is a commonly encountered situation as a legacy from the early days of cellular telephony when typically two operators were awarded spectrum in the 850 or 900 MHz bands, while later market entrants could only acquire spectrum in bands around 2 GHz. However, several countries are correcting the imbalances caused by early spectrum giveaways. In the Netherlands, Ireland, and Australia, the expiration of original cellular licenses in sub-1 GHz spectrum has been, or is envisaged as being used, in combination with the award of licenses in the digital dividend band, to achieve a more balanced distribution of sub-1 GHz spectrum licenses than exists prior to the award of digital dividend licenses. The re-auctioning, or renewal of cellular band licenses (900 or 850 MHz), is also designed to generate revenue for the public Treasury that their renewal at no cost, as is the U.S. practice, does not provide.[37] Spectrum licenses for mobile services are generally awarded for finite periods (ten to twenty years) not in perpetuity.

Since there is significantly less bandwidth available below than above 1 GHz[38], the risks and consequences of spectrum concentration are greater in the sub-1 GHz range than they are in high frequency bands, as was explained in the multi-band auction rules in the Netherlands discussed above. The advent of the "digital dividend" band is enabling regulators in other countries, such as Germany, the Netherlands, and Japan, among others, to redress imbalances arising from the legacy assignments of sub-1 GHz frequencies. Although used originally for narrowband mobile networks, these low band frequencies are now being exploited to deploy mobile broadband networks.

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[37] Renewal, and possible re-assignment, of existing licenses raises concerns about continuity of service and the fate of substantial investments made in networks deployed in the frequencies involved. These concerns were specifically addressed in the rules for the multi-band auction in the Netherlands. Consequently, there was only a limited set aside at 900 MHz for newcomers in the realistic expectation that was borne out in the event that the current 900 MHz license holders would be best placed to, and would acquire, the majority of licenses in the 900 MHz band that were not reserved, which they would be re-farming for broadband during the life of the new licenses, see p.40 of auction rules at: http://www.agentschaptelecom.nl/binaries/content/assets/agentschaptelecom/Mobiele-communicatie/multibandveiling/courtesy-translation-auction-rules).

[38] Currently in the U.S., around 106 MHz of paired bandwidth below 1 GHz is allocated to mobile networks, with perhaps another 60 to 100 MHz to come in the 600 MHz band, compared to about 220 MHz of paired bandwidth already available near and above 2 GHz (in the PCS and AWS bands), and about 190 MHz in the 2.5 GHz band (as unpaired spectrum) with more paired bandwidth (about 70 MHz) becoming available in the AWS-4 (DISH Network) and 2.3 GHz (for AT&T) bands, as well as the PCS H block (10 MHz to be auctioned).

To date, the U.S. has not assigned the sub-1 GHz frequencies that have become available in recent years in a manner that would achieve this desirable outcome. In the future, allowing AT&T and Verizon equal or unrestricted access to new spectrum as it becomes available, especially in the highly coveted frequencies below 1 GHz, will possibly dissuade other potential bidders from participating in the auction of the spectrum licenses on offer, just as Wind Mobile has indicated it may refrain from bidding on 700 MHz spectrum licenses in Canada. The consequence would be that the competitive intensity for acquiring new spectrum might be limited, possibly even ***reducing*** auction revenues.

Conclusions & Findings

This report has produced data and relevant evidence based on past spectrum auctions to support the following two core conclusions and findings:

1. Spectrum below 1 GHz is substantially more valuable than spectrum above 1 GHz for national mobile broadband deployments due to its propagation characteristics and relative scarcity of bandwidth compared to high bands, and therefore it is appropriate for competition policy reasons to have a cap on sub-1 GHz spectrum.

2. Introducing well-designed bidding eligibility restrictions into auctions will not adversely affect the revenues they generate.

Multiple spectrum auctions have been held where countries adopted bidding eligibility conditions that differentially affect existing and potential operators and bidders in order to sustain downstream competition. Their purpose was to prevent the accumulation of spectrum portfolios by one or two operators that would be much larger than those of their competitors, and therefore have a significant anti-competitive effect to the detriment of customer/consumer welfare.

