May 12, 2016

VIA ELECTRONIC FILING

Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

Re: Notice of *Ex Parte* – Use of Spectrum Bands Above 24 GHz For Mobile Radio Services Notice of Proposed Rulemaking, GN Docket No. 14–177, IB Docket Nos. 15-256 & 97-95; RM-11664; WT Docket No. 10-112

Dear Ms. Dortch:

On May 10, 2016, representatives of EchoStar, Inmarsat, Intelsat, O3b Limited, OneWeb, SES Americom, Inc., and ViaSat Inc. (collectively, the "Satellite Operators") met with FCC staff to discuss the above referenced proceeding. At the meeting, the Satellite Operators presented information on aggregate interference concerns from the proposed Upper Microwave Flexible Use ("UMFU") service into 28 GHz band FSS receivers. A copy of the presentation is attached to this filing.

Participating on behalf of the Satellite Operators were: Jennifer Manner and Alexander Gerdenitsch, EchoStar; Suzanne Malloy, Zach Rosenbaum, and Joslyn Read, O3b; John Hane, Pillsbury (for O3b); Petra Vorwig, SES Americom; Elizabeth Park and John Janka, Latham & Watkins, LLP (for ViaSat); Chris Murphy and Daryl Hunter, ViaSat; Giselle Creeser and Ethan Lucarelli, Inmarsat; Whitney Lohmeyer and Marc Dupuis, OneWeb; and Cynthia Grady, Intelsat.

Participating on behalf of the FCC were: Jose Albuquerque; Charles Oliver; Michael Ha; John Schauble; Blaise Scinto; Mathew Pearl; Kal Krautkramer; Brian Regan; Chris Helzer; Simon Banyai; Reza Biazaran; Catherine Schroeder; Martin Doczkat; Bahman Badipour; Nancy Zaczek; Stephen Buenzow; and Tim Hilfiger.

We discussed the need for an aggregate EIRP density limit on UMFU emissions toward space, and to propose a suitable limit. To illustrate the possibility that UMFU deployment could exceed the proposed limit, absent adequate and effective regulation, the presentation included certain exemplary UMFU parameters based on data provided by certain UMFU proponents to date. We emphasized that those illustrations are not proposed "limits" on the number or type of UMFU transmitters. To the contrary, the illustrations do not account for possible deployment scenarios with more directive UMFU antennas (*i.e.*, with more discrimination in antenna gain and better control over sending unwanted energy toward space), or with UMFU transmitters operating inside

buildings. We continue to work with Nokia as a representative of the UMFU proponents. In light of the Chairman's announced intention to address this issue at the Commission's open meeting in July, we will reach out to Nokia and other vendors in order to schedule meetings during the week of May 16, to better model the interference scenario and arrive at a more precise definition of aggregate EIRP density limits.

Please contact the undersigned with any questions related to this filing.

Respectfully submitted,

/s/

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The FCC Must Adopt an Emission Envelope for UMFU to Protect FSS Systems in the 28 GHz Band and Appropriate Management and Enforcement Mechanisms

