Effect of Satellite Power Control at Minimum Range (Overhead)

Aggregrate sidelobe power from LMDS CPE transmissions is small when the satellite is at short range because the satellite footprint size is smaller at higher satellite elevations. At minimum range, the footprint is 75 km x 75 km for an area of 5625 sq-km. Compared to the maximum footprint area of 800,000 sq-km, this represents an area reduction of 0.007 which reduces the number of subscribers accordingly. The equivalent CPE sidelobe energy is reduced -21.5 dB. Satellite power would be reduced from maximum range of 2747 km to 780 km, or -10.9 dB. Therefore, return link sidelobe energy is reduced more than the satellite uplink power is reduced by power control.

Main beam coupling would occur if CPE antenna is mispointed and temporarily aligns with the satellite main beam. At minimum range, the satellite uplink is at minimum power. Table A shows the satellite link with a 3 dB margin at minimum range. An LMDS CPE transmission main beam is compared in the last column. The increase in No+Io is from -197.1 dBW/Hz to -196.4 dBW/Hz, or an increase of 0.7 dB. With a normal margin of 3 dB, this would require 0.2 dB additional uplink power.

Table A

Parameters	Units	Elev 90 deg Iridium Clear	Elev 90 deg LMDS Clear
Frequency	GHz	29.2	29.2
Transmit Power	dBW	-26.8	-14.0
Antenna Gain	dB	56.3	34
Losses	dB	-1.3	
EIRP	dBWi	28.2	20.0
Range	Km	780	780
Space Loss	dB	-179.5	-179.5
Propagation Loss	dB	-0.2	-0.2
Polarization Loss	dB	-0.2	-3
TOTAL LOSS	dB	-179.9	-182.7
Receive Sig Strength	dBW	-151.7	-162.7
Pointing Loss	dB	-0.8	-0.8
Antenna Gain	dB	31.1	31.1
RECEIVED SIG POWER	dBW	-121.4	-132.4
Received Eb (3.125 Mbps)	dBW/bit	-186.3	
Received Io (2.5 MHz)	dBW/Hz		-196.4
Tn	deg K	1295	1295
Io (degrees)	deg K	129	1649
No + Io (Power Density)	dBW/Hz	-197.1	-193.9
Match BW (3.125 Mbps)	dB	64.9	64.9
No+Io IN SV MATCHED BW	dBW/Hz	-132.1	-129.0
Link Eb/(No+Io)	dB	10.7	7.5
Required Eb/(No+Io)	dB	7.7	7.7
SV Margin	dB	3.0	-0.2

Conclusions

- The aggregate sidelobe power from CPE return link transmissions reduce more than the SV power during power control at minimum range.

- At 90 degrees elevation, a CPE transmitter with maximum rule power increase that results in main beam coupling only has 0.2 dB Eb/(no+Io) and does not significantly degrade satellite bit error performance, 1E-7 to 2E-7.

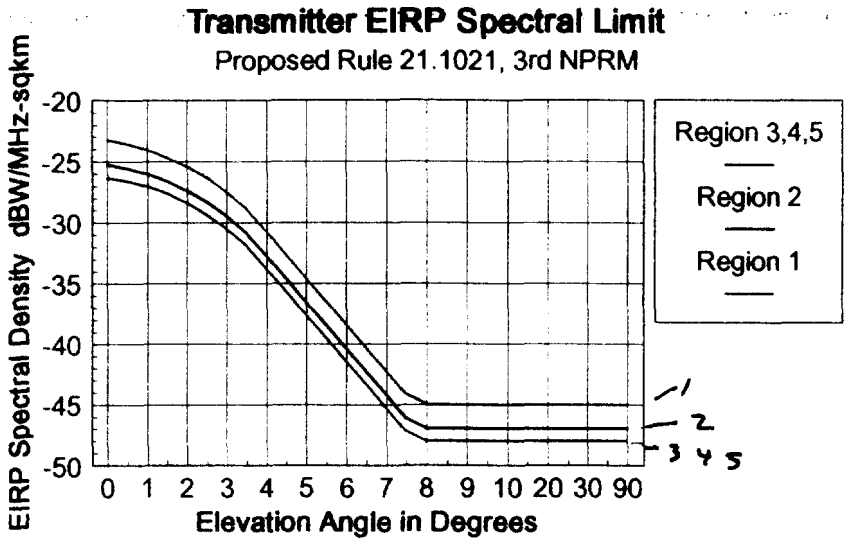
Analysis of CPE Tx's Fit to Proposed Rules, 21.1020 & 21.1021 per 3rd NPRM for 28 GHz using Proposed Rules for CPE Tx's in 150 MHz Band

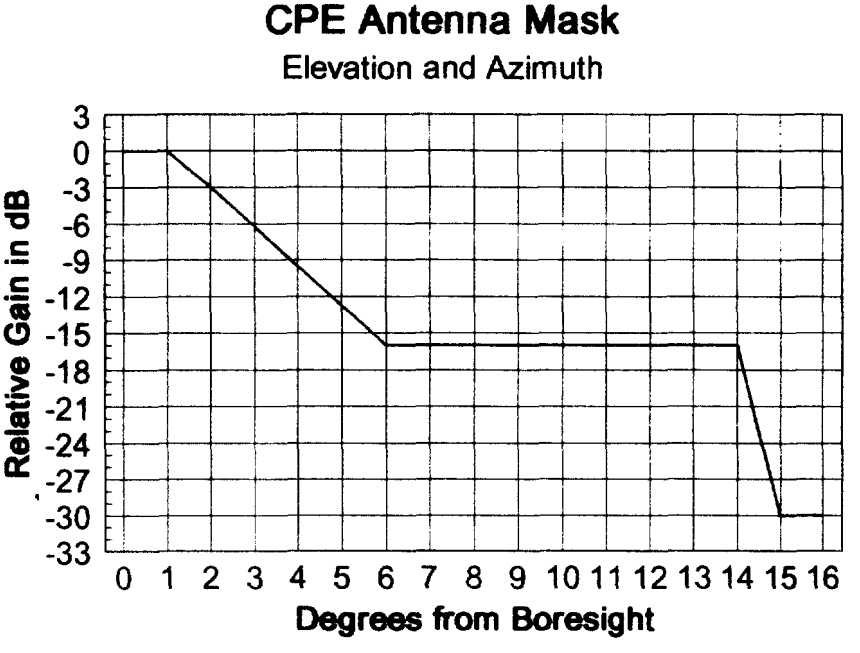
Doug Gray, Hewlett-Packard Co.

HEWLETT PACKARD

D.Gray/11/22/95

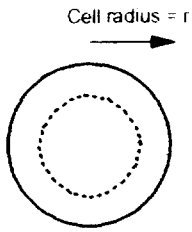
ATTACHMENT K


Transmitter EIRP Spectral Limit
Proposed Rule 21.1021, 3rd NPRM
EIRP Spectral Density dBW/MHz-sqkm
-20
-25
-30
-35
-40
-45
-50
0 1 2 3 4 5 6 7 8 9 10 20 30 90
Elevation Angle in Degrees
Region 3,4,5
Region 2
Region 1
1
2
3 4 5


CPE Antenna Mask
Elevation and Azimuth
Relative Gain in dB
3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Degrees from Boresight

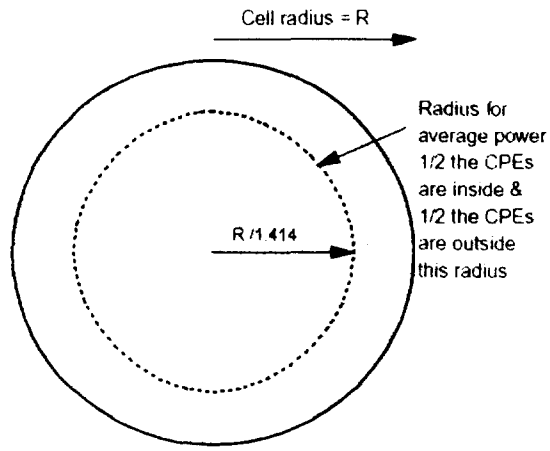
Total power spectral density is dependent only on Maximum EIRP (EIRP at the cell periphery) assuming uniform housing density

