

**Before the
Federal Communications Commission
Washington, DC**

In the Matter of:)
)
Amendment of the Commission's Rules) GN Docket No. 12-354
with Regard to Commercial Operations)
in the 3550-3650 MHz Band)

Reply Comments of Pierre de Vries

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via electronic filing

¹ These comments reflect my views alone, and not those of the Silicon Flatirons Center or any other party.

I. Introduction and Summary

In my response to the recent Further Notice of Proposed Rulemaking in the above-captioned proceeding (FNPRM), I supported the Commission's proposal to introduce reception limits.²

A few commenters argue that the Commission should not mandate receiver requirements.³ Such concerns, while valid in general, are unfounded in the present context because the reception limits proposed in the FNPRM are not receiver performance requirements.

The Commission's proposal elicited only two negative references to the reception limit concept or its proposed values.⁴ Since reception limits cannot be equated to values in receiver performance requirements such as industry standards, objections to reception limit values based on standards specifications are difficult to justify.⁵

² *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Further Notice of Proposed Rulemaking, GN Docket No. 12-354, 29 FCC Rcd 4273 (2014) (FNPRM); *see also Commission Seeks Comment on Shared Commercial Operations in the 3550-3650 MHz Band*, 79 Fed. Reg. 31247-31282 (June 2, 2014); *Comments of Pierre de Vries*, GN Docket No. 12-354 (Jul. 14, 2014) (De Vries Comments), *correction filed* Jul. 29, 2014 (the correction substitutes the term "reception limit" in a few places where the term "receiver limit" was used in error), *available at* <http://apps.fcc.gov/ecfs/document/view?id=7521744373>.

³ *Comments of Nokia Solutions and Networks US LLC*, GN Docket No. 12-354, at 18, (Jul. 14, 2014) (Nokia Comments); *Comments of Telecommunications Industry Association*, GN Docket No. 12-354, at 7 (Jul. 14, 2014) (TIA Comments); *Comments of The Wireless Innovation Forum*, GN Docket No. 12-354, at 54 (Jul. 11, 2014) (Forum Comments).

⁴ *Comments of Motorola Mobility LLC*, GN Docket No. 12-354, at 10 (Jul. 14, 2014) (Motorola Mobility Comments); *Comments of Motorola Solutions, Inc.*, GN Docket No. 12-354, at 7-8 (Jul. 14, 2014) (MSI Comments).

⁵ While the absolute values of reception limits cannot be read off from blocking requirements in industry receiver standards, differences between blocking power values at different frequency offsets can inform the step heights (in dB) and step widths (in MHz) of a reception limit profile.

II. Reception limits are not receiver performance requirements, aka receiver standards

Some commenters argue that the Commission should not adopt receiver performance requirements.⁶ I concur, because as a general matter it is neither practicable nor desirable for the Commission to develop or mandate receiver performance standards; it should leave the task to industry whenever possible.⁷ Indeed, the TAC White Paper on interference limits policy explains that “signal strength thresholds above which receivers may claim protection from harmful interference can obviate FCC-mandated receiver performance specifications.”⁸ The reception limit proposed in the FNPRM is this very type of signal strength threshold.

Receiver performance requirements, whether industry standards or regulatory mandates, are qualitatively different from the reception limits that are being proposed in this proceeding. Reception limits, and interference limits in general, are “ways to describe the environment in which a receiver must operate without necessarily specifying receiver performance.”⁹ Conversely, receiver performance standards—also known as receiver standards—specify the required behavior of specific device in great detail.

⁶ Motorola Mobility Comments at 10 (“receiver limits . . . should be set by standards organizations, and the Commission should refrain from adopting requirements”); Forum Comments at 54 (“The commission should not specify technology or receiver limits. GAA users are responsible for their own receiver designs and assume the performance risk.”); TIA Comments at 7 (“TIA urges the Commission not to establish mandatory receiver standards at this time. . . . TIA urges the Commission to address these issues through existing industry-led standards processes or through public-private partnerships rather than through prescriptive regulations.”); Nokia Comments at 18 (“The Commission should not specify minimum receiver standards”).

⁷ FCC Technological Advisory Council, Receivers and Spectrum Working Group, *Interference Limits Policy - The use of harm claim thresholds to improve the interference tolerance of wireless systems, White Paper* (Feb. 6, 2013) (TAC White Paper) at 32, available at <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/WhitePaperTACInterferenceLimitsv1.0.pdf> (“Developing its own receiver performance mandates is the most challenging option since the FCC would have to first determine what harmful interference means . . . , and then define receiver performance parameters . . . Care must be taken not to preclude market development, e.g., due to implementation costs or other burdens on product development.”).