May 10, 2016

EchoStar

Inmarsat

O3B

OneWeb

SES

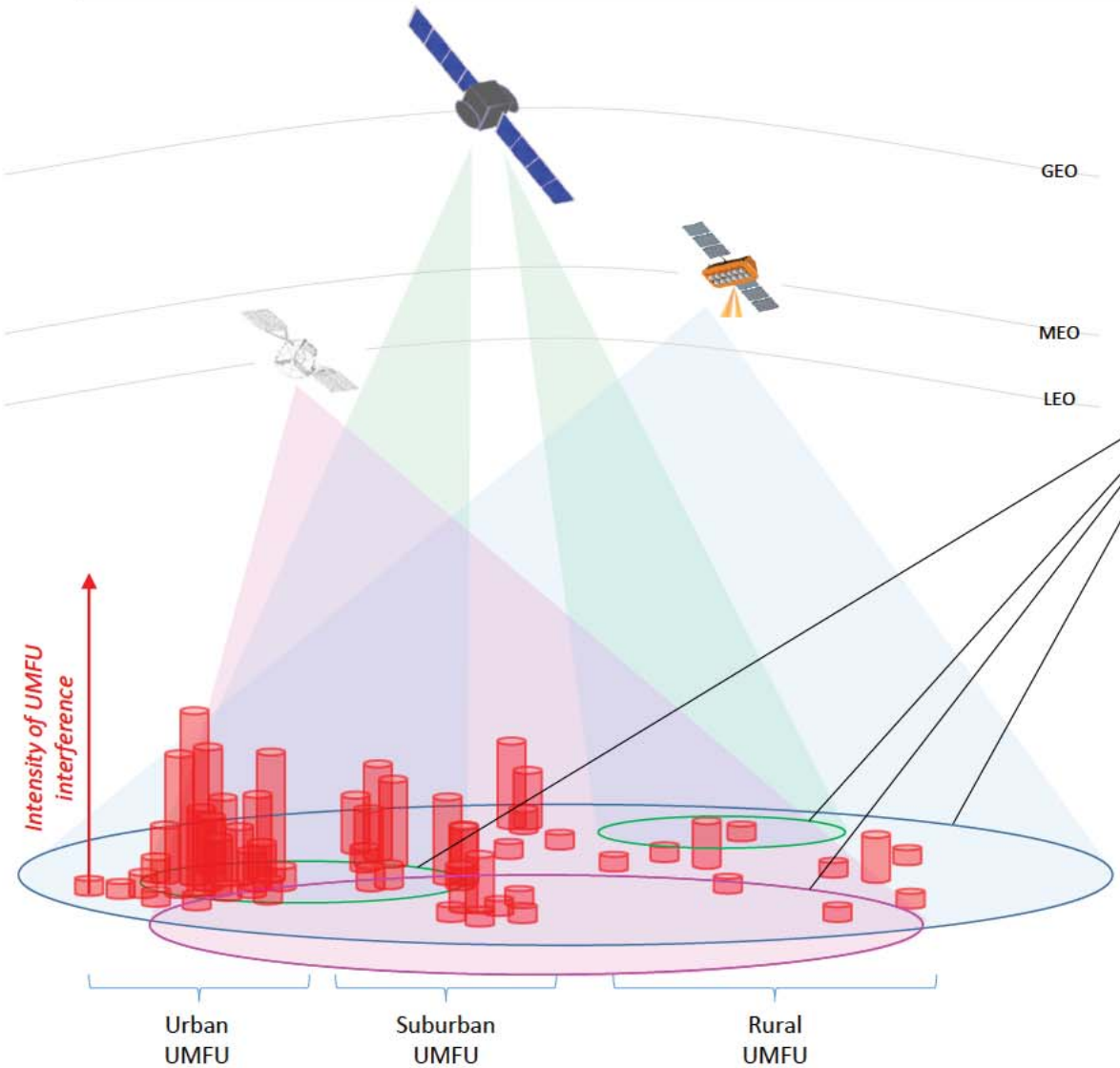
ViaSat

GN Docket No. 14-177

Overview

- UMFU skyward aggregate interference in 27.5-28.35 GHz ("28 GHz band") can result in severe degradation of broadband satellite service to US customers
- Results show that even with low UMFU base station deployment density the permissible interference levels at the satellite are exceeded
- The FCC must adopt an emission envelope in its rules to limit the aggregate interference radiated skyward from UMFU transmitters
- The UMFU limit on aggregate emissions radiated skyward that should be adopted is 16.5 dBm/MHz per 1000 km^2
- The FCC must adopt management and enforcement mechanisms to ensure that UMFU does not cause harmful aggregate interference into FSS satellites operating in the 28 GHz band

UMFU Aggregate Interference Scenario



FSS satellites operate at various altitudes

- GEO: 35,786 km
- MEO: e.g. 8,000 km
- LEO: e.g. 1,000 km

Satellite receive beams in 28 GHz have an area of 31,000 km^2 up to 1,756,000 km^2

UMFU deployment assumptions:

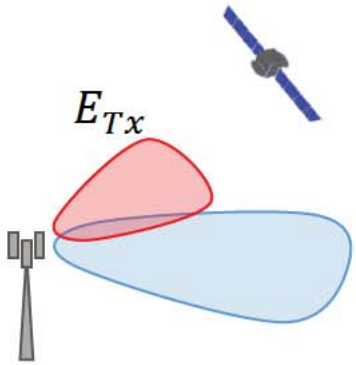
- Deployment density from 1 BS to 10 BS per km^2