Small Cell Case



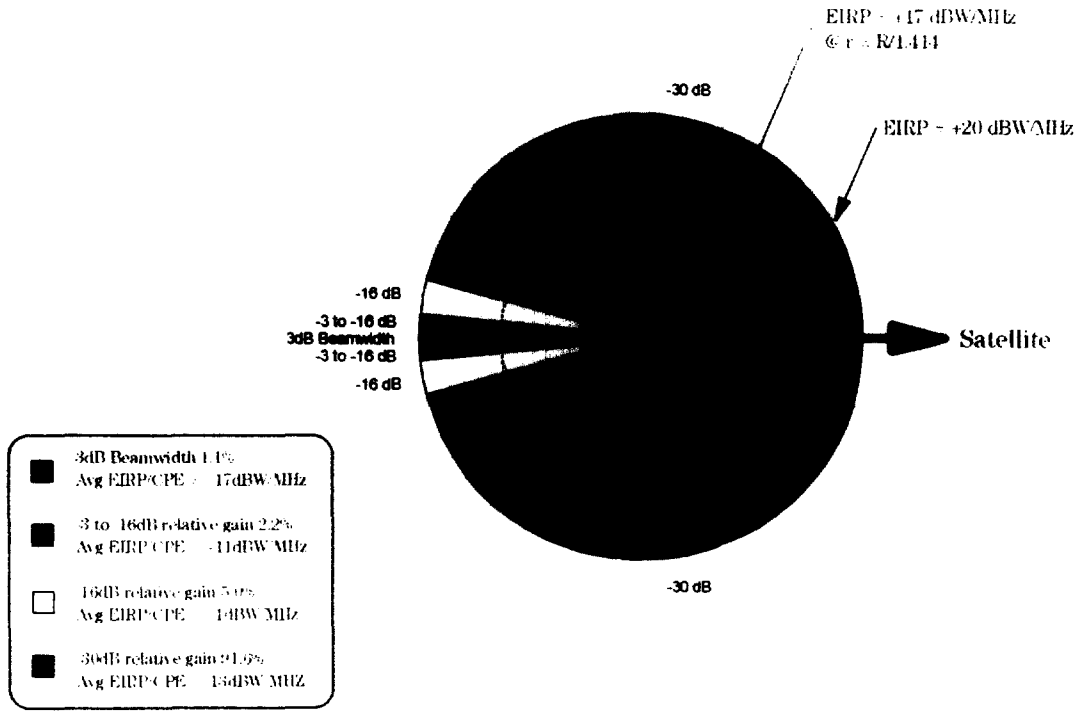
Cell Area = a = $(r/R)^2$ x A
Max EIRP = P
Avg EIRP = P/2 (assuming adaptive pwr control)
PSD/Cell = h x a x P/2
Number of cells to achieve same coverage as large cell = A/a
Total PSD = h x a x (P/2) x (A/a)
= h x (P/2) x A
where h = housing density in households/sq-km

Large Cell Case

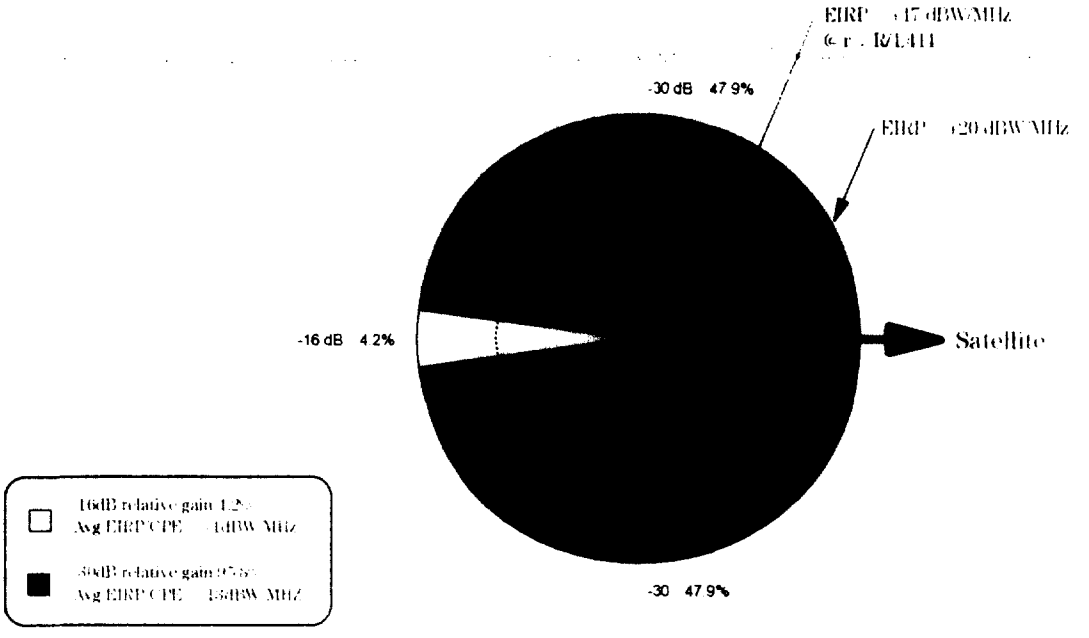


Cell Area = a = A
Max EIRP = P
Avg EIRP = P/2 (assuming adaptive pwr control)
PSD/Cell = h x A x P/2
where h = housing density in households/sq-km

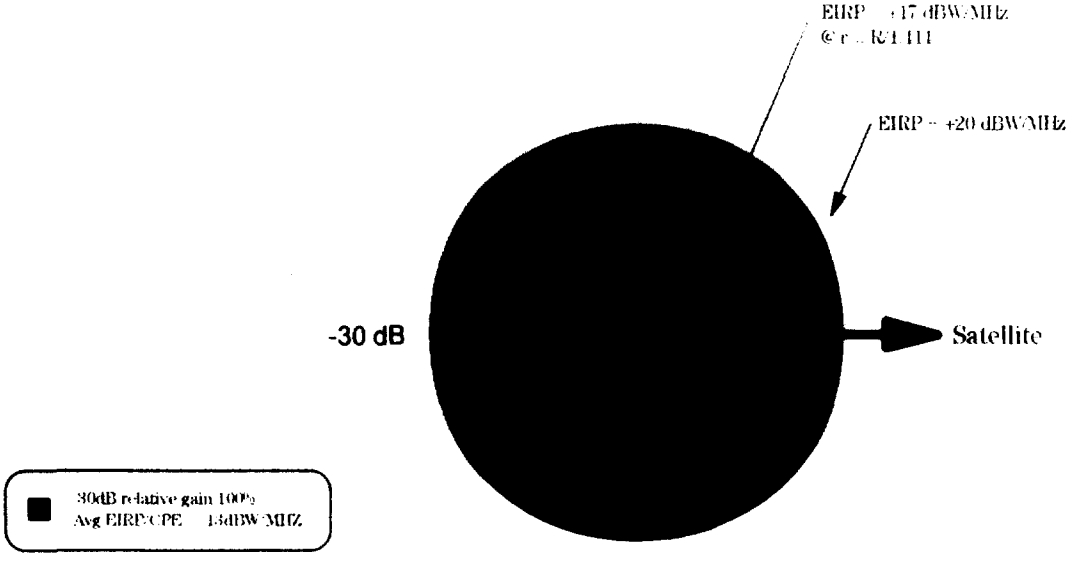
Composite CPE Tx Satellite Interference Potential at 0 Degrees Elevation



Composite CPE Tx Satellite Interference Potential at 6-15 Degrees Elevation



Composite CPE Tx Satellite Interference Potential at 15-90 Degrees Elevation



Calculation of Total EIRP

Equivalent Power per Antenna Sector =

10Log(S) + 10Log(Sector Beamwidth) - 10Log(360) + (Avg EIRP/CPE)

Where S = total number of active subscribers

Demographic Data — 15 Northeast/Mid-Atlantic States

			Column A	Column B	
1	Population	millions	75	75	
2	Surface Area	sq-km	825,700	825,700	
3	Households	millions	25	25	
4	Household Density	HH/sq-km	30	30	
5	Dwelling Units	millions	25	20	Note A.
6	Suitable for LMDS	%	80%	50%	Note B.
7	Take	%	25%	25%	
8	Total Subscribers		5,000,000	2,500,000	
9	Subscribers/MHz	1/150	33,333	16,667	
10	Peak Demand	%	25%		
11	Average Demand	%		10%	Note C.
12	# Active CPEs	@64kbits/s	8,333	1,667	
13	Modulation Efficiency		1	1.5	Note D.
14	Net Active CPEs		533	71	
15	Circuit Efficiency	%	60%	60%	
16	Active CPEs		889	119	
17	Active CPEs/sq-km		0.001077	0.000144	

Column "A" summarizes the numbers used in previous analysis and was generated to represent a "worse" case scenario.