⁸ TAC White Paper at 7.

⁹ FCC Technological Advisory Council, Spectrum & Receiver Performance Working Group, *Interference Limits Policy and Harm Claim Thresholds: An Introduction*, (Mar. 5, 2014) at 1, available at <http://transition.fcc.gov/oet/tac/tacdocs/reports/TACInterferenceLimitsIntro1.0.pdf>.

The stark contrast between the reception limit proposed in the FNPRM and the 3GPP receiver standard cited by two commenters illustrates the intrinsic difference between reception limits and receiver performance standards:¹⁰

Reception limit:¹¹

- Citizens Broadband Radio Service Devices (CBSDs) operating on a Priority Access basis must accept an interfering power [flux] spectral density of -30 dBm/10 MHz [into a 0 dBi antenna]¹² not to be exceeded with greater than 99 percent probability [at a specified confidence level]¹³.

3GPP TS 36.101 receiver blocking requirement:¹⁴

- Performance is tested with a desired signal 6 dB above the reference sensitivity power level of the receiver in a 10 MHz channel, effectively the power received by a device at the edge of coverage.¹⁵
- In the presence of the blocking signal, the throughput shall be $\geq 95\%$ of the maximum throughput of the reference measurement channels.
- The reference sensitivity depends on E-UTRA band, modulation scheme and channel bandwidth, e.g. for QPSK (the only specified modulation scheme) in

¹⁰ *Motorola Mobility Comments* at 9, 11; *MSI Comments* at 8.

¹¹ FNPRM at ¶ 86.

¹² De Vries Comments, Section III.D at 15 (“Adding antenna gain to fully define Reception Limits as a field strength”).

¹³ *Id.*, Section III.B at 8 (“Providing confidence intervals”).

¹⁴ 3GPP TS 36.101 V10.6.0 (2012-03), *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (Release 10)*, (TS 36.101), Sections 7.6.1 “In-band blocking” and 7.6.2, “Out-of-band blocking,” available at <http://www.3gpp.org/DynaReport/36101.htm>.

¹⁵ *Id.*, Section 7.3 at 74 (“The reference sensitivity power level REFSENS is the minimum mean power applied to both the UE antenna ports at which the throughput shall meet or exceed the requirements for the specified reference measurement channel”); REFSENS varies depending on modulation and standard, and is e.g. -97 dBm for QPSK in 3GPP TS 36.101, see Table 7.3.1-1.

10 MHz for 3GPP Band 42 (3400-3600 MHz) and Band 43 (3600-3800 MHz) it is -96 dBm.

- Different interferer power levels in dBm are given for various frequency offsets, e.g. -44 dBm/5 MHz at ± 12.5 MHz from the receive channel.

The 3GPP TS 36.101 blocking requirement specifies not only the interference power (e.g., -44 dBm/5 MHz) but also the desired signal power at which performance must be tested (6 dB above reference sensitivity) and the service level that must be achieved (throughput shall be $\geq 95\%$ of the maximum), among many other things. On the other hand, the reception limit specification makes no reference to receiver performance, and only requires that the CBSD “must accept” a probabilistic level of interference.¹⁶ Because no service level is specified, the proposed rule leaves to the individual operator to decide what “accept” amounts to.

The acceptable performance of a system—a combination of transmitters and receivers—in the presence of interfering signals can be achieved in many ways; receiver performance is just one of many variables. Both the desired and undesired signal levels affect performance, which can be enhanced by better receiver selectivity (reducing the undesired signal) or by a denser deployment of transmitters (increasing the desired signal). It is up to the user/operator to decide what constitutes acceptable performance. For example, an operator may determine that throughput better than 80% of maximum in the 1% of cases when adjacent band signals might exceed the reception limit—rather than $\geq 95\%$, with other parameters at their specified values, as specified in 3GPP TS 36.101—would be perfectly acceptable to its customers. The reception limit is just one of many constraints under which system performance is optimized.

¹⁶ FNPRM at ¶ 86.

III. Reception limits should not be equated to values in receiver standards

Since reception limits are not receiver standards, there is no direct link between, for example, a blocking value in a receiver specification and a reception limit that will not be exceeded with 99 percent probability. Figure 1 illustrates that a reception limit is just one of many factors that determine receiver performance specifications, and that while a receiver standard depends (indirectly) on the reception limit, the reverse is not true.

