

CBA Replies to NPRM Comments Customer Technology Briefing

December 7, 2018

C-band Alliance Membership



Agenda

Highlights of the CBA Reply – Crandall and Vorwig

Discussion of Technical Annex – Corda

Question and Answer – Dianne.VanBeber@intelsat.com



CBA Reply Comments to NPRM

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Highlights of the CBA Reply Comments

Replies to NPRM comments filed on October 29, 2018 are due on December 11, 2018

The CBA will file its reply comments today (December 7) in order to provide our customers an opportunity to consider the CBA filing in any replies they plan to file next week

Highlights include:

- Statement that under their market-based proposal, C-Band Alliance members will launch enough new satellites capable of nationwide distribution, so as to have the capacity necessary to carry audio, video, and data content in 300 MHz that they currently have in 500 MHz
- Response to T-Mobile alternate proposal
- Technical Annex Update



CBA Reply Comments to NPRM Technical Annex Summary

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Introduction

Providing this overview, and will forward a written summary, to facilitate your review leading up to the December 11, 2018 Reply Comment deadline at the FCC

In the technical annex to its reply comments, the CBA proposes rules to be adopted by the FCC that will ensure that FSS operations in 3900-4200 MHz are being protected from terrestrial 5G operations in the adjacent 3700-3880 MHz band

The proposed rules are based upon further review and extensive analysis of key technical issues raised in the opening round of comments and discussions of those issues with customers, mobile network operators and 5G equipment providers



What will be protected?

- The CBA proposes that protection is based on the location of:
 - all FSS earth stations registered before the freeze
 - additional FSS earth stations to be registered during a period of 30 days following publication of the Report and Order in the Federal Register
- For each location, an area of 150 m radius is to be protected
- Within this area, antennas with a diameter of between 3 m and 13 m and with an elevation angle of 5 degrees or more, are protected in the entire 3900-4200 MHz band and across the accessible geostationary arc



How will protection of operations in the band 3900-4200 MHz be achieved?

LNB saturation

- Each 5G licensee will have to comply with an aggregate power density limit of -81.6 dBm/MHz to be met in the band 3700-3900 MHz at the input of a LNB for all 5G base stations within 40 km of an earth station
- The calculation is made taking into account a reference antenna pattern and a reference filter attenuation
- The aggregate power density limit of -81.6 dBm/MHz summed over the entire 3700-3880 MHz 5G transmission band ensures that a maximum LNB input of -59 dBm is not exceeded



How will protection of operations in the band 3900-4200 MHz be achieved?

C-band signal interference

- Each 5G licensee will have to comply with an aggregate power density limit of -128 dBm/MHz to be met in the band 3900-4200 MHz at the input of an LNB for all 5G base stations within 40 km of an earth station.
- The calculation is made taking into account a reference antenna pattern and a reference filter insertion loss.
- The aggregate power density limit of -128 dBm/MHz ensures that the contributed interference to C-band signals is at a level at least 10 dB below the noise floor.



What other items are considered in the Technical Annex?