Column "B" represents a more realistic scenario. It would be appropriate to apply a distribution to the final result to account for the effects of non-uniform CPE Tx densities and the effects of varying demand.

Notes:

A. Number of households include those in multiple dwelling units (MDUs), these housholds would not have 1 CPE per houshold. Individual dwelling units are a better indication of the number of possible subscribers.

B. LMDS will not be economically viable in all geographic areas due to the need for line-of-sight or near" line-of-sight conditions. The density of trees, buidings of different heights, mountains, etc. will affect the suitability of a given area. Housing density will also affect the economic viability of LMDS as a delivery system versus other alternatives. The percent suitable for LMDS will vary from region to region.

C. Peak demand will occur for only short periods of time. Average demand is a better measure for calculating average EIRP.

D. This reflects the use of QPSK modulation which has a typical modulation efficiency of at least 1.5 bits per Hz.

Demographic Data By Region

			Northeast	South	Midwest	West		U.S. Total
1	Population	millions	58.93	78.83	59.83	53.66		251.25
2	Surface Area	sq-km	515,434	2,171,282	1,950,893	4,543,136		9,180,745
3	Households	millions	21.79	28.98	22.12	19.84		92.73
4	Household Density	HH/sq-km	42	13	11	4		10
5	Dwelling Units	millions	17.43	23.18	17.70	15.87		74.18
6	Suitable for LMDS	%	**50%**	**30%**	**70%**	**70%**	←	**53%**
7	Take	%	25%	25%	25%	25%		25%
8	Total Subscribers		2,179,000	1,738,800	3,096,800	2,777,600		9,792,200
9	Subscribers/MHz	1/150	14,527	11,592	20,645	18,517		65,281
10	Average Demand	%	10%	10%	10%	10%		10%
11	# Active CPEs	@64kbits/s	1,453	1,159	2,065	1,852		6,528
12	Modulation Efficiency		1.5	1.5	1.5	1.5		1.5
13	Net Active CPEs		62	49	88	79		279
14	Circuit Efficiency	%	60%	60%	60%	60%		60%
15	Active CPEs		**103**	**82**	**147**	**132**		**464**
16	Active CPEs/sq-km		0.0002	0.000038	0.000075	0.000029		0.000051

Source: 1992 Rand-McNally Commercial Atlas

EIRP per Hub at 0 Degrees Elevation — 15 Northeast/Mid-Atlantic States

Active CPE's #	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area of 15 NE States sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
119	-2.6	-5.6	-12.0	-13.4	-0.28	20.47	-38.53	-3.00	-3.00	825,700	[illegible]	-25
200	-2.6	-5.6	-12.0	-13.4	-0.28	22.73	-37.27	-3.00	-3.00	825,700	-42.44	-25
300	-2.6	-5.6	-12.0	-13.4	-0.28	24.49	-35.51	-3.00	-3.00	825,700	-40.68	-25
400	-2.6	-5.6	-12.0	-13.4	-0.28	25.74	-34.26	-3.00	-3.00	825,700	-39.43	-25
500	-2.6	-5.6	-12.0	-13.4	-0.28	26.71	-33.29	-3.00	-3.00	825,700	-38.46	-25
600	-2.6	-5.6	-12.0	-13.4	-0.28	27.50	-32.50	-3.00	-3.00	825,700	-37.67	-25
700	-2.6	-5.6	-12.0	-13.4	-0.28	28.17	-31.83	-3.00	-3.00	825,700	-37.00	-25
800	-2.6	-5.6	-12.0	-13.4	-0.28	28.75	-31.25	-3.00	-3.00	825,700	-36.42	-25
900	-2.6	-5.6	-12.0	-13.4	-0.28	29.26	-30.74	-3.00	-3.00	825,700	-35.91	-25
1000	-2.6	-5.6	-12.0	-13.4	-0.28	29.72	-30.28	-3.00	-3.00	825,700	-35.45	-25

EIRP per Hub at 7.5 Degrees Elevation

Active CPE's #	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area of 15 NE States sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
119			-9.8	-13.4	-8.23	12.63	-47.47	-3.00	0.00	825,700	[illegible]	-46
200			-9.8	-13.4	-8.23	14.78	-45.22	-3.00	0.00	825,700	-47.38	-46
275			-9.8	-13.4	-8.23	16.17	-43.83	-3.00	0.00	825,700	-46.00	-46
400			-9.8	-13.4	-8.23	17.79	-42.21	-3.00	0.00	825,700	-44.38	-46
500			-9.8	-13.4	-8.23	18.76	-41.24	-3.00	0.00	825,700	-43.41	-46
600			-9.8	-13.4	-8.23	19.55	-40.45	-3.00	0.00	825,700	-42.61	-46
700			-9.8	-13.4	-8.23	20.22	-39.78	-3.00	0.00	825,700	-41.94	-46
800			-9.8	-13.4	-8.23	20.80	-39.20	-3.00	0.00	825,700	-41.36	-46
900			-9.8	-13.4	-8.23	21.31	-38.69	-3.00	0.00	825,700	-40.85	-46
1000			-9.8	-13.4	-8.23	21.77	-38.23	-3.00	0.00	825,700	-40.40	-46

EIRP per Hub at 90 Degrees Elevation

Active CPE's #	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area of 15 NE States sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
119				-13.0	-13.00	7.76	-52.24	-3.00	0.00	825,700	-54.41	-47
200				-13.0	-13.00	10.01	-49.99	-3.00	0.00	825,700	-52.16	-47
300				-13.0	-13.00	11.77	-48.23	-3.00	0.00	825,700	-50.40	-47
400				-13.0	-13.00	13.02	-46.98	-3.00	0.00	825,700	-49.15	-47
500				-13.0	-13.00	13.99	-46.01	-3.00	0.00	825,700	-48.18	-47
600				-13.0	-13.00	15.17	-44.83	-3.00	0.00	825,700	-47.00	-47
700				-13.0	-13.00	15.45	-44.55	-3.00	0.00	825,700	-46.72	-47
800				-13.0	-13.00	16.03	-43.97	-3.00	0.00	825,700	-46.14	-47
900				-13.0	-13.00	16.54	-43.46	-3.00	0.00	825,700	-45.63	-47
1000				-13.0	-13.00	17.00	-43.00	-3.00	0.00	825,700	-45.17	-47

EIRP per Hub at 0 Degrees Elevation

Northeast as defined in Rand-McNally Commercial Atlas

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
163	-2.6	-5.6	-12.0	-13.4	-0.26	19.85	-40.15	-3.00	-3.00	515,434	-43.30	-25
200	-2.6	-5.6	-12.0	-13.4	-0.26	22.73	-37.27	-3.00	-3.00	515,434	-40.39	-25
300	-2.6	-5.6	-12.0	-13.4	-0.26	24.49	-35.51	-3.00	-3.00	515,434	-38.63	-25
400	-2.6	-5.6	-12.0	-13.4	-0.26	25.74	-34.26	-3.00	-3.00	515,434	-37.38	-25
500	-2.6	-5.6	-12.0	-13.4	-0.26	26.71	-33.29	-3.00	-3.00	515,434	-36.41	-25
600	-2.6	-5.6	-12.0	-13.4	-0.26	27.50	-32.50	-3.00	-3.00	515,434	-35.62	-25
700	-2.6	-5.6	-12.0	-13.4	-0.26	28.17	-31.83	-3.00	-3.00	515,434	-34.95	-25
800	-2.6	-5.6	-12.0	-13.4	-0.26	28.75	-31.25	-3.00	-3.00	515,434	-34.37	-25
900	-2.6	-5.6	-12.0	-13.4	-0.26	29.26	-30.74	-3.00	-3.00	515,434	-33.86	-25
1000	-2.6	-5.6	-12.0	-13.4	-0.26	29.72	-30.28	-3.00	-3.00	515,434	-33.40	-25

