

Dear Madam/Sir,

Thank you for the opportunity to contribute on this important topic – and for extending the deadline.

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SpectrumConsult's primary interests lie with license exempt technologies in general and with Wi-Fi in particular.

It is encouraging to see that the RSPG documents address Wi-Fi seriously although the main weight of the document lies in the area of licensed services and their spectrum needs.

A few remarks of a general nature:

- 1) IP protocols and smart applications will dominate data communications for the foreseeable future. The latter will keep evolving and become "smarter". In the process they will become more "chatty" and require background traffic capacity to maintain their usefulness and responsiveness. Apples' iCloud, Dropbox and similar cloud services are the first examples of this trend.
- 2) Technology certainly evolves but such evolution has its limits. This is true of jet engines as well as transmission technology: beyond a certain level of development, further improvement is subject to the law of diminishing returns. The expectation that major improvements in wireless capacity can be expected in the medium future is likely to prove unfounded.
- 3) On the other hand, capacity per user is limited only by economic considerations: more base stations = more capacity per users. This is true for any wireless technology but requires careful parameterization to optimize leverage of local conditions.
- 4) Wireless (link) performance is limited not only by RF power and distance but also by the modulation type – higher modulation types increase the distance at which spectrum can be re-used and therefore they are less spectrally efficient. Optimum capacity is achieved at medium modulation rates.

A few remarks related to licensed services:

- 1) Femto cells have to share spectrum with macro-cells with the latter taking priority. Therefore, the scope for femto cell deployment is limited as is the femto cell performance. The theoretical performance figures brandished by the LTE industry are unlikely to be realized (which is also true of Wi-Fi).

- 2) Licensed services covering large areas will remain essential for many applications and many types of user. Because of the link performance constraint above, using the licensed spectrum for high volume data services is not good use of the available spectrum.
- 3) Relaxation of co-existence requirements means an increase in business risk that should be carefully weighed against the potential gain in capacity.

Since Wi-Fi achieved market breakthrough in the late 1990's its growth has been spectacular – both in terms of volume and performance. As the RSPG opinion recognizes, Wi-Fi is already the medium of choice of consumers for the delivery of high volume data services because Wi-Fi is able to deliver the expected performance at very low cost. Mobile operators have been quick to recognize this and are turning to Wi-Fi as the medium of choice for off-loading high volume traffic to Wi-Fi – whether private or commercial.

For Wi-Fi to remain a viable communications tool, three requirements stand out:

- 1) it is crucial to assure the spectrum that has been designated for its use is not spoiled by other technologies. The co-existence of different technologies necessarily leads to inefficient spectrum use and dissatisfied users. The reason is very simply that different systems see each other as interferers. The popular belief that listen-before-talk protocols will address this is mistaken. Like systems are able to share spectrum efficiently – see LTE and Wi-Fi as two examples.
- 2) Secondly, the above spectrum will not be adequate in the medium to long term future. Demand here is largely driven by user demand for faster data rates and more capacity. Notably in very dense deployments such as apartment blocks and condominiums, current spectrum is showing its limitations. Studies to extend the WAS/RLAN designations to the range 5350-5470MHz and the range 5725-5875MHz are underway. One of the contradictions is the BFWA designation for the band 5725-5875. The absence of broad deployment of such systems suggests allowing WAS/RLAN use in this band.
- 3) As WAS/RLANs become more extensively used in critical applications – like industry process control and health care, at least part of its spectrum should be free of interference from military systems. Alternatively, some relaxation of the DFS requirements should be considered. Given the highly restrictive DFS arrangements imposed on WAS/RLAN equipment, service disruption remains a threat. On the other hand, past experience shows that only illegal equipment, operating without DFS and/or at illegal power levels are a problem.