Increasing Spectrum Piecemeal with LTE

By Keith Mallinson Tuesday, July 31, 2012

Wireless carriers need to exploit a wide and fragmented array of new spectrum possibilities, but this presents major challenges to them and their equipment manufacturers. Frequencies are scarce; with only limited prospects for more this decade, while demand for them increases massively as mobile broadband grows rapidly.

Not So Simple Any More

For the first couple of decades cellular was straightforward using just a few bands of mostly pristine spectrum. North America had 800MHz and 1900MHz for analog, 2G and 3G. Europe had 900MHz and 1800MHz for 2G and 2100MHz for 3G. Transatlantic roaming with 2G and 3G was dealt with by adding an extra band or two to the regional combos.

Matters have become more complex and difficult since the mid 2000s with the urgent need to supplement the above with a variety of other bands and a selection of improved radio technologies. For example, T-Mobile USA hurried to deploy UMTS technologies in 1700MHz AWS spectrum in 2008 because it had insufficient frequencies to overlay 2G with 3G in the 1900MHz band. However, most other U.S. carriers have deployed or earmarked their AWS spectrum for LTE. T-Mobile is belatedly following suit with a banding strategy reversal to align itself with other U.S. carriers by moving UMTS to 1900MHz and deploying LTE in AWS 1700MHz. Carriers are also using the 700MHz spectrum for LTE. And it's all different in Europe, and different again elsewhere.

No Room Left at the Inn

Starting in the 1980s, cellular was a latecomer to the spectrum land grab -- a long way behind broadcasters, the military, aviation, nautical and even many satellite users. With very little prime spectrum left -- below around 2.5GHz that provides the best propagation --the cellular industry is in the arduous position of needing other users to become much more spectrum-efficient and relinquish much of their holdings. For example, despite demand for many more TV channels—increasingly in HD—exponential growth in mobile broadband requires that mobile operators obtain access to additional spectrum including some from broadcasting and other frequency bands. The digital dividend in the FCC's 2008 Auction 73 of the 700MHz band is an example of this. The FCC's proposed incentive auctions are a useful way of financially encouraging other incumbent spectrum holders to decamp so wireless carriers, who put a higher economic value on spectrum than existing licensees, can pay a market price adopt it.

If mobile broadband growth is to continue at current triple-digit percentage rates annually, there will need to be at least the doubling of current spectrum allocation promised in the U.S. and in other nations. The National Broadband Plan sets goals for the U.S. to free up an additional 500MHz within 10 years and 300 MHz within 5 years. This includes recycling spectrum from previous allocations, such as satellite and entirely new allocations that are typically in the higher frequency bands above 2.5GHz. Even all that will fall short of satisfying the world's leader in LTE, smartphones and tablet usage. Mobile broadband network traffic is already dwarfing voice with a 30-fold increase over five years. Network capacity growth must increase at a corresponding rate. Improving radio technology,

increasing cell site density (including small cells and WiFi offload) together with substantial amounts of additional spectrum are the three compounding supply factors that must all contribute to the required increase.

Managing Complexity and Coping with Interference

Maximizing spectrum use for cellular requires an increasingly diverse set of frequency bands. The 700MHz band has even had to be subdivided into different band classes so that high-performance RF devices can be produced. That is why Verizon's LTE devices are incompatible with AT&T's. On a global basis, there will be 20 or more different bands for LTE within the next year. This number will quite likely double over the years.

This fragmentation creates significant challenges for the manufacturers of RF front-end electronics and device manufacturers in general. It is difficult, requires engineering compromises that can result in performance degradation and costly to support multiple radio protocols and bands in the same device. On the other hand, innovators are trying to cram more and more of these in so that the same devices can be sold and used as widely as possible, including roaming. Having fewer device platforms and product SKUs can reduce costs through economies of scale in manufacture and distribution. For example, Antenova has released a switch-less wideband LTE antenna reference design for smartphones. According to the firm, its antenna covers all the LTE bands without the use of switches or tuneable active components: LTE 700, GSM850, GSM900, DCS1800, PCS1900, WCDMA2100, LTE B7 (2.5-2.69GHz), LTE B38 (2.57-2.62GHz), and LTE B40 (2.3-2.4GHz).

And with the easy pickings already taken, candidate spectrum bands for new cellular allocations are increasingly impaired with risks of or known interference problems. LightSquared obtained a waiver to refarm satellite spectrum for terrestrial use with LTE, but this was revoked when interference with GPS receivers was identified. Lower A Block 700MHz spectrum sold for less than half the price of the, higher-frequency, adjacent Lower B Block due to expected interference from the former's neighboring band on the other, lower-frequency, side which is used for digital TV broadcasting with much higher transmission power than cellular. Network planning, technological innovation with improved filtering, wider guard bands and other measures help mitigate these kinds of interference problems. However, this still means that significant amounts of spectrum cannot be fully employed -- anywhere near high-power transmitters, in particular.

We'll Take What We Can Get

The cellular industry needs all the spectrum it can obtain. The introduction of TD-LTE means that the cellular carriers pursuing 3GPP standards will also be able to use large swathes of unpaired licensed spectrum. In addition to the good and not-so-good licensed spectrum, wireless carriers will increasingly be dependent on unlicensed spectrum to maximize capacity. Carriers already significantly offload to WiFi – for example, home WiFi and its public hotspots were a Godsend to AT&T with the severe demands on it while it was the exclusive carrier for the iPhone prior to its LTE service launch. At a recent 3GPP workshop on proposals for LTE in its Release 12 standard, integrating unlicensed spectrum including radio carrier aggregation with paired and unpaired licensed spectrum was one of the proposed work items. I described this among many other initiatives in a White Paper I recently published for 3GPP on its web site.

Nobody is making any new spectrum, but innovative technologists will continue to help squeeze more network capacity out of the scarce and disparate amount available.

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