EIRP per Hub at 7.5 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
163			-9.8	-13.4	-8.23	11.90	-48.10	-3.00	0.00	515,434	-46.27	-46
172			-9.8	-13.4	-8.23	14.13	-45.87	-3.00	0.00	515,434	-46.00	-46
300			-9.8	-13.4	-8.23	16.54	-43.46	-3.00	0.00	515,434	-43.58	-46
400			-9.8	-13.4	-8.23	17.79	-42.21	-3.00	0.00	515,434	-42.33	-46
500			-9.8	-13.4	-8.23	18.76	-41.24	-3.00	0.00	515,434	-41.36	-46
600			-9.8	-13.4	-8.23	19.55	-40.45	-3.00	0.00	515,434	-40.57	-46
700			-9.8	-13.4	-8.23	20.22	-39.78	-3.00	0.00	515,434	-39.90	-46
800			-9.8	-13.4	-8.23	20.80	-39.20	-3.00	0.00	515,434	-39.32	-46
900			-9.8	-13.4	-8.23	21.31	-38.69	-3.00	0.00	515,434	-38.81	-46
1000			-9.8	-13.4	-8.23	21.77	-38.23	-3.00	0.00	515,434	-38.35	-46

EIRP per Hub at 90 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
163				-13.0	-13.00	7.13	-52.87	-3.00	0.00	515,434	-52.00	-47
200				-13.0	-13.00	10.01	-49.99	-3.00	0.00	515,434	-50.11	-47
300				-13.0	-13.00	11.77	-48.23	-3.00	0.00	515,434	-48.35	-47
400				-13.0	-13.00	13.12	-46.88	-3.00	0.00	515,434	-47.00	-47
500				-13.0	-13.00	13.99	-46.01	-3.00	0.00	515,434	-46.13	-47
600				-13.0	-13.00	14.78	-45.22	-3.00	0.00	515,434	-45.34	-47
700				-13.0	-13.00	15.45	-44.55	-3.00	0.00	515,434	-44.67	-47
800				-13.0	-13.00	16.03	-43.97	-3.00	0.00	515,434	-44.09	-47
900				-13.0	-13.00	16.54	-43.46	-3.00	0.00	515,434	-43.58	-47
1000				-13.0	-13.00	17.00	-43.00	-3.00	0.00	515,434	-43.12	-47

EIRP per Hub at 0 Degrees Elevation

South as defined in Rand-McNally Commercial Atlas

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polarization in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/sq-km	Region 1 EIRP Spec dBW/MHz/sq-km
82	-2.6	-5.6	-12.0	-13.4	-0.28	16.86	-41.14	-3.00	-3.00	2,171,282	-39.51	-23
200	-2.6	-5.6	-12.0	-13.4	-0.28	22.73	-37.27	-3.00	-3.00	2,171,282	-45.64	-23
300	-2.6	-5.6	-12.0	-13.4	-0.28	24.49	-35.51	-3.00	-3.00	2,171,282	-44.88	-23
400	-2.6	-5.6	-12.0	-13.4	-0.28	25.74	-34.26	-3.00	-3.00	2,171,282	-43.63	-23
500	-2.6	-5.6	-12.0	-13.4	-0.28	26.71	-33.29	-3.00	-3.00	2,171,282	-42.66	-23
600	-2.6	-5.6	-12.0	-13.4	-0.28	27.50	-32.50	-3.00	-3.00	2,171,282	-41.87	-23
700	-2.6	-5.6	-12.0	-13.4	-0.28	28.17	-31.83	-3.00	-3.00	2,171,282	-41.20	-23
800	-2.6	-5.6	-12.0	-13.4	-0.28	28.75	-31.25	-3.00	-3.00	2,171,282	-40.62	-23
900	-2.6	-5.6	-12.0	-13.4	-0.28	29.26	-30.74	-3.00	-3.00	2,171,282	-40.11	-23
1000	-2.6	-5.6	-12.0	-13.4	-0.28	29.72	-30.28	-3.00	-3.00	2,171,282	-39.65	-23

EIRP per Hub at 7.5 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polarization in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/sq-km	Region 1 EIRP Spec dBW/MHz/sq-km
82			-9.8	-13.4	-8.23	10.91	-49.09	-3.00	0.00	2,171,282	-46.48	-44
200			-9.8	-13.4	-8.23	14.78	-45.22	-3.00	0.00	2,171,282	-51.59	-44
300			-9.8	-13.4	-8.23	16.54	-43.46	-3.00	0.00	2,171,282	-49.82	-44
400			-9.8	-13.4	-8.23	17.79	-42.21	-3.00	0.00	2,171,282	-48.57	-44
500			-9.8	-13.4	-8.23	18.76	-41.24	-3.00	0.00	2,171,282	-47.60	-44
600			-9.8	-13.4	-8.23	19.55	-40.45	-3.00	0.00	2,171,282	-46.81	-44
700			-9.8	-13.4	-8.23	20.22	-39.78	-3.00	0.00	2,171,282	-46.14	-44
800			-9.8	-13.4	-8.23	20.80	-39.20	-3.00	0.00	2,171,282	-45.58	-44
900			-9.8	-13.4	-8.23	21.31	-38.69	-3.00	0.00	2,171,282	-45.05	-44
1000			-9.8	-13.4	-8.23	21.77	-38.23	-3.00	0.00	2,171,282	-44.59	-44

EIRP per Hub at 90 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polarization in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/sq-km	Region 1 EIRP Spec dBW/MHz/sq-km
82				-13.0	-13.00	6.14	-53.86	-3.00	0.00	2,171,282	-50.23	-45
200				-13.0	-13.00	10.14	-49.86	-3.00	0.00	2,171,282	-54.23	-45
300				-13.0	-13.00	11.77	-48.23	-3.00	0.00	2,171,282	-53.60	-45
400				-13.0	-13.00	13.02	-46.98	-3.00	0.00	2,171,282	-52.35	-45
500				-13.0	-13.00	13.99	-46.01	-3.00	0.00	2,171,282	-51.38	-45
600				-13.0	-13.00	14.78	-45.22	-3.00	0.00	2,171,282	-50.59	-45
700				-13.0	-13.00	15.45	-44.55	-3.00	0.00	2,171,282	-49.92	-45
800				-13.0	-13.00	16.03	-43.97	-3.00	0.00	2,171,282	-49.34	-45
900				-13.0	-13.00	16.54	-43.46	-3.00	0.00	2,171,282	-48.82	-45
1000				-13.0	-13.00	17.00	-43.00	-3.00	0.00	2,171,282	-48.37	-45

EIRP per Hub at 0 Degrees Elevation

Midwest as defined in Rand-McNally Commercial Atlas

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
100	-2.6	-5.6	-12.0	-13.4	-0.28	19.72	-40.28	-3.00	-3.00	1,950,893	-49.18	-25
147	-2.6	-5.6	-12.0	-13.4	-0.28	21.39	-38.61	-3.00	-3.00	1,950,893	-47.51	-25
300	-2.6	-5.6	-12.0	-13.4	-0.28	24.49	-35.51	-3.00	-3.00	1,950,893	-44.41	-25
400	-2.6	-5.6	-12.0	-13.4	-0.28	25.74	-34.26	-3.00	-3.00	1,950,893	-43.16	-25
500	-2.6	-5.6	-12.0	-13.4	-0.28	26.71	-33.29	-3.00	-3.00	1,950,893	-42.19	-25
600	-2.6	-5.6	-12.0	-13.4	-0.28	27.50	-32.50	-3.00	-3.00	1,950,893	-41.40	-25
700	-2.6	-5.6	-12.0	-13.4	-0.28	28.17	-31.83	-3.00	-3.00	1,950,893	-40.73	-25
800	-2.6	-5.6	-12.0	-13.4	-0.28	28.75	-31.25	-3.00	-3.00	1,950,893	-40.15	-25
900	-2.6	-5.6	-12.0	-13.4	-0.28	29.26	-30.74	-3.00	-3.00	1,950,893	-39.64	-25
1000	-2.6	-5.6	-12.0	-13.4	-0.28	29.72	-30.28	-3.00	-3.00	1,950,893	-39.18	-25