The Challenge

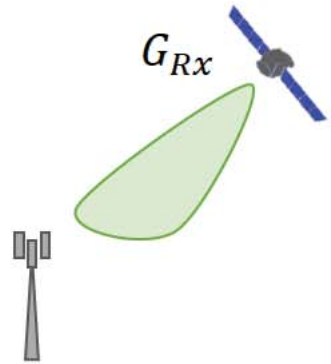
FSS satellites, at any orbit, will receive aggregated UMFU interference potentially from urban, suburban and rural deployments

UMFU and FSS parameters that drive the compatibility between the two services

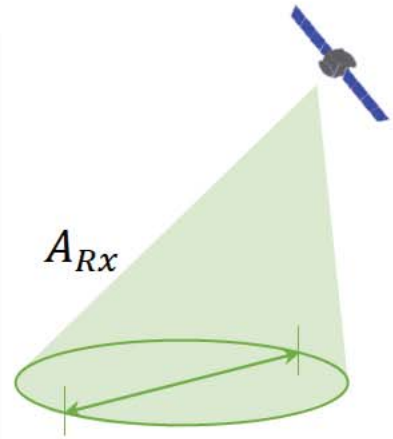
Four fundamental parameters that drive the interference from UMFU into FSS:



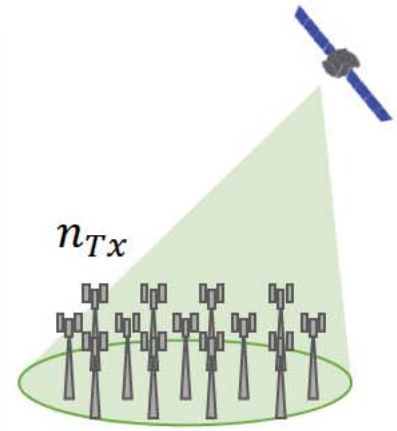
EIRP of the UMFU in direction of FSS satellite



Gain of the satellite antenna in the direction of the UMFU



Area of the satellite antenna receive beam on the Earth



Number of transmitting UMFUs within area, A_{Rx}

I_{sat} is proportional to each of the variables meaning an increase any value on the right side of equation results in an increased I_{sat}.

$$I_{sat} \; \alpha \; E_{Tx} \times n_{Tx}(A_{Rx}) \times G_{Rx}$$

FSS is deployed and in operation. A_{Rx} and G_{Rx} values are fixed for in-orbit systems.

The E_{Tx} and n_{Tx} of UMFUs in a given area are the future systems that can be carefully designed to be compatible with FSS satellite receivers without unduly constraining either service

FSS satellite parameters and calculation methodology

- Satellite parameters vary amongst FSS operators
  - Satellite noise temperature: 571 K – 1300 K
  - Peak receive antenna gain: 36 dBi – 61 dBi
  - Orbit altitude: 1000 km – 36000 km
  - Area of satellite receive beam: 31000 km^2 – 1756000 km^2
- FSS Protection criteria
  - 6% increase in noise floor → $I_{UMFU}/N_{thermal} < -12.2$ dB
- The maximum permissible aggregate interference from UMFU emissions into FSS satellite receivers is determined using the parameters above
  - The resulting value is expressed as an aggregate UMFU EIRP in dBm/MHz
  - The area of the satellite receive beams varies and so a reference of 1000 km^2 is used to normalize the maximum UMFU emission envelope