Maximum 5G base station power levels

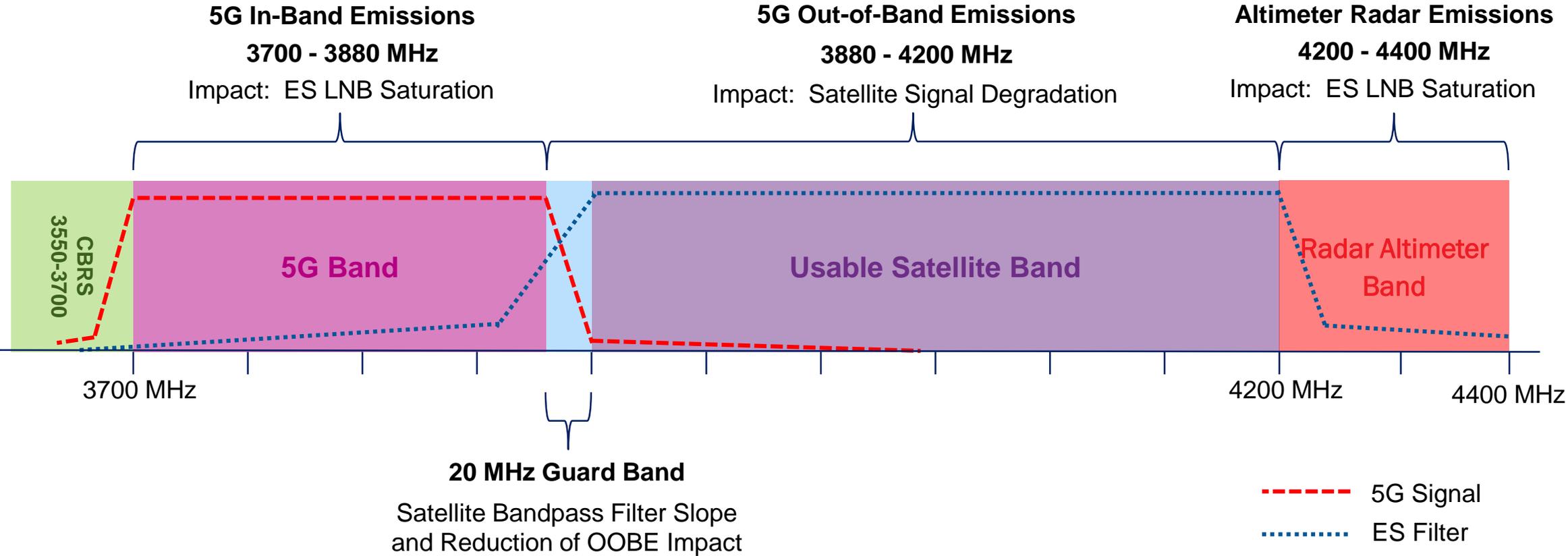
- As the proposed rules as outlined – specifying power levels at the earth station LNB input as power spectral density – would provide the necessary protection of C-band earth stations, then assuming adoption of such rules, the CBA would not require 5G base station power levels to be limited to 46 dBm/MHz or to 75 dBm total power

5G out-of-band emission levels

- Upon analyzing Nokia's proposed OOB level of -3 dBm/MHz from the 5G band edge to 20 MHz from the band edge, the CBA has determined that this level does not result in any appreciable increase in power over the previously proposed -13 dBm/MHz level as it pertains to potential earth station LNB saturation; therefore, the CBA accepts Nokia's new proposed level

