INPUT DATA FOR CO-FREQUENCY SHARING ANALYSIS
VIDEOPHONE VERSUS IRIDIUM®
INTERFERENCE/SHARING SCENARIO #6
LMDS SUBSCRIBERS INTO IRIDIUM® SATELLITE RECEIVER

	QPSK	16 QAM	256 QAM
TRANSMITTER POWER SPECTRAL DENSITY (DBW/HZ) (INCLUDES REDUCTION FOR POWER CONTROL)	- 89.9	- 93.5	- 90.0
# OF HUBS/SWATH (200KM X 110KM)	8360	8360	8360
# OF SUBSCRIBERS/HUB POINTED AT SATELLITE	1	1	1
FREQUENCY REUSE	1/1	1/1	1/1
PEAK ANTENNA GAIN (DB)	38	38	38

9/10/94

SYSTEM MARGIN
VIDEOPHONE Versus IRIDIUM®
SUBSCRIBER TO SATELLITE
"Quick Look" Program

REGION	QPSK dB	16 QAM dB	256 QAM dB
1	-39.9	-36.3	-39.8
2	-40.8	-37.2	-40.7
3,4,5	-41.3	-37.7	-41.2

9/10/94

VP/1 QPSK SUB

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9
hub xmit gain (dBI)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zone 1	-13.5	-8.2	-5.6	-4.2	-3.2	-2.7	-2.2	-1.9	-1.6	-1.4	-1.3
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBI)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-193.6	-188.0	-185.1	-183.4	-182.0	-181.2	-180.3	-179.6	-178.9	-178.3	-177.8
received power density (W/Hz)	4.3E-20	1.6E-19	3.1E-19	4.6E-19	6.3E-19	7.6E-19	9.3E-19	1.1E-18	1.3E-18	1.5E-18	1.7E-18
percent total interference/swath	0.5	1.8	3.5	5.2	7.1	8.6	10.6	12.4	14.6	16.8	19.0
total power received (W/Hz)	8.8E-18										
total power received (dBW/Hz)	-170.5										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	26.9										
Interference Margin (dB)	-39.9										

VP/2 QPSK SUB

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.9	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9
hub xmit gain (dBI)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zone 2	-8.0	-5.0	-3.5	-2.6	-2.1	-1.7	-1.4	-1.2	-1.1	-0.9	-0.8
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-188.1	-184.8	-183.0	-181.8	-180.9	-180.2	-179.5	-178.9	-178.4	-177.8	-177.3
received power density (W/Hz)	1.5E-19	3.3E-19	5.0E-19	6.6E-19	8.1E-19	9.6E-19	1.1E-18	1.3E-18	1.4E-18	1.7E-18	1.9E-18
percent total interference/swath	1.4	3.0	4.6	6.1	7.5	8.9	10.4	11.9	13.3	15.4	17.4
total power received (W/Hz)	1.1E-17										
total power received (dBW/Hz)	-169.7										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	27.8										
Interference Margin (dB)	-40.8										

VP/3 QPSK SUB

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9	-89.9
hub xmit gain (dBi)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zones 3-5	-5.2	-3.4	-2.4	-1.9	-1.5	-1.2	-1.1	-0.9	-0.8	-0.7	-0.6
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-185.3	-183.2	-181.9	-181.1	-180.3	-179.7	-179.2	-178.6	-178.1	-177.6	-177.1
received power density (W/Hz)	2.9E-19	4.8E-19	6.4E-19	7.8E-19	9.3E-19	1.1E-18	1.2E-18	1.4E-18	1.5E-18	1.7E-18	2.0E-18
percent total interference/swath	2.4	4.0	5.4	6.5	7.7	9.0	10.0	11.4	12.8	14.5	16.4
total power received (W/Hz)	1.2E-17										
total power received (dBW/Hz)	-169.2										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	28.3										
Interference Margin (dB)	-41.3										