EIRP per Hub at 7.8 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
100			-9.8	-13.4	-8.23	11.77	-48.23	-3.00	0.00	1,950,893	-54.13	-46
147			-9.8	-13.4	-8.23	13.45	-46.55	-3.00	0.00	1,950,893	-52.45	-46
300			-9.8	-13.4	-8.23	16.54	-43.46	-3.00	0.00	1,950,893	-49.36	-46
400			-9.8	-13.4	-8.23	17.79	-42.21	-3.00	0.00	1,950,893	-48.11	-46
500			-9.8	-13.4	-8.23	18.76	-41.24	-3.00	0.00	1,950,893	-47.14	-46
600			-9.8	-13.4	-8.23	19.55	-40.45	-3.00	0.00	1,950,893	-46.35	-46
650			-9.8	-13.4	-8.23	19.90	-40.10	-3.00	0.00	1,950,893	-46.00	-46
800			-9.8	-13.4	-8.23	20.80	-39.20	-3.00	0.00	1,950,893	-45.10	-46
900			-9.8	-13.4	-8.23	21.31	-38.69	-3.00	0.00	1,950,893	-44.59	-46
1000			-9.8	-13.4	-8.23	21.77	-38.23	-3.00	0.00	1,950,893	-44.13	-46

EIRP per Hub at 90 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBW/MHz	Equiv. Pwr Ant. Sect 2 dBW/MHz	Equiv. Pwr Ant. Sect 3 dBW/MHz	Equiv. Pwr Ant. Sect 4 dBW/MHz	Tot. Equiv. EIRP dBW/MHz	Total EIRP dBW/MHz	Total EIRP dBW/Hz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBW/MHz/ sq-km	Region 2 EIRP Spec dBW/MHz/ sq-km
100				-13.0	-13.00	7.00	-53.00	-3.00	0.00	1,950,893	-58.90	-47
147				-13.0	-13.00	8.67	-51.33	-3.00	0.00	1,950,893	-57.23	-47
300				-13.0	-13.00	11.77	-48.23	-3.00	0.00	1,950,893	-54.13	-47
400				-13.0	-13.00	13.02	-46.98	-3.00	0.00	1,950,893	-52.88	-47
500				-13.0	-13.00	13.99	-46.01	-3.00	0.00	1,950,893	-51.91	-47
600				-13.0	-13.00	14.78	-45.22	-3.00	0.00	1,950,893	-51.12	-47
700				-13.0	-13.00	15.45	-44.55	-3.00	0.00	1,950,893	-50.45	-47
800				-13.0	-13.00	16.03	-43.97	-3.00	0.00	1,950,893	-49.87	-47
900				-13.0	-13.00	16.54	-43.46	-3.00	0.00	1,950,893	-49.36	-47
1000				-13.0	-13.00	17.00	-43.00	-3.00	0.00	1,950,893	-48.90	-47

EIRP per Hub at 0 Degrees Elevation

West as defined in Rand-McNally Commercial Atlas

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBWMHz	Equiv. Pwr Ant. Sect 2 dBWMHz	Equiv. Pwr Ant. Sect 3 dBWMHz	Equiv. Pwr Ant. Sect 4 dBWMHz	Tot. Equiv. EIRP dBWMHz	Total EIRP dBWMHz	Total EIRP dBWHz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBWMHz/ sq-km	Reg. 3,4,5 EIRP Spec dBWMHz/ sq-km
100	-2.6	-5.6	-12.0	-13.4	-0.26	19.72	-40.28	-3.00	-3.00	4,543,136	-52.86	-26
132	-2.6	-5.6	-12.0	-13.4	-0.26	20.92	-39.08	-3.00	-3.00	4,543,136	-51.65	-26
300	-2.6	-5.6	-12.0	-13.4	-0.26	24.49	-35.51	-3.00	-3.00	4,543,136	-48.08	-26
400	-2.6	-5.6	-12.0	-13.4	-0.26	25.74	-34.26	-3.00	-3.00	4,543,136	-46.83	-26
500	-2.6	-5.6	-12.0	-13.4	-0.26	26.71	-33.29	-3.00	-3.00	4,543,136	-45.87	-26
600	-2.6	-5.6	-12.0	-13.4	-0.26	27.50	-32.50	-3.00	-3.00	4,543,136	-45.07	-26
700	-2.6	-5.6	-12.0	-13.4	-0.26	28.17	-31.83	-3.00	-3.00	4,543,136	-44.40	-26
800	-2.6	-5.6	-12.0	-13.4	-0.26	28.75	-31.25	-3.00	-3.00	4,543,136	-43.82	-26
900	-2.6	-5.6	-12.0	-13.4	-0.26	29.26	-30.74	-3.00	-3.00	4,543,136	-43.31	-26
1000	-2.6	-5.6	-12.0	-13.4	-0.26	29.72	-30.28	-3.00	-3.00	4,543,136	-42.86	-26

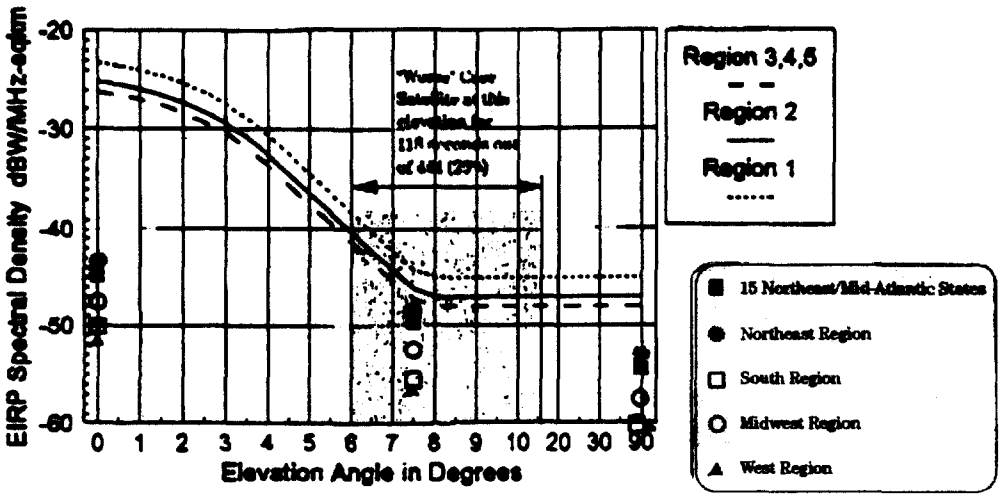
EIRP per Hub at 7.5 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBWMHz	Equiv. Pwr Ant. Sect 2 dBWMHz	Equiv. Pwr Ant. Sect 3 dBWMHz	Equiv. Pwr Ant. Sect 4 dBWMHz	Tot. Equiv. EIRP dBWMHz	Total EIRP dBWMHz	Total EIRP dBWHz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBWMHz/ sq-km	Reg. 3,4,5 EIRP Spec dBWMHz/ sq-km
100			-9.6	-13.4	-8.23	11.77	-48.23	-3.00	0.00	4,543,136	-57.80	-47
132			-9.6	-13.4	-8.23	12.98	-47.02	-3.00	0.00	4,543,136	-56.59	-47
300			-9.6	-13.4	-8.23	16.54	-43.46	-3.00	0.00	4,543,136	-53.03	-47
400			-9.6	-13.4	-8.23	17.79	-42.21	-3.00	0.00	4,543,136	-51.78	-47
500			-9.6	-13.4	-8.23	18.76	-41.24	-3.00	0.00	4,543,136	-50.81	-47
600			-9.6	-13.4	-8.23	19.55	-40.45	-3.00	0.00	4,543,136	-50.02	-47
700			-9.6	-13.4	-8.23	20.22	-39.78	-3.00	0.00	4,543,136	-49.35	-47
800			-9.6	-13.4	-8.23	20.80	-39.20	-3.00	0.00	4,543,136	-48.77	-47
900			-9.6	-13.4	-8.23	21.31	-38.69	-3.00	0.00	4,543,136	-48.26	-47
1000			-9.6	-13.4	-8.23	21.77	-38.23	-3.00	0.00	4,543,136	-47.80	-47