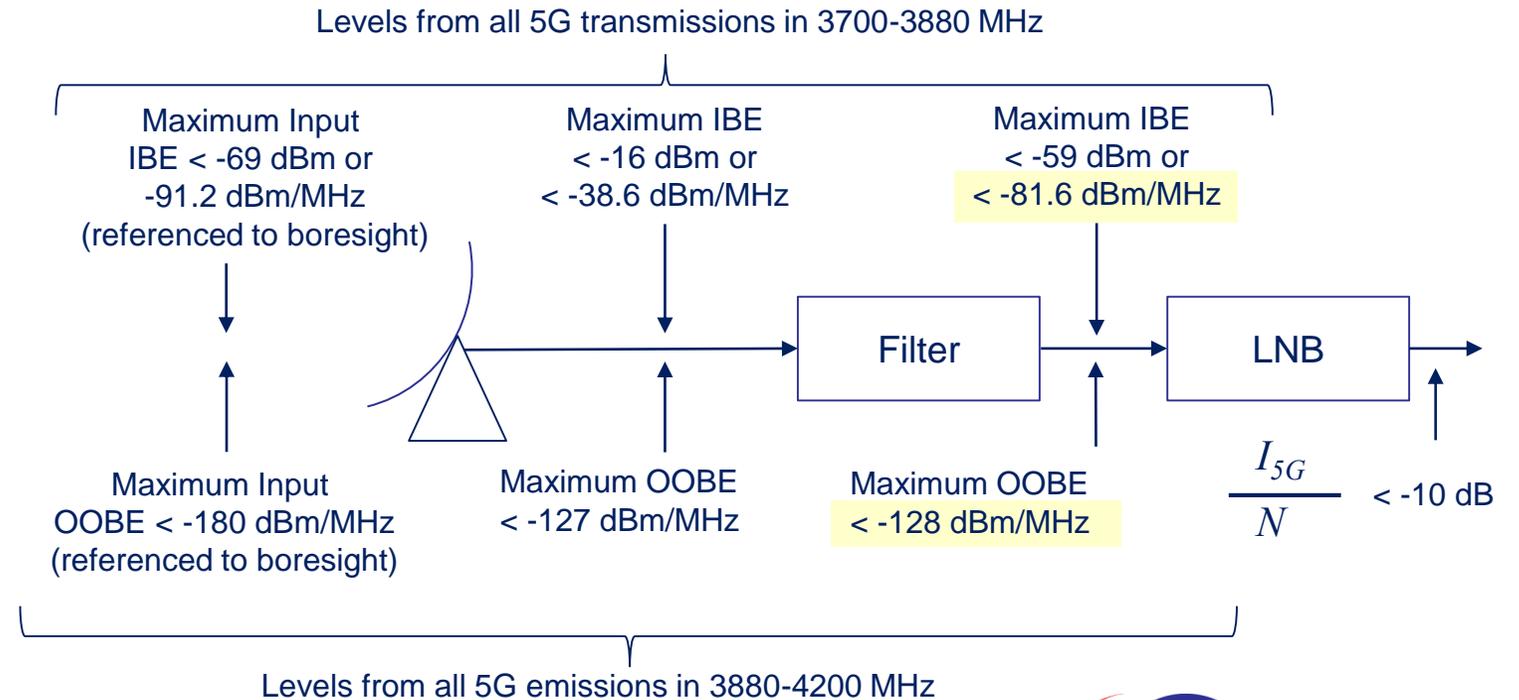


Satellite Spectrum Environment – 5G Signal & Waveguide Filter



5G In-Band and Out-of-Band Power Levels at ES

- 5G BS power level + 5G deployment = ES received power level
 - Ultimately, we are primarily concerned about ES received power, not BS transmit power levels
 - Impact of receive power level depends upon ES antenna and filter performance



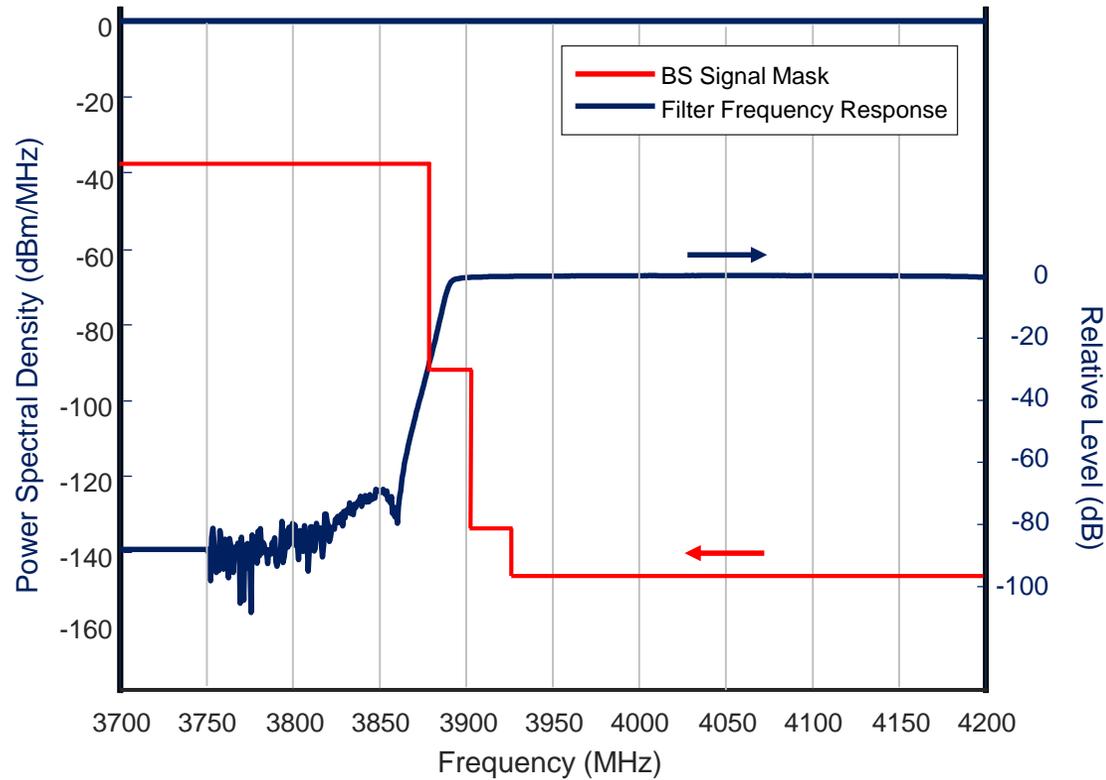
Notes

- 1) Required levels for < 0.5 dB satellite link degradation
- 2) Assumes noise floor post LNB of -118 dBm/MHz
- 3) Filter IBE rejection = 43 dB; Filter OOBE insertion loss = 1 dB

