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Spectrum – All Options Essential, Including Incentive Auctions

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In recent months, various articles have advanced the idea that there is no spectrum crisis. The articles assert that if operators invested more in their networks, that they wouldn't need more spectrum. This argument appeals because it is true that greater investment in infrastructure can increase network capacity. However, this overly simplistic analysis does not take into account the cost of this additional infrastructure, nor does it properly consider the maturity of the technology to achieve significantly greater network densification.

From an engineering point of view, it is not difficult to show that we are extremely spectrum constrained, and that the situation will only get worse. Technically speaking, there are three ways of looking at this.

First, consider that wireless networks have extremely low data capacity to begin with. This is not because operators have made poor choices in technology; rather radio spectrum simply cannot carry that much data compared to wireline alternatives like fiber-optic cable. Even if you had all the spectrum up to 100 GHz (which would actually be 200 times the current cellular allocation), and combined that with an extremely aggressive modulation scheme that yielded 10 bps/Hz (which is about 7 times higher than can be achieved with LTE today), the aggregate capacity of 1 terabit per second would be less than 10% of what can be achieved in a single fiber optic cable. This is the reality of the physics. Translating this finite capacity to actual deployments means that a dozen YouTube viewers in the same city block can swamp the capacity of a modern LTE network that has aggregate downlink capacity in a sector of about 14 Mbps. And that's exactly the type of activity in which users are engaging.

Second, one can do a top-down analysis, exactly as the FCC has done, to quantify the need for more spectrum and the spectrum shortfall we will experience. This model looks at the amount of spectrum in use then scales it for improvements in technology, more cell sites, and increasing data demand. The FCC has stated all of its assumptions and methodologies in their October 2010 report "Mobile Broadband: The Benefits Of Additional Spectrum." See page 17. If critics contend there is not a spectrum issue, why don't they analyze the FCC model and point out the engineering flaws? For some reason, they haven't.

Third, a bottom-up analysis that looks at the capacity of a cell site, anticipates the number of active subscribers in the coverage area and the data they are consuming, considers the spectral

efficiency of the wireless network, and can then calculate the amount of required spectrum. I have such a model, and it clearly shows that the amount of needed spectrum will exceed what is available within a few years. I first published details of the model in 2010 in a report titled "Mobile Broadband Capacity Constraints And the Need for Optimization." See http://www.rysavy.com/Articles/2010_02_Rysavy_Mobile_Broadband_Capacity_Constraints.pdf. Details of this model are also covered in this report that I developed for Rogers Communications and submitted to the Canadian Government in 2011, "Operator Spectrum Requirements for Mobile Broadband," http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/smse-018-10-rysavy-submission.pdf/$FILE/smse-018-10-rysavy-submission.pdf.

Both the FCC and Rysavy models predict steadily increasing data capacity relative to the amount of spectrum employed. In other words, both models anticipate that through continued investment in infrastructure and technology (items such as smart antennas and small cells), networks will keep extracting more capacity from the same amount of spectrum. But both models also predict that this investment alone will not be enough, that in addition to better efficiency more spectrum will be required.

Therefore, it is poor science to suggest that investing more in infrastructure or deploying better technology will solve the problem, since the industry is already investing massive sums in infrastructure. The investment argument is a bit like saying that we could solve all of our traffic congestion problems by adding numerous extra lanes to each freeway. Sure, with enough hundreds of billions of extra dollars you could do that. Similarly, if you put in Wi-Fi everywhere, or many hundreds of thousands of small cells (ignoring for the moment that we don't have the backhaul technology to hook all these up), you could vastly increase wireless network capacity. But the investment cost would now be so high that nobody would be able to afford the resulting service costs.

Another factor is service pricing. Operators can in fact control demand with pricing, and to some extent current pricing tiers do make users more careful about how they consume their data allocations. But this is not an answer. In a recent poll I did with Information Week, fully 50% of IT professionals who responded indicated that mobile-broadband pricing was too high and needed to go down to support their applications. So operators are feeling the pressure to reduce pricing, which will only make demand go up even higher. As it is, demand has consistently increased by 100% per year.

One can finally look at what is happening in the market. If operators didn't really need more spectrum, why then are they going to such extraordinary lengths to obtain additional pieces of spectrum to augment network capacity?

All of the actual data clearly shows the need for additional spectrum. Not spectrum by itself, but additional spectrum combined with huge investments in denser networks, smart antennas, small cells, carrier aggregation, offload, creative service plans, and even ultimately spectrum sharing once we know how to actually do that.

Given the long timelines involved for making certain spectrum options a reality, such as spectrum sharing, it is essential to maintain momentum for already-established pathways to getting more spectrum into the hands of the companies that use it and need it, such as repurposing broadcast spectrum via incentive auctions, acting expeditiously on secondary market transaction, creating AWS-3 in a timely fashion by adding 1755 to 1780 MHz and taking affirmative steps to exploring other spectrum bands not already identified for wireless broadband use. Even with these efforts there will be a serious shortfall so time is of the essence.

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