VP/1 16QAM

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5
hub xmit gain (dBi)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zone 1	-13.5	-8.2	-5.6	-4.2	-3.2	-2.7	-2.2	-1.9	-1.6	-1.4	-1.3
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-197.2	-191.6	-188.7	-187.0	-185.6	-184.8	-183.9	-183.2	-182.5	-181.9	-181.4
received power density (W/Hz)	1.9E-20	6.9E-20	1.3E-19	2.0E-19	2.7E-19	3.3E-19	4.1E-19	4.8E-19	5.6E-19	6.5E-19	7.3E-19
percent total interference/swath	0.5	1.8	3.5	5.2	7.1	8.6	10.6	12.4	14.6	16.8	19.0
total power received (W/Hz)	3.9E-18										
total power received (dBW/Hz)	-174.1										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	23.3										
Interference Margin (dB)	-36.3										

VP/2 16QAM SUB

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5
hub xmit gain (dBi)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zone 2	-8.0	-5.0	-3.5	-2.6	-2.1	-1.7	-1.4	-1.2	-1.1	-0.9	-0.8
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-191.7	-188.4	-186.6	-185.4	-184.5	-183.8	-183.1	-182.5	-182.0	-181.4	-180.9
received power density (W/Hz)	6.7E-20	1.4E-19	2.2E-19	2.9E-19	3.5E-19	4.2E-19	4.9E-19	5.6E-19	6.3E-19	7.3E-19	8.2E-19
percent total interference/swath	1.4	3.0	4.6	6.1	7.5	8.9	10.4	11.9	13.3	15.4	17.4
total power received (W/Hz)	4.7E-18										
total power received (dBW/Hz)	-173.3										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	24.2										
Interference Margin (dB)	-37.2										

VP/3 16QAM

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5	-93.5
hub xmit gain (dBi)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zones 3-5	-5.2	-3.4	-2.4	-1.9	-1.5	-1.2	-1.1	-0.9	-0.8	-0.7	-0.6
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-188.9	-186.8	-185.5	-184.7	-183.9	-183.3	-182.8	-182.2	-181.7	-181.2	-180.7
received power density (W/Hz)	1.3E-19	2.1E-19	2.8E-19	3.4E-19	4.0E-19	4.7E-19	5.2E-19	6.0E-19	6.7E-19	7.6E-19	8.6E-19
percent total interference/swath	2.4	4.0	5.4	6.5	7.7	9.0	10.0	11.4	12.8	14.5	16.4
total power received (W/Hz)	5.3E-18										
total power received (dBW/Hz)	-172.8										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	24.7										
Interference Margin (dB)	-37.7										

VP/1 256 QAM

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0
hub xmit gain (dBi)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zone 1	-13.5	-8.2	-5.6	-4.2	-3.2	-2.7	-2.2	-1.9	-1.6	-1.4	-1.3
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-193.7	-188.1	-185.2	-183.5	-182.1	-181.3	-180.4	-179.7	-179.0	-178.4	-177.9
received power density (W/Hz)	4.2E-20	1.5E-19	3.0E-19	4.5E-19	6.1E-19	7.5E-19	9.1E-19	1.1E-18	1.3E-18	1.4E-18	1.6E-18
percent total Interference/swath	0.5	1.8	3.5	5.2	7.1	8.6	10.6	12.4	14.6	16.8	19.0
total power received (W/Hz)	8.6E-18										
total power received (dBW/Hz)	-170.6										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	26.8										
Interference Margin (dB)	-39.8										

VP/2 256 QAM

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0
hub xmit gain (dBi)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zone 2	-8.0	-5.0	-3.5	-2.6	-2.1	-1.7	-1.4	-1.2	-1.1	-0.9	-0.8
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-188.2	-184.9	-183.1	-181.9	-181.0	-180.3	-179.6	-179.0	-178.5	-177.9	-177.4
received power density (W/Hz)	1.5E-19	3.2E-19	4.9E-19	6.5E-19	7.9E-19	9.4E-19	1.1E-18	1.3E-18	1.4E-18	1.6E-18	1.8E-18
percent total Interference/swath	1.4	3.0	4.6	6.1	7.5	8.9	10.4	11.9	13.3	15.4	17.4
total power received (W/Hz)	1.1E-17										
total power received (dBW/Hz)	-169.8										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	27.7										
Interference Margin (dB)	-40.7										