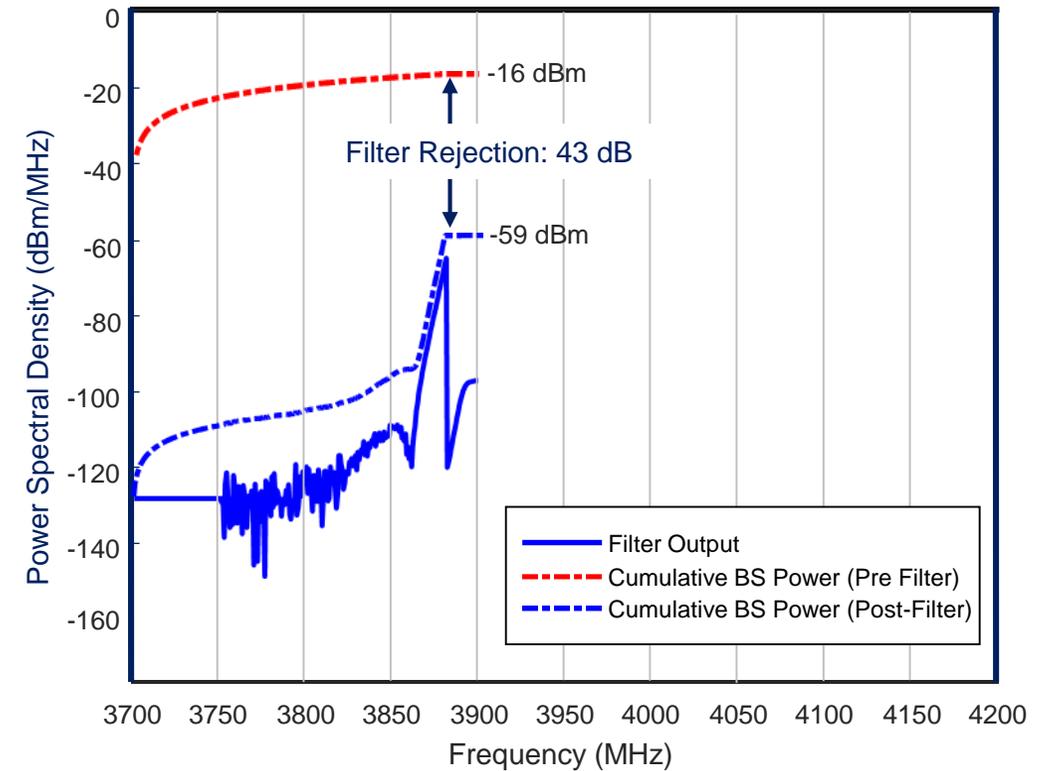


Filter Performance

5G Base Station Mask at Filter Input and Filter Frequency Response



5G Base Station In-Band Power Pre/Post Filter



FSS Earth Station Reference Antenna and Filter Mask

- 5G license holders will apply reference antenna and filter masks in the operation of their base stations to ensure emissions do not exceed maximum levels
 - Antenna mask: 47 CFR 25.209 with addition of constraint at angles $< 1.5^\circ$ from antenna boresight
 - Filter mask: -43 dB from 3700-3900 MHz and -1 dB from 3900 to 4200 MHz
- FSS earth station LNB input levels, maximum:
 - IBE < -81.6 dBm/MHz
 - OOBE < -128 dBm/MHz
- The maximum levels are aggregated from all base stations from each 5G license holder within a 150 m radius of a registered earth station lat/lon