EIRP per Hub at 90 Degrees Elevation

Active CPE's S	Equiv. Pwr Ant. Sect 1 dBWMHz	Equiv. Pwr Ant. Sect 2 dBWMHz	Equiv. Pwr Ant. Sect 3 dBWMHz	Equiv. Pwr Ant. Sect 4 dBWMHz	Tot. Equiv. EIRP dBWMHz	Total EIRP dBWMHz	Total EIRP dBWHz	Antenna Polariza-tion in dB	Blocking in dB	Area in sq-km	PSAD dBWMHz/ sq-km	Reg. 3,4,5 EIRP Spec dBWMHz/ sq-km
100				-13.0	-13.00	7.00	-53.00	-3.00	0.00	4,543,136	-62.57	-48
132				-13.0	-13.00	8.21	-51.79	-3.00	0.00	4,543,136	-61.37	-48
300				-13.0	-13.00	11.77	-48.23	-3.00	0.00	4,543,136	-57.80	-48
400				-13.0	-13.00	13.02	-46.98	-3.00	0.00	4,543,136	-56.55	-48
500				-13.0	-13.00	13.99	-46.01	-3.00	0.00	4,543,136	-55.58	-48
600				-13.0	-13.00	14.78	-45.22	-3.00	0.00	4,543,136	-54.79	-48
700				-13.0	-13.00	15.45	-44.55	-3.00	0.00	4,543,136	-54.12	-48
800				-13.0	-13.00	16.03	-43.97	-3.00	0.00	4,543,136	-53.54	-48
900				-13.0	-13.00	16.54	-43.46	-3.00	0.00	4,543,136	-53.03	-48
1000				-13.0	-13.00	17.00	-43.00	-3.00	0.00	4,543,136	-52.57	-48

Transmitter EIRP Spectral Limit as per Proposed Rule 21.1020 & 21.1021, 3rd NPRM with Projected EIRP Levels for U.S. Regions



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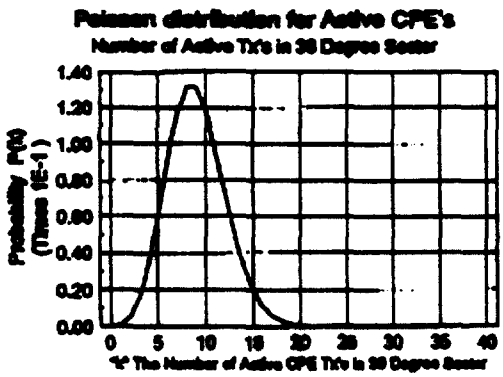
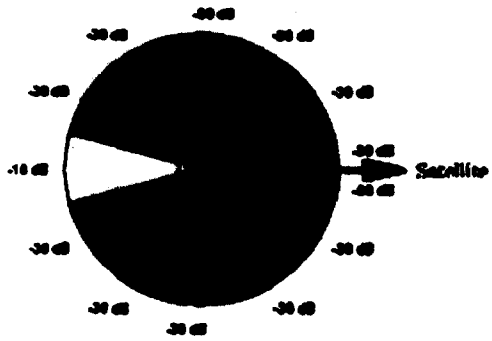
Composite CPE Tx Satellite Interference Potential at 6-15 Degrees Elevation





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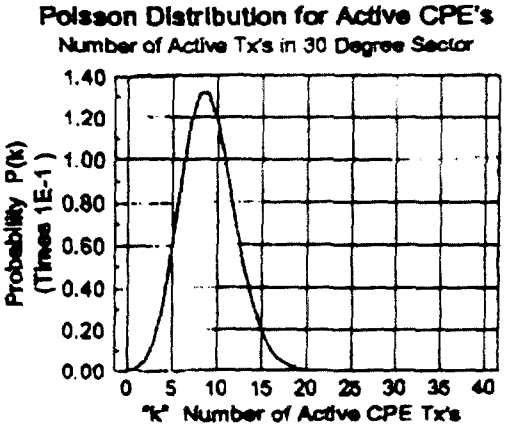
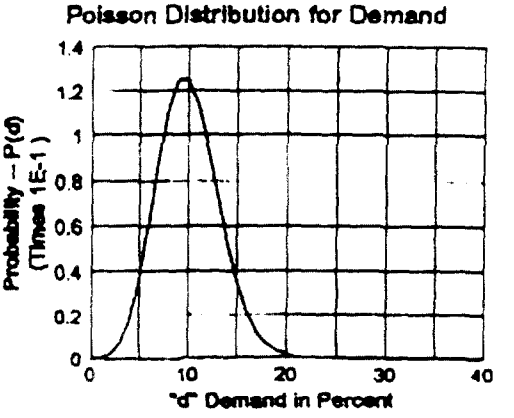
Probability Distribution for Demand and Active CPE Tx's in 30 Degree Sector





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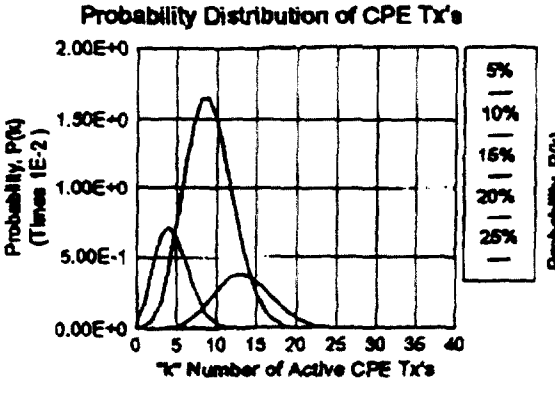
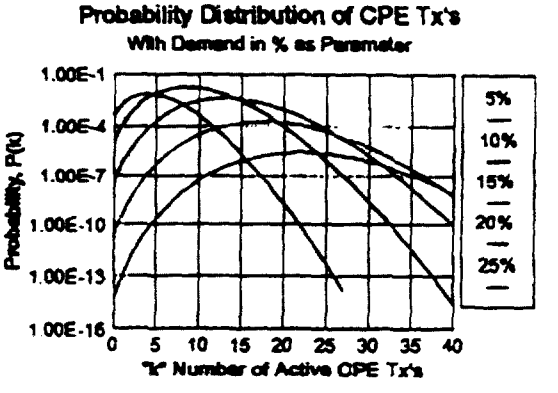
Joint Probability Distribution for Demand and Active CPE Tx's in 30 Degree Sector





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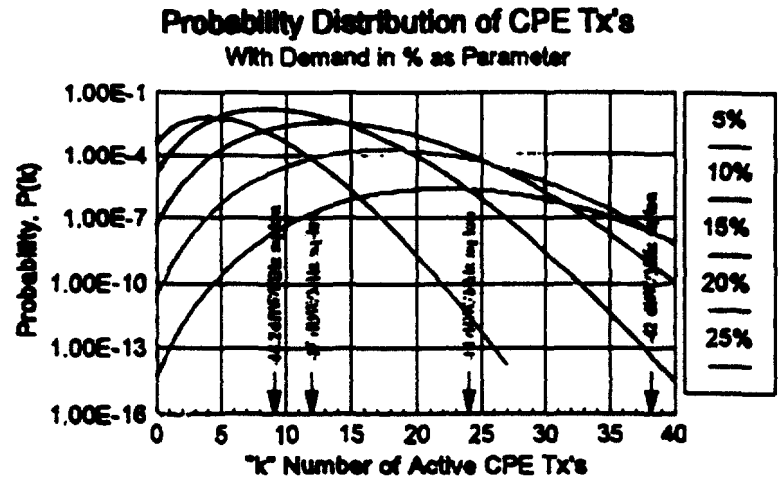
Joint Probability Distribution for Demand and Active CPE Tx's in 30 Degree Sector