VP/3 256 QAM

mid swath elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2	11.8	13.4
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26	60.72	60.07
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5	17.5	16.5
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308	2198	2090
hub xmit power(dBW/Hz)	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0	-90.0
hub xmit gain (dBi)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0	-188.5	-188.1
atmosph loss (dB) Zones 3-5	-5.2	-3.4	-2.4	-1.9	-1.5	-1.2	-1.1	-0.9	-0.8	-0.7	-0.6
antenna polarization loss(dB)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
satellite receive gain (dBi)	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
no. of hubs in each swath (dB)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
received power density (dBW/Hz)	-185.4	-183.3	-182.0	-181.2	-180.4	-179.8	-179.3	-178.7	-178.2	-177.7	-177.2
received power density (W/Hz)	2.9E-19	4.6E-19	6.3E-19	7.6E-19	9.1E-19	1.1E-18	1.2E-18	1.3E-18	1.5E-18	1.7E-18	1.9E-18
percent total interference/swath	2.4	4.0	5.4	6.5	7.7	9.0	10.0	11.4	12.8	14.5	16.4
total power received (W/Hz)	1.2E-17										
total power received (dBW/Hz)	-169.3										
satellite noise floor (dBW/Hz)	-197.5										
Io/No (dB)	28.2										
Interference Margin (dB)	-41.2										

```
c LMDS antenna gain
          call antlmds(elevaid,depreang,shapelmd,ahornull,
     #                 sideattn,Gant_hub)
          cxi=aimx-xi
          cyi=aimy-yi
          czi=aimz-zi
          chordi=sqrt(cxi*cxi+cyi*cyi+czi*czi)
          cosphe=(disti*disti+aimdists-chordi*chordi)/(2.0*disti*aimdist)
          phei=acos(cosphe)
          pheid=phei*rtd
c
c LEOsat antenna gain
          call antsat(pheid,hpbw,phezero,Gant_leo)
c
c atmospheric attenuation of the LMDS hub for 1100ft(363m)MSL LMDS hubs
          call atmos(elevaid,0.363,iclim,atmosi)
c
c cross-polarization attenuation of the LMDS hub
          if((pheid .LT. satlobe) .AND. (elevaid .LT. ahornull)) then
           xxpol=xpol
          else
           xxpol=0.0
          endif
c
c path loss from LMDS hub to LEOsat (dB)
          Lpi=92.45+20.0*log10(disti)+logf+atmosi
          Ix=eirplmds+Gant_hub+(Gant_leo+G0_leo)-xxpol-Lpi
c received power at LEOsat (W)
          Ioi=10.0**(Ix/10.0)
c
c add power to appropriate LMDS-antenna elevation-angle bin
          if(elevaid .LT. 5.0) then
           Io_e(1)=Io_e(1)+Ioi
           Ne(1)=Ne(1)+1
          else if(elevaid .LT. 10.0) then
           Io_e(2)=Io_e(2)+Ioi
           Ne(2)=Ne(2)+1
          else if(elevaid .LT. 15.0) then
           Io_e(3)=Io_e(3)+Ioi
           Ne(3)=Ne(3)+1
          else if(elevaid .LT. 20.0) then
           Io_e(4)=Io_e(4)+Ioi
           Ne(4)=Ne(4)+1
          else if(elevaid .LT. 25.0) then
           Io_e(5)=Io_e(5)+Ioi
           Ne(5)=Ne(5)+1
          else if(elevaid .LT. 30.0) then
           Io_e(6)=Io_e(6)+Ioi
           Ne(6)=Ne(6)+1
          else if(elevaid .LT. 35.0) then
           Io_e(7)=Io_e(7)+Ioi
           Ne(7)=Ne(7)+1
          else if(elevaid .LT. 40.0) then
           Io_e(8)=Io_e(8)+Ioi
           Ne(8)=Ne(8)+1
          else if(elevaid .LT. 45.0) then
```

```