ES Reference Antenna Mask	
$G = 52.6$ dBi	for $0^\circ \leq \varphi < 1.5^\circ$
$G = 2 - 25 \log \varphi$ dBi	for $1.5^\circ \leq \varphi < 7^\circ$
$G = 8$ dBi	for $7^\circ \leq \varphi < 9.2^\circ$
$G = 32 - 25 \log \varphi$ dBi	for $9.2^\circ \leq \varphi < 48^\circ$
$G = -10$ dBi	for $48^\circ \leq \varphi \leq 180^\circ$

The CBA has developed a tool to assist terrestrial mobile operators in calculating AAPD for a given 5G base station deployment scenario



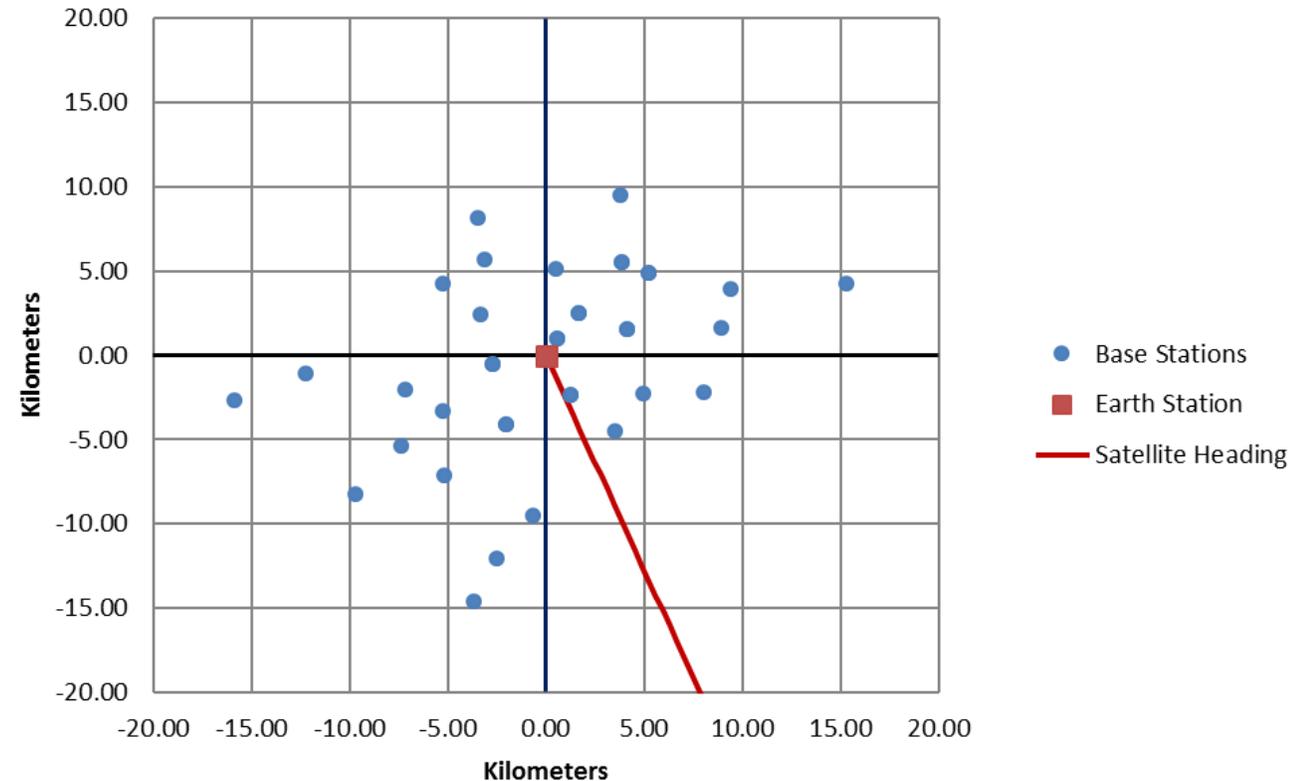
AAPD Modeling Tool

Inputs

- ES lat, lon, altitude, antenna height
- BS lat, lon, altitude, antenna height, path loss to earth station, IBE and OOB E in direction of ES