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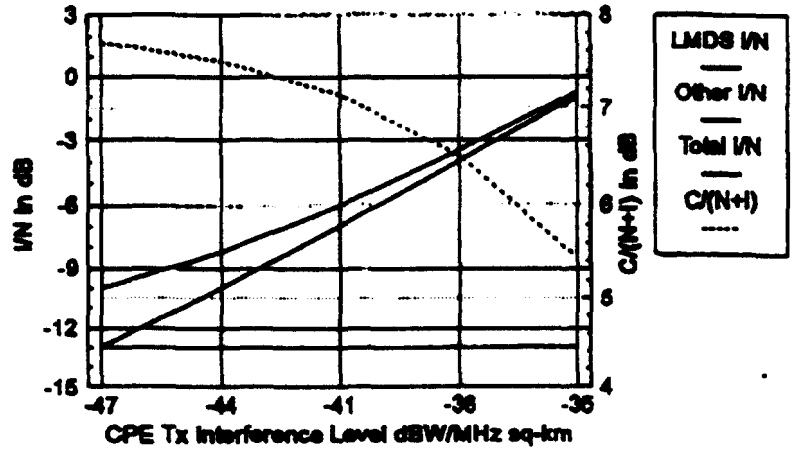
Effect of Interference Level on C/(N+I)



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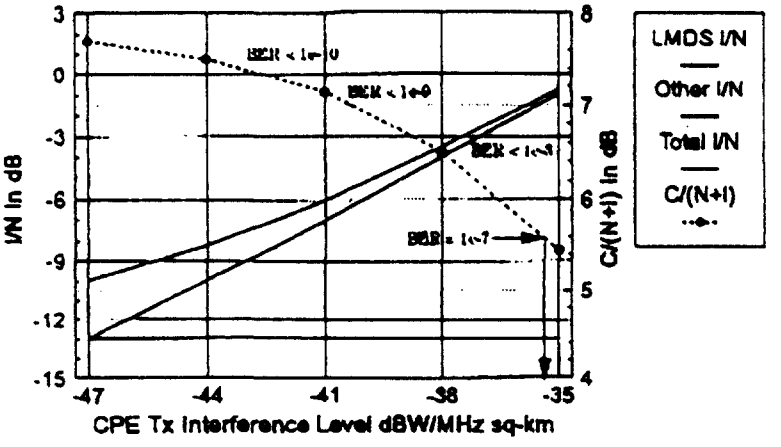
Effect of Interference Level on C/(N+I) and BER



Summary

- In the major geographical regions in the continental U.S., assuming a uniform distribution of active CPE Tx's pointing in their intended direction, the PSAD can be expected to be:
  - At 0 degrees elevation, 17dB to 27dB below the level specified in proposed Rule 21.1021, 3rd NPRM.
  - At 6.0 to 15 degrees elevation, 2dB to 11dB below the level specified in proposed Rule 21.1021, 3rd NPRM.
  - At 15 to 90 degrees elevation, 6dB to 15dB below the level specified in proposed Rule 21.1021, 3rd NPRM.
- Statisical spread in PSAD due to demand and non-uniformly distributed active CPE Tx's will result in higher PSAD and in the Northeast could result in levels exceeding proposed Rule 21.1021, 3rd NPRM, but with very low probabilities.
  - Assuming a Poisson distribution, the probability of sufficient interference to cause BER to drop to 1e-8 is < 1e-7.

D.Gray/11/22/95

DISTRIBUTION

November 28, 1995

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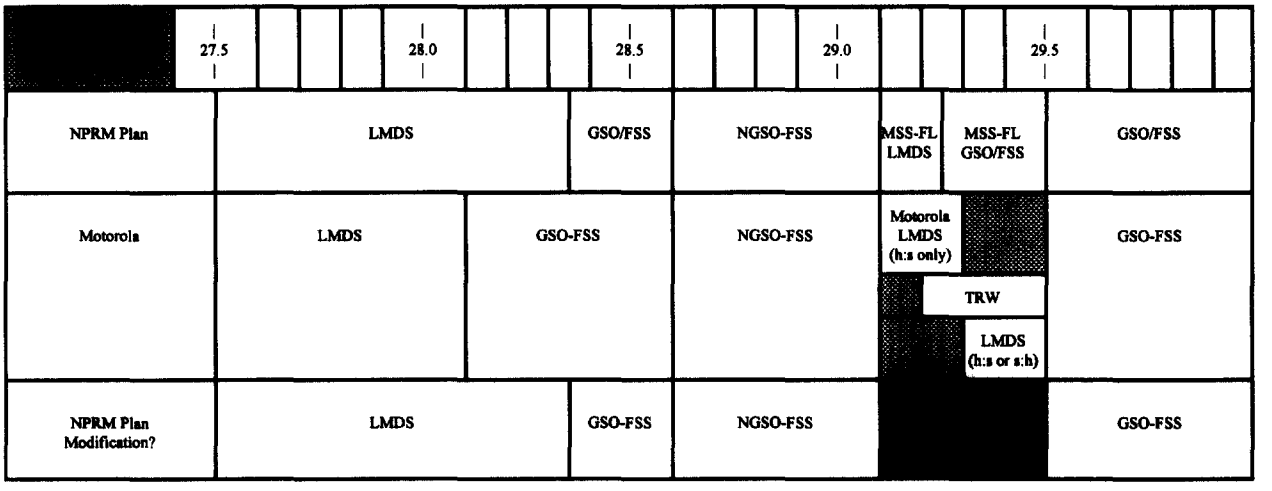
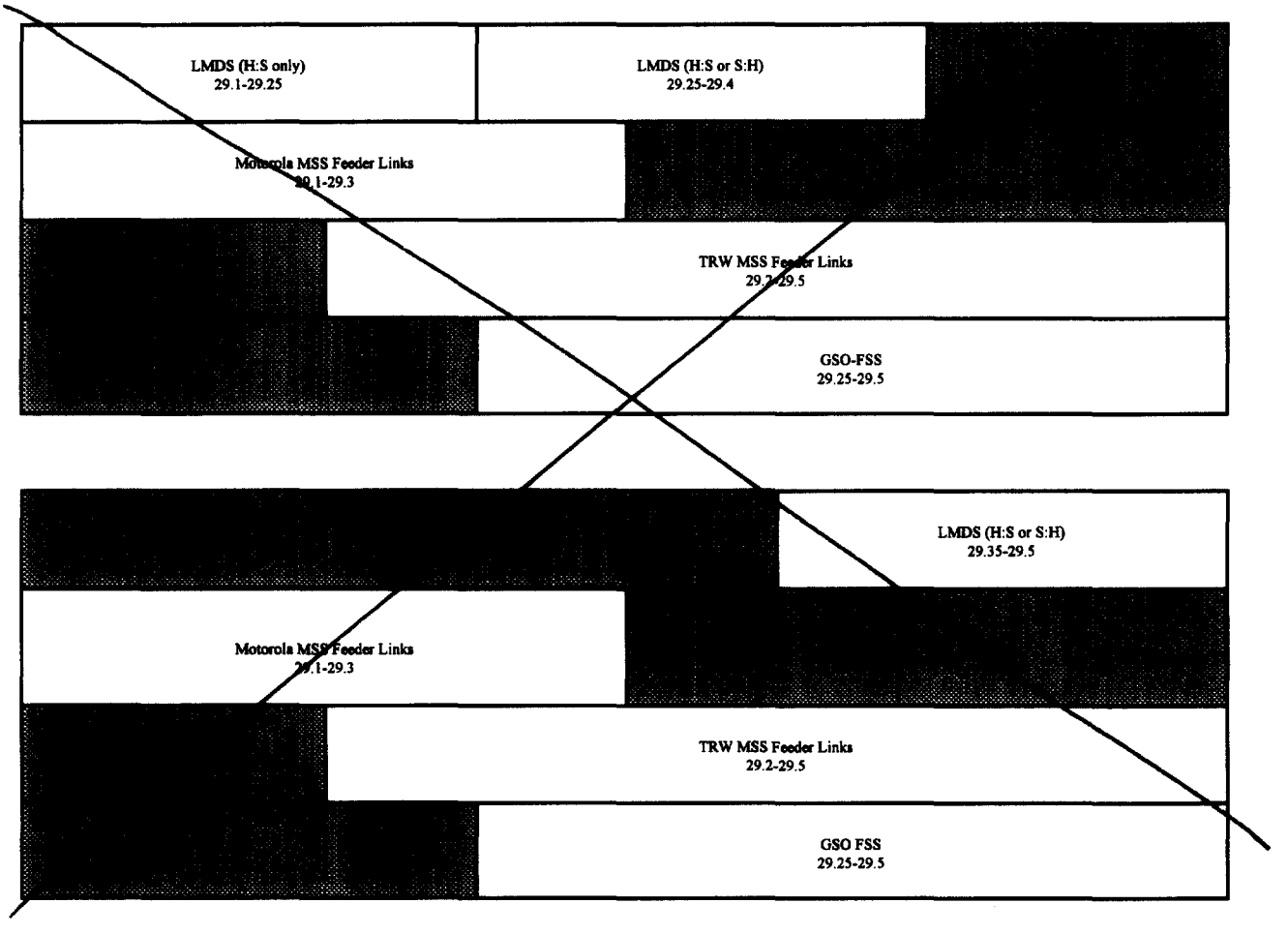
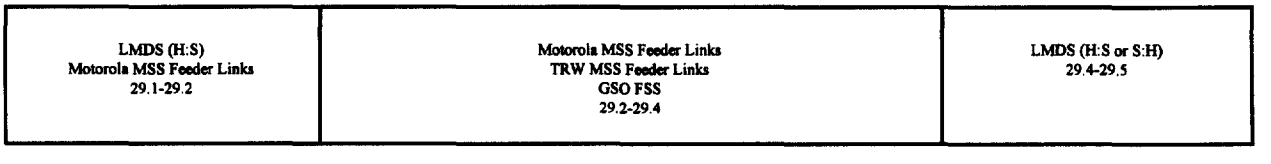