Maximum Permissible Interference into FSS Receiver

Satellite		EchoStar	O3B	SES	Inmarsat	ViaSat-2	ViaSat-3
Center frequency	GHz	28	28	28	28	28	28
Distance from satellite[1]	km	37988	9841	37988	37988	37988	37988
Free space loss	dB	212.99	201.25	212.99	212.99	212.99	212.99
Satellite noise temperature	K	1259	571	1047	1349	1050	650
Thermal noise density	dBm/Hz	-167.60	-171.03	-168.40	-167.30	-168.39	-170.47
Protection threshold 6% increase in noise floor	dB	-12.22	-12.22	-12.22	-12.22	-12.22	-12.22
Interference limit	dBm/Hz	-179.82	-183.25	-180.62	-179.52	-180.61	-182.69
Interference limit @ satellite orbital location	dBm/MHz	-119.82	-123.25	-120.62	-119.52	-120.61	-122.69
Satellite antenna gain	dBi	57	33[2]	51	42.4	61	61
Polarization gain of satellite	dB	3	3	3	3	3	3
Atmospheric absorption[3]	dB	1	1	1	1	1	1
Aggregate interference limit of UMFU transmitting EIRP	**dBm/MHz**	**40.17**	**49.00**	**45.37**	**55.07**	**35.38**	**33.30**
Satellite receive beam size on surface	km^2	100000	1756000	165000	853000	31000	31000
Permissible transmitting EIRP in 1000 km^2	**dBm/MHz**	**20.17**	**16.56**	**23.19**	**25.76**	**20.47**	**18.38**

[1]Average distance to GSO orbit in mid CONUS is assumed to be 37988 km
[2]The O3b case reflects a single instant in time at a particular elevation angle to illustrate the impact at that point in time
[3]Approximate value, variable for each link

UMFU aggregate skyward emission limit: 16.5 dBm/MHz per 1000 km^2

UMFU Deployment Parameters

- Example calculation of UMFU deployment in one satellite receive beam
  - Permissible UMFU transmitting EIRP density of 16.5 dBm/MHz per 1000 km^2

- Considered UMFU parameters
  - Base station
    - EIRP of 62 dBm and 75 dBm
    - Antenna discrimination towards the satellite
      - 25 dB (FSS earth station with 15° elevation angle)
      - 28 dB (FSS earth station with 30° elevation angle)
  - User equipment
    - EIRP of 43 dBm and 23 dBm
    - Omnidirectional antenna characteristics, however 6 dB antenna discrimination towards the satellite is assumed

- Considered illustrative UMFU deployment scenarios (not validated)
  - Rural: 100% LOS
  - Suburban: 50% LOS/50% NLOS
  - Urban: 10% LOS/90% NLOS

UMFU Deployment Scenario – Rural (100%LOS)

NGSO 15° elevation angle

base station transmitter		62 dBm	75 dBm
max base station EIRP value	dBm	62	75
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	42	55
antenna discrimination towards satellite (15° elevation angle)	dBi	25	25
EIRP density towards the satellite	dBm/MHz	17	30
interference margin for one base station to 49.00 dBm/MHz	dB	32.00	19.00
Cumulative interference - base stations			
number of UMFU sectors transmitting		1581	79
additional interference	dB	31.99	18.98
interference margin to 49.00 dBm/MHz	dB	0.01	0.03
user equipment transmitter		23 dBm	43 dBm
max user terminal EIRP value	dBm	23	43
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	3	23
antenna discrimination towards satellite	dBi	6	6
EIRP density towards the satellite	dBm/MHz	-3	17
interference margin for one user terminal to 49.00 dBm/MHz	dB	52.00	32.00
Cumulative interference – user equipment			
number of UMFU user terminals transmitting		158186	1581
additional interference	dB	51.99	31.99
interference margin to 49.00 dBm/MHz	dB	0.01	0.01

Results in this table are for a satellite receive beam size of 1756000 km²

Analysis Demonstrates the Need for an UMFU Emission Envelope

- Number of supported base stations sectors and user equipment in one satellite receive beam depend on UMFU parameters and deployment scenario

	Rural	Suburban	urban
	UMFU transmitting sectors		
62 dBm base station – NGSO 15° elevation angle	1,581	3,156	14,427
75 dBm base station – NGSO 15° elevation angle	79	158	723
62 dBm base station – NGSO 30° elevation angle	3,156	6,298	28,785
75 dBm base station – NGSO 30° elevation angle	158	316	1,442
62 dBm base station – GSO case (25.76 dBm/MHz/1000 km^2, 30° elevation angle)	12,757	25,455	116,351
	UMFU transmitting user terminals		
23 dBm user equipment – NGSO	158,186	315,624	1,442,681
43 dBm user equipment – NGSO	1,581	3,156	14,427

- UMFU deployment with LOS has a major impact on aggregate interference
- Results show a lower number of supported base stations and user equipment than the expected UMFU deployment density (1 BS to 10 BS per km^2) which will lead to a degradation of the FSS