          Io_e(9)=Io_e(9)+Ioi
          Ne(9)=Ne(9)+1
         else if(elevaid .LT. 50.0) then
          Io_e(10)=Io_e(10)+Ioi
          Ne(10)=Ne(10)+1
         else if(elevaid .LT. 55.0) then
          Io_e(11)=Io_e(11)+Ioi
          Ne(11)=Ne(11)+1
         else if(elevaid .LT. 60.0) then
          Io_e(12)=Io_e(12)+Ioi
          Ne(12)=Ne(12)+1
         else if(elevaid .LT. 70.0) then
          Io_e(13)=Io_e(13)+Ioi
          Ne(13)=Ne(13)+1
         else if(elevaid .LT. 80.0) then
          Io_e(14)=Io_e(14)+Ioi
          Ne(14)=Ne(14)+1
         else if(elevaid .LE. 90.0) then
          Io_e(15)=Io_e(15)+Ioi
          Ne(15)=Ne(15)+1
         endif
c
c also add power to appropriate LEOsat-antenna off-axis-angle bin
         if(pheid .LT. 5.0) then
          Io_p(1)=Io_p(1)+Ioi
          Np(1)=Np(1)+1
         else if(pheid .LT. 10.0) then
          Io_p(2)=Io_p(2)+Ioi
          Np(2)=Np(2)+1
         else if(pheid .LT. 15.0) then
          Io_p(3)=Io_p(3)+Ioi
          Np(3)=Np(3)+1
         else if(pheid .LT. 20.0) then
          Io_p(4)=Io_p(4)+Ioi
          Np(4)=Np(4)+1
         else if(pheid .LT. 25.0) then
          Io_p(5)=Io_p(5)+Ioi
          Np(5)=Np(5)+1
         else if(pheid .LT. 30.0) then
          Io_p(6)=Io_p(6)+Ioi
          Np(6)=Np(6)+1
         else if(pheid .LT. 35.0) then
          Io_p(7)=Io_p(7)+Ioi
          Np(7)=Np(7)+1
         else if(pheid .LT. 40.0) then
          Io_p(8)=Io_p(8)+Ioi
          Np(8)=Np(8)+1
         else if(pheid .LT. 45.0) then
          Io_p(9)=Io_p(9)+Ioi
          Np(9)=Np(9)+1
         else if(pheid .LT. 50.0) then
          Io_p(10)=Io_p(10)+Ioi
          Np(10)=Np(10)+1
         else if(pheid .LT. 55.0) then
          Io_p(11)=Io_p(11)+Ioi
          Np(11)=Np(11)+1
```

```
          else if(pheid .LT. 60.0) then
           Io_p(12)=Io_p(12)+Ioi
           Np(12)=Np(12)+1
          else if(pheid .LT. 70.0) then
           Io_p(13)=Io_p(13)+Ioi
           Np(13)=Np(13)+1
          else if(pheid .LT. 80.0) then
           Io_p(14)=Io_p(14)+Ioi
           Np(14)=Np(14)+1
          else if(pheid .LE. 90.0) then
           Io_p(15)=Io_p(15)+Ioi
           Np(15)=Np(15)+1
          endif
c
c also add power to total interference power
          Io_total=Io_total+Ioi
c
 2099   continue
 2001  continue
 2000 continue
c
c double the number of sites and increase the Io/No by 3 dB
c to account for the 'below the equator' or 'southern hem' LMDS sites
        do 2002 i=1,15
         Ix=10.0*log10(Io_e(i))
         itne(i)=Ix+3.0-No
         Ix=10.0*log10(Io_p(i))
         itnp(i)=Ix+3.0-No
         Ne(i)=Ne(i)*2
         Np(i)=Np(i)*2
 2002 continue
c
        Ncell=Ncell*2
        Ix=10.0*log10(Io_total)
        itntotal=Ix+3.0-No
c
        write(*,1081) Ncell,itntotal
        write(*,1088)
        write(*,1101) Ne(1),itne(1)
        write(*,1102) Ne(2),itne(2)
        write(*,1103) Ne(3),itne(3)
        write(*,1104) Ne(4),itne(4)
        write(*,1105) Ne(5),itne(5)
        write(*,1106) Ne(6),itne(6)
        write(*,1107) Ne(7),itne(7)
        write(*,1108) Ne(8),itne(8)
        write(*,1109) Ne(9),itne(9)
        write(*,1110) Ne(10),itne(10)
        write(*,1111) Ne(11),itne(11)