The results of these auctions provide evidence that:

- The imposition of carefully crafted BECs does not lead to unreasonably low auction revenues.
- The absence of BECs, i.e., complete freedom for the largest operators with the highest market shares to bid for all new spectrum that becomes available, can result in lower than desired auction revenues because non-dominant and prospective competitors are discouraged from bidding against the deep-pocketed incumbents.

- In order for BECs to enable effective competition for spectrum licenses, they and the other conditions of the auction, should be constructed in light of the specific market and competitive environments in which the auction takes place in order to ensure that more than one financially and operationally capable bidder will be motivated to compete for each license on offer.
- The use of BECs will not undermine goals with regard to the level of spectrum auction revenues as long as (i) there is competitively intense bidding (the number of financially capable bidders exceeds the number of licenses that are being competed for) and/or (ii) reserve prices are set at levels that are based on realistic market valuations and are not burdensome to the bidders so they will be met, even if the number of bidders is no greater than the number of licenses on offer.
- Only the application of well-crafted BECs can protect and sustain downstream competition in circumstances in which existing sub-1 GHz spectrum is heavily concentrated in the hands of one or two operators, and in the absence of BECs these operators would be able to acquire all or predominant amounts of any new sub-1 GHz spectrum that becomes available.

Several regulators in the countries reviewed in this report have concluded after extensive analyses and consultations that highly asymmetric spectrum holdings below 1 GHz, such as the asymmetries in operators' spectrum portfolios in these low bands that now exist in the U.S., are as harmful to the effectiveness of competition in the mobile broadband market as are asymmetries in total spectrum holdings across all the bands involved. It is therefore critical for the FCC to take steps to rectify or preempt the continuation of an imbalanced distribution or assignment of sub-1 GHz frequencies in the U.S.

The situation in which the two largest U.S. mobile operators, Verizon and AT&T, currently hold the vast majority of sub-1 GHz frequencies constitutes an invaluable competitive advantage for them that the FCC should consider in setting the rules for future auctions.

The formulation of BECs for future auctions in the U.S. - including the planned auction of repurposed broadcast spectrum at 600 MHz - should depend on the specific circumstances under which they take place, including for example the total amounts and structure of the spectrum that will be made available. Among other issues, the FCC should consider whether to impose eligibility restrictions on some or all the spectrum to be auctioned. For example, in order to facilitate the ability of other carriers, who today hold no or very little sub-1 GHz spectrum, the FCC should consider the use of set asides or a sub-1 GHz spectrum cap. If the amount of 600 MHz spectrum made available substantially exceeds some agreed threshold, then it may be reasonable to allow those with existing substantial holding below 1 GHz to

compete for some spectrum licenses at these frequencies[39], just as the largest sub-1 GHz spectrum holders have not been entirely excluded from bidding for digital dividend band licenses in other countries cited in this report. If the quantity of new sub-1 GHz spectrum becomes abundant in comparison to the number of unrestricted bidders, reducing or removing BECs on the holders of the largest amounts of sub-1 GHz spectrum can also be a safeguard against inadequate competition for new licenses.

Two key assertions made by Verizon in its recent filing with the FCC[40] are that:

- Band-specific limits, e.g., sub-1 GHz, will inevitably lead to lower prices being paid at auctions, and
- A single, comprehensive spectrum screen is sufficient to capture any competitive concerns.

Verizon also claims that any band-specific limits would raise regulatory parity, and associated equity considerations, if some operators were permitted to acquire spectrum available in the market, while others were prohibited simply because of their current holdings in the band.

The evidence from actual auctions presented in this report refutes both of these assertions by Verizon. As for the first assertion, there are many reasons to expect that there will be strong competition for 600 MHz spectrum licenses even if the FCC imposes eligibility restrictions in the auction. Other players in the U.S. market who do not have any or only very limited sub-1 GHz licenses can be expected to bid aggressively, like their counterparts in other countries.