Outputs

- Margin to IBE and OOB E AAPD limits
- Impact per BS on AAPD



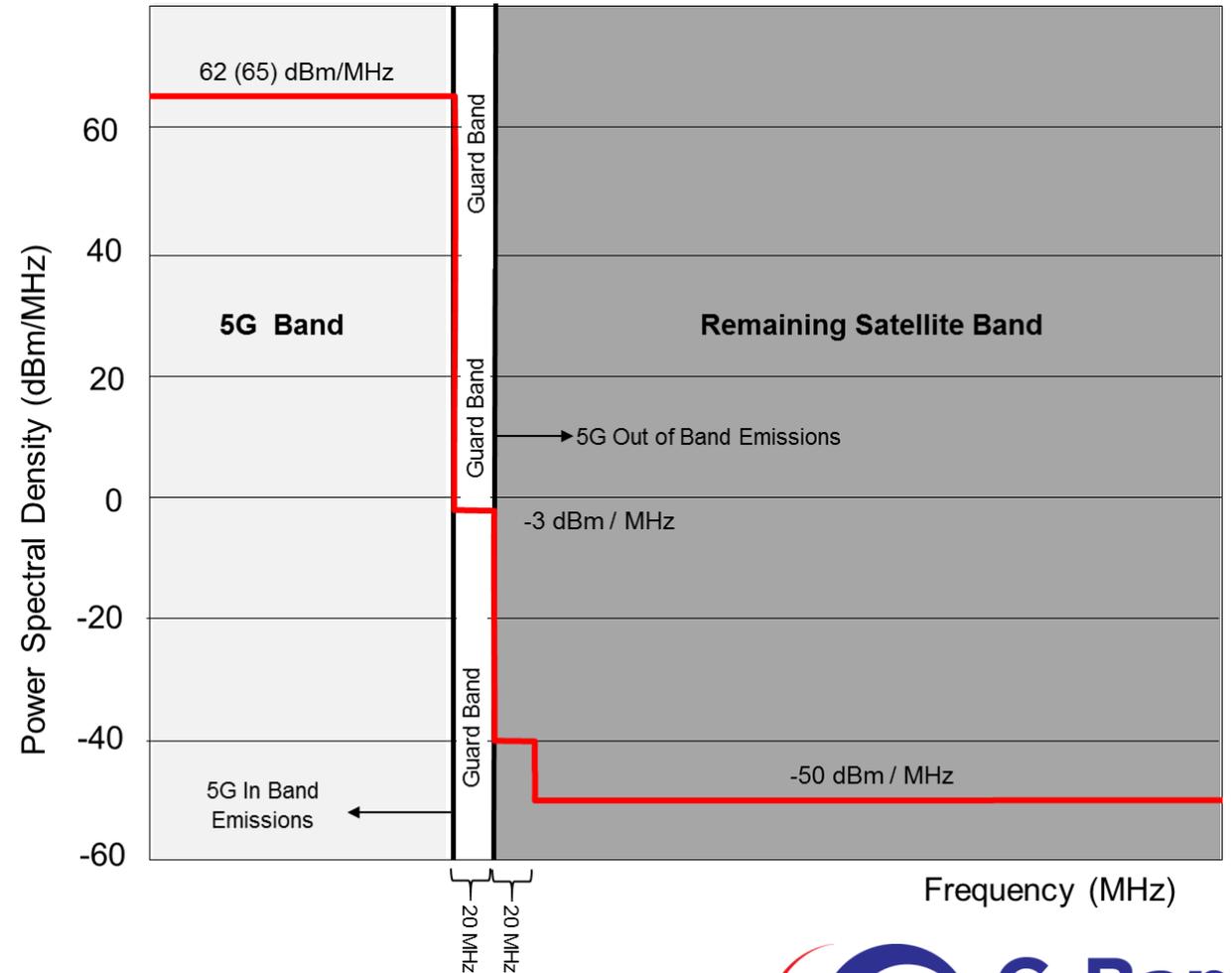
5G Base Station EIRP and PSD Levels

- The CBA supports the 5G base station EIRP and PSD levels proposed by the FCC in the NPRM
 - Urban: 1640 watts/MHz (62 dBm/MHz)
 - Rural: 3280 watts/MHz (65 dBm/MHz)
- The total EIRP limit of 75 dBm (regardless of 5G transmission bandwidth) is not needed **provided** that the FCC adopts the CBA's proposed limits at FSS earth stations in the Rules



5G Base Station Out-of-Band Emission Levels (conductive)