        write(*,1112) Ne(12),itne(12)
        write(*,1113) Ne(13),itne(13)
        write(*,1114) Ne(14),itne(14)
        write(*,1115) Ne(15),itne(15)
c
        write(2,1081) Ncell,itntotal
        write(2,1088)
```

```
      write(2,1101) Ne(1),itne(1)
      write(2,1102) Ne(2),itne(2)
      write(2,1103) Ne(3),itne(3)
      write(2,1104) Ne(4),itne(4)
      write(2,1105) Ne(5),itne(5)
      write(2,1106) Ne(6),itne(6)
      write(2,1107) Ne(7),itne(7)
      write(2,1108) Ne(8),itne(8)
      write(2,1109) Ne(9),itne(9)
      write(2,1110) Ne(10),itne(10)
      write(2,1111) Ne(11),itne(11)
      write(2,1112) Ne(12),itne(12)
      write(2,1113) Ne(13),itne(13)
      write(2,1114) Ne(14),itne(14)
      write(2,1115) Ne(15),itne(15)
c
      write(*,'(a)') '     ***** To continue type "Enter" *****'
      read(*,10) yestext
c
      write(*,1086)
      write(*,1101) Np(1),itnp(1)
      write(*,1102) Np(2),itnp(2)
      write(*,1103) Np(3),itnp(3)
      write(*,1104) Np(4),itnp(4)
      write(*,1105) Np(5),itnp(5)
      write(*,1106) Np(6),itnp(6)
      write(*,1107) Np(7),itnp(7)
      write(*,1108) Np(8),itnp(8)
      write(*,1109) Np(9),itnp(9)
      write(*,1110) Np(10),itnp(10)
      write(*,1111) Np(11),itnp(11)
      write(*,1112) Np(12),itnp(12)
      write(*,1113) Np(13),itnp(13)
      write(*,1114) Np(14),itnp(14)
      write(*,1115) Np(15),itnp(15)
c
c
      write(2,1086)
      write(2,1101) Np(1),itnp(1)
      write(2,1102) Np(2),itnp(2)
      write(2,1103) Np(3),itnp(3)
      write(2,1104) Np(4),itnp(4)
      write(2,1105) Np(5),itnp(5)
      write(2,1106) Np(6),itnp(6)
      write(2,1107) Np(7),itnp(7)
      write(2,1108) Np(8),itnp(8)
      write(2,1109) Np(9),itnp(9)
      write(2,1110) Np(10),itnp(10)
      write(2,1111) Np(11),itnp(11)
      write(2,1112) Np(12),itnp(12)
      write(2,1113) Np(13),itnp(13)
      write(2,1114) Np(14),itnp(14)
      write(2,1115) Np(15),itnp(15)
c
 9999 continue
c
```

```
      close (1)
      close (2)
      end
c
c
c
c
      subroutine antlmds(elevaid,depreang,shapelmd,ahornull,
     #                   sideattn,antlmdsg)
c
c Compute the LMDS hub relative antenna gain toward the LEOsat.
c The LMDS hub antenna pattern is assumed to be of form [sin(x)/x]^2
c where x is normalized to the angle between axis and main-lobe null.
c     x = (pi*elevaid/ahornull)
c
c This [sin(x)/x]^2 function is modified by four shaping factors:
c     - antenna shape factor
c     - mainbeam depression angle
c     - overall sidelobe attenuation
c     - minimum relative gain (preset by the program at -45dB).
c
c (1) The function is modified by an antenna shaping factor: 1./(1+z^E)
c     z = elevation angle/antenna null, "elevaid/ahornull"
c     E = the shape factor, "shapelmd"
c
c (2) The mainlobe depression angle simulates the down-looking of a
c     typical LMDS hub antenna.  The effect is to add the depression
c     angle to the calculated elevation angle toward the satellite.
c
c (3) All sidelobes can be attenuated by a constant.
c
c (4) The lowest relative antenna gain is limited to "antmingn" dB.
c
c    elevaid=the elevation angle toward the LEO satellite (deg)
c   ahornull=the above 'horizon' main-lobe null angle (deg)