Note: Results in this slide are for an NGSO satellite receive beam area of 1756000 km^2 except for the GSO case which is for a satellite receive beam area of 853000 km^2

The FCC Must Adopt an Emission Envelope To Ensure FSS Service is Not Degraded and Appropriate Management and Enforcement Mechanisms

- Analysis demonstrates that satellite service in 28 GHz could be severely degraded by expected UMFU deployment
- Failure to adopt an aggregate emission limit could result in service degradation and outages to commercial customers and critical public service users including the public safety community, utilities and the U.S. Government
- The FCC must adopt a limit on aggregate emissions radiated skyward expressed as an EIRP of 16.5 dBm/MHz per 1000 km^2 in the 28 GHz band
  - Each individual UMFU geographical license will have that aggregate EIRP emission limit attached to its license scaled appropriately
- The FCC must adopt management and enforcement mechanisms to protect against aggregate interference including:
  - An annual certification requirement from UMFU licensees to demonstrate that operational base stations and user equipment do not exceed the aggregate interference limit for each geographic license
  - Require all UMFU equipment and devices to support the limitation of power radiated skywards to ensure compliance with the aggregate interference limit

ANNEX

UMFU Deployment Scenario – Suburban (50%LOS)

NGSO 15° elevation angle

base station transmitter		62 dBm	75 dBm
max base station EIRP value	dBm	62	75
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	42	55
antenna discrimination towards satellite (15° elevation angle)	dBi	25	25
additional loss due suburban scenario (50%LOS/50%NLOS)	dBm/MHz	3	3
EIRP density towards the satellite	dB	14	27
interference margin for one base station to 49.00 dBm/MHz	dB	35.00	22.00
Cumulative interference - base stations			
number of UMFU sectors transmitting		3156	158
additional interference	dB	34.99	21.99
interference margin to 49.00 dBm/MHz	dB	0.01	0.01
user equipment transmitter		23 dBm	43 dBm
max user terminal EIRP value	dBm	23	43
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	3	23
antenna discrimination towards satellite	dBi	6	6
additional loss due suburban scenario (50%LOS/50%NLOS)	dBm	3	3
EIRP density towards the satellite	dB/MHz	-6	14
interference margin for one user terminal to 49.00 dBm/MHz	dB	55.00	35.00
Cumulative interference – user equipment			
number of UMFU user terminals transmitting		315624	3156
additional interference	dB	54.99	34.99
interference margin to 49.00 dBm/MHz	dB	0.01	0.01

Results in this table are for a satellite receive beam size of 1756000 km²

UMFU Deployment Scenario – Urban (10%LOS)

NGSO 15° elevation angle

base station transmitter		62 dBm	75 dBm
max base station EIRP value	dBm	62	75
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	42	55
antenna discrimination towards satellite (15° elevation angle)	dBi	25	25
additional loss due suburban scenario (10%LOS/90%NLOS)	dBm/MHz	9.6	9.6
EIRP density towards the satellite	dB	7.4	20.4
interference margin for one base station to 49.00 dBm/MHz	dB	41.60	28.60
Cumulative interference - base stations			
number of UMFU sectors transmitting		14427	723
additional interference	dB	41.59	28.59
interference margin to 49.00 dBm/MHz	dB	0.01	0.01
user equipment transmitter		23 dBm	43 dBm
max user terminal EIRP value	dBm	23	43
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	3	23
antenna discrimination towards satellite	dBi	6	6
additional loss due urban scenario (10%LOS/90%NLOS)	dB	9.6	9.6
EIRP density towards the satellite	dBm/MHz	-12.6	7.4
interference margin for one user terminal to 49.00 dBm/MHz	dB	61.60	41.60
Cumulative interference – user equipment			
number of UMFU user terminals transmitting		1442681	14427
additional interference	dB	61.59	41.59
interference margin to 49.00 dBm/MHz	dB	0.01	0.01

Results in this table are for a satellite receive beam size of 1756000 km²

UMFU Deployment Scenario – Rural (100%LOS)