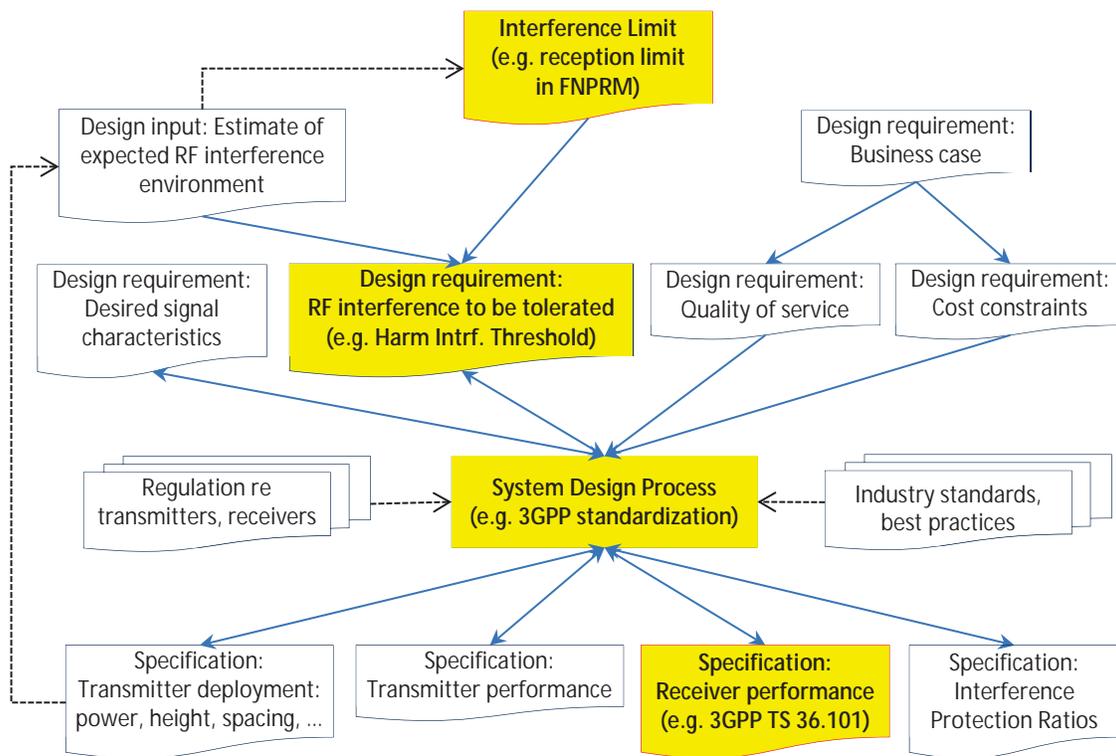


Figure 1. Relationship between a reception limit, the actual interference environment, a system design process, and receiver performance requirements.¹⁷ The arrows indicate the direction of influence. The examples provided in the figure reflect proposals made in this proceeding.

¹⁷ Based on TAC White Paper at 19, fig. 5; see pp. 18-19 for an explanation of the boxes in flow chart.

The combination of circumstances when both (1) the undesired signal exceeds the allowed 99th percentile reception limit, and (2) an affected receiver is in a weak desired signal location (i.e., 6 dB above reference sensitivity) will be rare. The combined likelihood is the product of the two probabilities, and will therefore be well below one percent. The blocking levels in receiver standards have no relation to this likelihood; therefore, the blocking level should not be equated to the reception limit.

In fact, operational cellular systems seem to function perfectly well with 99th percentile adjacent channel power levels of -38 MHz/5 MHz.¹⁸ This confirms that in-band receiver blocking levels of -56 dBm/5 MHz specified in the TS 36.101 standard have no direct bearing on the determination or appropriate level of a reception limit.¹⁹

Respectfully submitted,

Pierre de Vries

¹⁸ De Vries Comments at 5 (reporting results of J. Riihijärvi, A. Achtzehn, P. Mähönen, & P. De Vries, *A study on the design space for harm claim thresholds*, in 9th International Conference on Cognitive Radio Oriented Wireless Networks (CrownCom 2014) (2014), (Riihijärvi et al.), *available at* <http://www.inets.rwth-aachen.de/fileadmin/templates/images/PublicationPdfs/2014/2014-CrownCom-Harm-Claim-Thresholds.pdf>).

¹⁹ *Cf.* Motorola Mobility Comments at 10 (“Motorola Mobility stresses that any such requirements should not be more stringent than those already defined by standards bodies”). *Cf.* also Motorola Solutions’ objection to a -30 dBm / 10 MHz reception limit because it “is too burdensome as a general requirement, and implies more adjacent channel selectivity than is feasible in typical broadband system designs,” MSI Comments at 7. The operational evidence reported in Riihijärvi et al., *supra* note 18, indicate that this level is neither burdensome nor infeasible: it indicates that 3G systems currently operate at 99th percentile signal levels higher than this amount, and indeed much higher than the -40 dBm/10 MHz that Motorola Solutions proposes.