Alternatives for 29.1 - 29.5 GHz:





LMDS AND IRIDIUM SHARING
FOR THE
29.1 TO 29.25 GHZ BAND

DECEMBER 1, 1995

SHARING SUMMARY

EXTENSIVE ANALYSES SHOW LMDS SUBSCRIBER RETURN LINKS AND IRIDIUM MSS/FSS FEEDER LINKS CAN SHARE THE 29.1-29.25 GHZ BAND.

- Acceptable bit error rates are achievable while sharing.(attachments A-D)
- Minimum elevation for the mid-CONUS gateway is 11.9 degrees resulting in a 4 dB system power control margin. (attachment E)
- Power spectral density is not dependent on LMDS cell radius. (attachment F)
- Look-up angle for CPEs are typically not greater than 5 degrees. (attachment G)
- Maximum slant range to the satellite is less at the 11 degree elevation
  - -results in 1.73 dB increase in the gateway signal, which is more than adequate to offset the 0.2 dB or 0.4 dB produced by either 5 or 10 percent interference.
  - -sufficient margin exist to offset 10 dB interference increase. (attachment H and I)
- CPE aggregate sidelobe power decreases 11.5 dB more than the satellite power control at short range, 90 degree elevation. (attachment J)
- CPE transceivers can fit the Proposed rules, 21.1020 and 21.1021 of the Third NPRM suggested for LMDS hubs. (attachment K)

ATTACHMENTS
28 November 1995

LMDS SUBSCRIBER AND IRIDIUM CO-PRIMARY SHARING OF THE 29.1-29.25 GHZ BAND

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LMDS SUBSCRIBER AND IRIDIUM CO-PRIMARY SHARING OF THE 29.1-29.25 GHZ BAND

A. INTRODUCTION
-Extensive analysis shows LMDS subscriber return links and Iridium MSS/FSS feeder links can share the 29.1-29.25 GHz band.

B. LOCAL MULTIPOINT DISTRIBUTION SERVICE CUSTOMER PREMISE EQUIPMENT TRANSMISSION AND IRIDIUM SATELLITE RECEIVER COMPATIBILITY ANALYSIS, SEPTEMBER 12, 1995.
-LMDS subscriber CPE parameters and Iridium feeder links are shown to yield acceptable C/I ratios using both the statistical analysis program that models the LMDS CPE deployment and the direct beam interaction analysis.

C. PROPOSED RULES FOR LMDS SUBSCRIBER TRANSCEIVERS IN THE 29.1-29.25 GHZ BAND.
-Proposed rules for maximum EIRP, (20 dBW/MHz, clear air with power control and 14 dBW/MHz without power control), and antenna mask allows for co-primary operation.

D. POPULATION DENSITY AND GATEWAY PARAMETERS BIT ERROR RATE ANALYSIS.
-Shows Motorola's N/I and C/I ratio levels along with acceptable bit error rates for the Iridium gateway link.

E. AN EXAMINATION OF IRIDIUM ORBITS AND GATEWAY ELEVATION ANGLE-IMPACT ON SYSTEM AVAILABILITY IN THE PRESENCE OF LMDS SUBSCRIBER TRANSMITTERS, NOVEMBER 17, 1995. Eric Barnhart, CellularVision.
-Minimum elevation angle for mid-CONUS (40 degrees North Latitude) is 11.9 degrees and produces 4 dB system power margin available to allow Motorola to maintain their desired satellite receiver operating point.

F. TOTAL POWER SPECTRAL DENSITY DEPENDENCY, OCTOBER 29, 1995. Doug Gray, Hewlett-Packard.
-Total power spectral density is dependent only on maximum EIRP at the cell periphery.

G. LOOK-UP ANGLE VERSUS HUB ANTENNA HEIGHT, OCTOBER 29, 1995. Doug Gray, Hewlett-Packard.
-Subscriber look-up angle is less than 10 degrees for ranges greater than 2 KM (300 meter hub antenna height) and less than 5 degrees for ranges greater than 100 meters, (30 meter hub antenna height).

H. SLANT RANGE TO SATELLITE AND SIGNAL LEVEL VERSUS ELEVATION ANGLE. Leland Langston, Texas Instruments.
-Elevation angle of 11 degrees, (Iridium CONUS elevation angle minimum), versus 5 degrees produces 1.73 dB increase in gateway signal level due to decreased range and space loss.

I. EFFECTS OF 5 PERCENT INTERFERENCE ALLOCATION.
Bill Myers, Texas Instruments
-An interference of -210 dBW/Hz (5 percent interference budget) only represents 0.2 dB change of the system noise temperature, an interference of -207 dBW/Hz, (10 percent interference budget) results in 0.4 dB thermal noise increase. An interference of -200 dBW/Hz (10 dB increase) results in 1.7 dB power change which can be easily compensated by the system margin due to reduced range (11 degree minimum elevation angle) or by increasing the gateway power by 1.7 dB.

J. EFFECT OF SATELLITE POWER CONTROL AT MINIMUM RANGE.
Bill Myers, Texas Instruments
-The aggregate sidelobe power from CPE return link transmissions will produce signal reductions much greater than the satellite link power control reductions. For main beam coupling at minimum range (90 degree elevation) a CPE operating at the maximum proposed rule power will result in only 0.2 dB degradation.

K. ANALYSIS OF CPE TRANSCEIVERS SHOWS FIT TO THE PROPOSED RULES 21.1020 AND 21.1021 PER THE THIRD NPRM FOR 28 GHZ, NOVEMBER 14, 1995. Doug Gray, Hewlett-Packard.
-At 7.5 degrees elevation, the aggregate of the LMDS CPEs power spectral area density (PSAD) is 2 dB to 9 dB below the required limit proposed for hubs.
-At 90 degrees elevation, the PSAD is 6 dB to 15 dB below the required limit.