NGSO 30° elevation angle

base station transmitter		62 dBm	75 dBm
max base station EIRP value	dBm	62	75
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	42	55
antenna discrimination towards satellite (30° elevation angle)	dBi	28	28
EIRP density towards the satellite	dBm/MHz	14	27
interference margin for one base station to 49.00 dBm/MHz	dB	35.00	22.00
Cumulative interference - base stations			
number of UMFU sectors transmitting		3156	158
additional interference	dB	34.99	21.99
interference margin to 49.00 dBm/MHz	dB	0.01	0.02

Results in this table are for a satellite receive beam size of 1756000 km²

UMFU Deployment Scenario – Suburban (50%LOS)

NGSO 30° elevation angle

base station transmitter		62 dBm	75 dBm
max base station EIRP value	dBm	62	75
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	42	55
antenna discrimination towards satellite (30° elevation angle)	dBi	28	28
additional loss due suburban scenario (50%LOS/50%NLOS)	dBm/MHz	3	3
EIRP density towards the satellite	dB	11	24
interference margin for one base station to 49.00 dBm/MHz	dB	38.00	25.00
Cumulative interference - base stations			
number of UMFU sectors transmitting		6298	316
additional interference	dB	37.99	24.99
interference margin to 49.00 dBm/MHz	dB	0.01	0.01

Results in this table are for a satellite receive beam size of 1756000 km²

UMFU Deployment Scenario – Urban (10%LOS)

NGSO 30° elevation angle

base station transmitter		62 dBm	75 dBm
max base station EIRP value	dBm	62	75
channel bandwidth	MHz	100	100
EIRP density	dBm/MHz	42	55
antenna discrimination towards satellite (30° elevation angle)	dBi	28	28
additional loss due suburban scenario (10%LOS/90%NLOS)	dBm/MHz	9.6	9.6
EIRP density towards the satellite	dB	4.4	17.4
interference margin for one base station to **49.00** dBm/MHz	dB	44.60	31.60
Cumulative interference - base stations			
number of UMFU sectors transmitting		**28785**	**1442**
additional interference	dB	44.59	31.59
interference margin to **49.00** dBm/MHz	dB	0.01	0.01

Results in this table are for a satellite receive beam size of 1756000 km²

UMFU Deployment Scenario – Rural (100%LOS)

GSO case (25.76 dBm/MHz/1000km^2)

base station transmitter		62 dBm
max base station EIRP value	dBm	62
channel bandwidth	MHz	100
EIRP density	dBm/MHz	42
antenna discrimination towards satellite (30° elevation angle)	dBi	28
EIRP density towards the satellite	dBm/MHz	14
interference margin for one base station to 55.07 dBm/MHz	dB	41.07
Cumulative interference - base stations		
number of UMFU sectors transmitting		12757
additional interference	dB	41.0
interference margin to **55.07** dBm/MHz	dB	0.01

Results in this table are for a satellite receive beam size of 853000 km^2

UMFU Deployment Scenario – Suburban (50%LOS)

GSO case (25.76 dBm/MHz/1000km^2)

base station transmitter		62 dBm
max base station EIRP value	dBm	62
channel bandwidth	MHz	100
EIRP density	dBm/MHz	42
antenna discrimination towards satellite (30° elevation angle)	dBi	28
additional loss due suburban scenario (50%LOS/50%NLOS)	dBm/MHz	3
EIRP density towards the satellite	dB	11
interference margin for one base station to **55.07** dBm/MHz	dB	44.07
Cumulative interference - base stations		
number of UMFU sectors transmitting		**25455**
additional interference	dB	44.06
interference margin to **55.07** dBm/MHz	dB	0.01

Results in this table are for a satellite receive beam size of 853000 km^2

UMFU Deployment Scenario – Urban (10%LOS)

GSO case (25.76 dBm/MHz/1000km^2)

base station transmitter		62 dBm
max base station EIRP value	dBm	62
channel bandwidth	MHz	100
EIRP density	dBm/MHz	42
antenna discrimination towards satellite (30° elevation angle)	dBi	28
additional loss due suburban scenario (10%LOS/90%NLOS)	dBm/MHz	9.6
EIRP density towards the satellite	dB	4.4
interference margin for one base station to **55.07** dBm/MHz	dB	50.67
Cumulative interference - base stations		
number of UMFU sectors transmitting		**116351**
additional interference	dB	50.66
interference margin to **55.07** dBm/MHz	dB	0.01

Results in this table are for a satellite receive beam size of 853000 km^2