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Re: *Authorizing Permissive Use of the "Next Generation TV" Broadcast Television Standard*, GN Docket No. 16-142

Nokia is submitting this *ex parte* to voice our concerns regarding recent suggestions that ATSC 3.0 be included in mobile devices. Nokia was heavily involved in the Commission's proceeding on Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, providing technical inputs on various mobile device issues that included antenna performance and helped develop the band plan and technical rules for the U.S. 600 MHz band,[1] and is actively working with several carriers to supply equipment for expeditious deployment of networks supporting that band. In this submission, Nokia seeks to augment the Commission's record in this proceeding by opposing proposals for a mandate that mobile devices receive ATSC 3.0 in mobile devices. Such a mandate would present technical challenges and disserve the public interest.

**1. Increasing the antenna bandwidth reduces the total antenna efficiency in mobile devices**

It is expected that in order to receive ATSC 3.0, mobile devices would need to operate at additional frequencies, possibly as low as 470 MHz. If the same antenna is used to receive ATSC 3.0 signals in the 470-608 MHz band in addition to 600 MHz band (3GPP Band 71 or 617-698 MHz), the antenna performance is likely to degrade. Indeed, as the Commission recognized in its *600 MHz R&O*, antenna performance degrades as the antenna bandwidth increases, quoting performance

[1] *See* Report and Order, In the Matter of Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268 (Rel. June 2, 2014 ("*600 MHz R&O*").

penalty of 4dB at 470 MHz by vendors with experience with digital video support in handsets in Europe.[2]

The 600 MHz and other low spectrum bands are prime bands for coverage. If an antenna has to support a large bandwidth that covers various LTE and 5G bands in addition to ATSC 3.0 frequency that is lower than 600 MHz, this antenna performance degradation can directly translate into significant loss in the coverage benefit typically provided by these lower frequencies.

**2. There is no "free" space for additional or larger antennas in mobile devices**

In addition to performance degradation, the antenna supporting both cellular and ATSC 3.0 is likely to result in increased device size. Modern mobile devices already have at least a second antenna to support receive diversity or Multiple-In Multiple-Out (MIMO) operation. Including a larger antenna to support ATSC 3.0 would require a larger amount of physical space and it would be more difficult to isolate these different antennas to maintain good performance of the mobile device. The "real estate" on a mobile device is very valuable and limited. The volume reserved for antennas on this limited and valuable real estate is typically not allowed to increase without very good business reasons. Adding more antennas to support MIMO has very valid business justification because of the enhancement of the end user experience, increase in coverage and capacity and it makes more efficient use of the spectrum. Indeed, the limited physical space in a mobile device should be available for more valuable uses than ATSC 3.0. In addition, if the same antenna was to be used by both the cellular transceiver and the ATSC 3.0 receiver in the same device, additional filtering would be needed to avoid interference between the ATSC 3.0 and the cellular signals.

**3. Adding a new receiver chain to mobile devices for ATSC 3.0 reception would impact device design, performance, and cost**

Adding an ATSC 3.0 receiver chain to a device implies the addition of the antenna and all subsequent signal processing through demodulation, equalization, and error correction.[3] Specifically, these new receiver elements that need to be added to the device are:

- Antenna and any antenna controls
- Tuner – including radio frequency (RF) amplifier(s), associated filtering, and the local oscillator(s) and mixer(s) required to bring the incoming RF channel frequency down the frequency where demodulation occurs
- Selectivity and passband shaping, whether at baseband or an Intermediate Frequency (IF)
- Gain control and signal conditioning
- A/D or D/A converters at any point in the signal path
- Demodulation, equalization, error correction, and synchronization.

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[2] *See* 600MHz R&O, Technical Appendix C, page 714 at 32-34.

[3] ATSC Recommended Practice: Mobile Receiver Performance Guidelines Doc. A/174:2011, Sept. 26, 2011, available at www.atsc.org/wp-content/uploads/2015/03/Mobile-Receiver-Performance-Guidelines.pdf.

In addition to the general issue of limited physical space as discussed above, adding more circuitry to accommodate the new receiver chain would add cost and impact device design and performance. For instance, since it is likely not feasible to add ATSC 3.0 bands to the existing cellular antenna, a new antenna design is needed. The ATSC 3.0 chip will also need to be accommodated on the device next to the cellular circuitry. The ATSC 3.0 receiver chain will need to be isolated from the cellular receiver chain to mitigate any interference issues.

With the differences in the ATSC 3.0 deployments compared to cellular deployments (e.g., height and transmit power of the cellular base station vs. TV station, receive signal strengths at the receiver from the cellular base station vs. the TV station, etc.), interference issues between devices supporting cellular vs. ATSC 3.0 could be an issue, for instance, when the cellular device is far from its own base station but close to a TV station. If those systems are now supported inside the same device, the interference issue could be further exacerbated and would need further study to ensure that any performance degradation of the device stays negligible. The existing 3GPP specifications such as receiver blocking would need to be studied to ensure that these specifications would still protect the cellular system since they have been derived without considering TV stations as potential interferers with an ATSC receiver co-located with a cellular receiver inside the same device.

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Through this submission, Nokia details only some of the main technical challenges associated with ATSC 3.0 reception in mobile devices. We urge that the Commission not mandate the inclusion of ATSC 3.0 in a device, but instead allow equipment vendors and service providers to compete to win customers, based on cost and the features that consumers demand in the competitive market for wireless equipment and services.

Respectfully submitted,

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