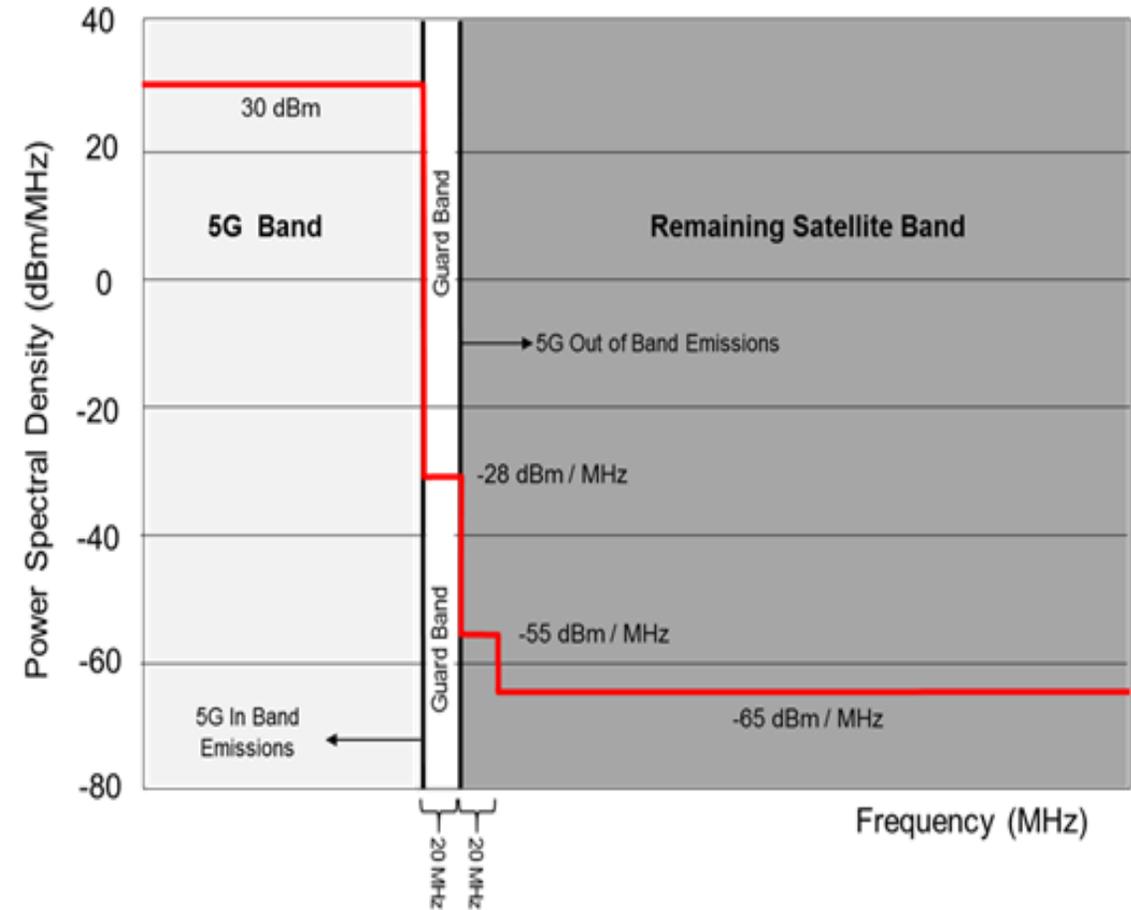
- The CBA supports Nokia's suggested OOB emission levels
 - -3 dBm/MHz from 0 to 20 MHz offset from the 5G spectrum block
 - -40 dBm/MHz from 20 MHz to 40MHz offset from the 5G spectrum block
 - -50 dBm/MHz for frequency offset greater than 40MHz



User Equipment Emission Mask (radiated)

- The CBA proposed a user equipment mask of
 - -28 dBm/MHz from 0 to 20MHz offset from the 5G spectrum block
 - -55 dBm/MHz from 20MHz to 40MHz offset from the 5G spectrum block
 - -65 dBm/MHz for frequency offset greater than 40MHz

NOTE: These levels are currently being discussed by CBA and various 5G stakeholders



Have questions? Ask one live!
Get in the queue

Email Dianne.VanBeber@intelsat.com and put your name and company affiliation in the Re: line



Thank you for your time and continued interest

Many thanks to the recent supportive comments filed at the FCC