In addition to U.S.-based bidders, foreign investors may also be attracted to bid for new U.S. spectrum licenses, in partnerships with U.S. players. SoftBank is far from being the only foreign operator that is today showing, or has shown in the past, a strong interest in participating in the U. S. mobile market. It is plausible that the interest of these foreign players would be heightened if it becomes evident to them that they will not have to face the two largest U.S. players in competing for all the licenses on offer. Mexico-based America Movil is already present in the U.S. through the largest MVNO, TracFone, with almost 19 million subscribers, as well as with its property Claro in Puerto Rico, while SK Telecom, the largest Korean mobile operator, as well as the Japanese incumbent, NTT DoCoMo, have invested in the U.S. in the past, albeit unsuccessfully. Hence there should be no shortage of bidders for new, valuable sub-

[39] This example is only meant to be illustrative of the kind of consideration to be borne in mind when eventually crafting BECs, and should not be interpreted as a recommendation.
[40] Ibid. "Comments of Verizon Wireless."

1 GHz licenses offered in the U.S. if the two largest operators are restricted from bidding for some of them.

As for the second assertion, which amounts to arguing that all spectrum is created equal, the evidence provided in this report supports the opposing finding, namely that highly asymmetric spectrum portfolios in the sub-1 GHz range in the mobile broadband era will lead to a substantial erosion of downstream or market competition. Regulators with the responsibility of sustaining market competition are therefore fully justified in taking steps, such as the imposition of bidding eligibility conditions in spectrum auctions, in order to avoid this outcome and to redress existing substantial imbalances in operators' sub-1 GHz spectrum portfolios.

Research Team

Alan Pearce, Ph.D.

Dr. Pearce founded Information Age Economics, a Washington, DC research company, in 1979 after a senior-level public policy career at the Federal Communications Commission, the US Congress, and the Executive Office of the President. At the FCC he was one of the prime architects that helped lay the foundation of a new information era. During a five-year tenure in the Office of the Chairman, Pearce helped oversee the investigation of AT&T and Western Electric, et al., which eventually led to the breakup of the Bell System in 1984; the early policies that encouraged the convergence of computers and communications; the launching of domestic satellites to provide telecommunications-information-entertainment services; the beginning of public policies encouraging the development of cable TV; investigations into the business and profits of children's TV programming, and business relationships between the Hollywood movie and program production industry and the TV networks; the economic effects, if any, of the sports anti-blackout legislation on professional football basketball, baseball, and ice hockey; and wireless and spectrum policies that resulted in the creation of universally available services at affordable prices.

Since leaving the government, Dr. Pearce has provided professional services to telecommunications, wireless, satellite, cable TV, movie and program production companies, and radio and TV broadcasting corporations, along with software and equipment manufacturers. He has also consulted with a wide variety of government organizations at the international, federal, state, and local levels. A prolific writer and researcher, he has also lectured on privatizations and appropriate regulatory structures, spectrum auctions, antitrust issues and actions, mergers and acquisitions, appraisals and valuations franchises and service rates throughout the world.

Prior to coming to the United States, Dr. Pearce was both an undergraduate and graduate student at The London School of Economics, leaving with bachelors and masters degrees, and has a doctorate in business and telecommunications from Indiana University.

Martyn Roetter, D.Phil.

Dr. Roetter is a former Vice President at Arthur D. Little Inc., and has over 30 years of global consulting experience at a number of U.S. and Europe-based firms, as well as his own sole proprietorship, with business strategy, technology-related issues, and public policy. He has frequently dealt with the interactions between business, technology, and finance, as well as regulation, politics, and public policy. He has carried out strategy assessment and implementation work as well as project due diligence for network operators, service providers, components and equipment vendors, and their investors. His clients and their target geographies have ranged extensively across the Americas, Europe, Asia, and the Middle East and Africa. Most recently he has been concentrating on the economics, markets, and business plans of wireless communications operators, including techno-economic comparisons of new broadband wireless technologies such as WiMAX, HSPA, EV-DO, and LTE, as well as, in the broader arena

of ICT, next generation Web services and the implications of all-IP networks for fixed/mobile competition and convergence and related regulatory issues. He has tackled a number of projects involving competitive and other business dynamics that reflect the changing shape of globalization, i.e. the “globalization of globalization”, in which the traditional economic powerhouses of North America, Western Europe, and Japan have been joined by major actors such as China, India, and Brazil, as well as financial investors from the Middle East.

He served as a non-executive member on the Board of Directors of Allen Telecom (leading global supplier of wireless subsystems) from 1998 until its acquisition by Andrew Corp. in 2003. He was educated in England, Germany, and the U.S., and holds a doctorate in physics from the University of Oxford. A U.S. citizen, he speaks English, French and German.