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Rysavy: Spectrum sharing with LTE is conceivable but not trivial

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INDUSTRYVOICES

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It sounds so appealing. You have a valuable resource but you don't need it all the time. Why not let somebody else use it when you're not using it? The resource in this case is spectrum, and the primary user for the bands under consideration is the government. This is the approach recommended by the President's Committee of Advisors on Science and Technology (PCAST) in its July report "Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth," which advocates spectrum sharing as the primary means of managing spectrum moving forward.

This approach, however, is extremely complicated other than in simple use cases. I explained this in a July report, "Spectrum Sharing - The Promise and the Reality." What I'd like to illustrate here is just how spectrum sharing might work in a hypothetical scenario with Long Term Evolution (LTE) technology, and some of the issues involved. LTE could actually operate in spectrum-sharing scenarios, even though it was never designed to do this.

LTE has been designed to operate in high-interference environments. The technology divides wide radio channels of 5 MHz or 10 MHz into tiny subcarriers of 15 kHz for actual transmission with the ability to selectively use just a subset of subcarriers at particular times. This makes it fundamentally different from previous CDMA technologies such as CDMA2000 and HSPA that employ wide radio channels of 1.25 MHz in the case of CDMA2000 and 5 MHz in HSPA. This use of subcarriers enables LTE to avoid frequencies on which there may be excessive interference. This core feature of LTE may enable the technology to support spectrum sharing, but don't get too excited that we have identified the silver bullet to the looming spectrum shortage. There are many caveats.

One of the approaches for spectrum sharing being investigated is for some government system to keep operating as is, and for the commercial system to use the same frequencies but simply

cope with the interference. This differs dramatically from the current (and historical) approach in which each system has its own dedicated range of frequencies.

This is where the interference tolerance and avoidance of LTE might possibly enable effective sharing. The problem, however, is that the type of interference LTE was designed for is self-interference, namely those same subcarriers being used by LTE in neighboring cells. That level of interference is predictable and somewhat consistent across cells and across city-by-city deployments. In contrast, the interference from the government system, perhaps a radar system, could vary tremendously across the LTE coverage area. If too high, the interference likely would prevent the operation of the LTE network entirely. Determining the precise effect on LTE would require significant analysis as well as possibly a vast set of measurements.

As for interference from the commercial system to the government system, if the LTE system was using the band for the uplink, the lower power levels of mobiles transmitting might not adversely affect the government system. But that too would have to be assessed very carefully, especially as this might depend on the aggregate effect of multiple mobiles transmitting simultaneously.

It is this very process that some operators are undergoing in evaluating the potential sharing opportunities for the 1755 MHz to 1780 MHz band, which ideally would be paired with 2155 MHz to 2180 MHz to create an additional, and badly needed, AWS band (called AWS-3) that would significantly augment the 90 MHz of AWS bands already in use. The results of this investigation are not yet known.

Even after analyzing the interference situation in one geographical area for one government application and possibly determining that LTE could co-exist with the government system, this measurement and interference analysis would likely have to be repeated in every coverage area, making it a tedious and involved process. Then even if this sharing approach was effective for one government application, the entire analysis would have to be repeated for the next government application.

Some have suggested that sharing could be done in a manner to avoid having the primary government system and secondary commercial system transmitting at the same time as each other; however, the necessary protocols to make this possible don't currently exist. Specifically, if a government system could inform the LTE network about what spectrum it needed moment by moment, the LTE network could theoretically dynamically adjust its operation accordingly. The practical problem is that there is no interface for the LTE network to receive this information, and no enhancements to accomplish this are even on any 3GPP (the organization that develops LTE specifications) roadmap through Release 12. Since features for 3GPP releases are defined years in advance of their being specified, with commercial equipment lagging at least an additional year, a standardized approach for spectrum coordination in LTE is years away.

One work-around in the short term could involve vendors and operators developing and implementing scenario-specific, non-standard solutions. These experiments could inform the eventual standards-based approaches for dynamic spectrum coordination; however, scenario-specific solutions are typically not scalable or sustainable and therefore are not long-term solutions.

So yes, LTE could theoretically support sharing scenarios with other systems. But making the sharing actually work will require a tremendous effort to assess the characteristics of each government system. Over time, industry and government will learn the subtleties involved, and LTE itself will evolve to work better in such scenarios.

But all this will take time, years if not ultimately decades to implement over large swaths of spectrum. I'm not inherently negative on spectrum sharing. It may well be the basis of how spectrum is used in the distant future given how many systems need spectrum and how little of it is actually available. I just don't see it as a solution in the short term for our spectrum woes.

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