c   depreang=the mainbeam depression angle (deg)
c   sideattn=the sidelobe attenuation (dB)
c
      common/const/ pi,antmingn
c
      elevaidd=elevaid+depreang
      eleonull=elevaidd/ahornull
      x=pi*eleonull
      sinx=sin(x)
      sinc2=sinx*sinx/(x*x)
      antlmdsg=10.0*log10(sinc2)
c
      if(shapelmd .GT. 0.0) then
       antlmdsg=antlmdsg+10.0*log10(1.0/(1.0+eleonull**shapelmd))
      endif
c
      if(elevaid .GT. ahornull) antlmdsg=antlmdsg-sideattn
      if(antlmdsg .LT. antmingn) antlmdsg=antmingn
c
      return
      end
```

```
c
c
c
      subroutine antsat(pheid,hpbw,phezero,antleogi)
c
c compute the LEOsat relative antenna gain toward the LMDS hub.
c The LEOsat antenna pattern is assumed to be equavalent to the WARC-83
c APPENDIX 30B's 'fast roll-off' pattern (ANNEX 1, Section 1.7).
c   -12(phe/phe0)        for 0 < (phe/phe0) < 0.5
c   -18.75*(phe0)^2((phe/phe0)-x)  for  0.5<(phe/phe0)<((1.16/phe0) +x)
c   -25.23               for ((1.16/phe0)+x)<(phe/phe0)<1.45
c   -(22+20log(phe/phe0)) for (phe/phe0>1.45
c
c**** where (phe/phe0)=pheophe0 is assumed to be (pheid/hpbw)**********
c****       phe0=phezero
c
c      pheid=the subtended angle at the LEOsat, between antenna aim-point
c            and LMDS site (deg)
c    phezero=the mainbeam shape factor
c           =0.8 ... a normal horn antenna
c                    -12(phe/phe0)          for 0<(phe/phe0)<1.45
c                    -(22+20log(phe/phe0)) for (phe/phe0)>1.45
c           =1.6 ... fast roll-off to -25.23 at phe=phe0
c           =3.2 ... fast roll-off to -25.23 at (phe/phe0)=0.576
c
      common/const/ pi,antmingn
c
c*************************************
c     phemod=(phezero/hpbw)*pheid     *
c     pheophe0=phemod/phezero         *
      pheophe0=pheid/hpbw
c*************************************
      x=0.5*(1.0-(0.8/phezero))
      phe0x=(1.16/phezero)+x
      if((pheophe0 .GE. 0.0) .AND. (pheophe0 .LE. 0.5)) then
       antleogi=-12.0*pheophe0*pheophe0
      else if(pheophe0 .LE. phe0x) then
       antleogi=-18.75*phezero*phezero*(pheophe0-x)*(pheophe0-x)
      else if(pheophe0 .LE. 1.45) then
       antleogi=-25.23
      else
       antleogi=-(22.0+20.0*log10(pheophe0))
      endif
c
      if(antleogi .LT. antmingn) antleogi=antmingn
      return
      end
c
c
      subroutine eras
c
c This subroutine clears the screen and places the cursor to home.
c
      write(*,10) char(27)
      write(*,20) char(27),1,1
   10 format(1x,1a,'[2J')
```

```
   20 format(1x,1a,'['I1,';',I1,'H'\)
      return
      end
c
c
      REAL function Fun(x)
c This function calculates an intermediate variable used in subroutine
c atmos, below
      Fun=1.0/(0.661*x+0.339*sqrt(x*x+5.51))
      end
c
c
      subroutine atmos(thetad, gs_alt, iclim, atmsph)
c
c Calculate the atmospheric attenuation (dB) at 29GHz along the path
c between a satellite and a ground station at altitude gs_alt (km, MSL)
c in accordance with [11] of CCIR Report 719-3, as a function of
c   thetad (deg)  elevation angle of the satellite from the ground station.
c   rho (gm/m^3) density of water vapor in the air
c    =10 for climate-type 1
c    = 5 for climate-type 2
c    = 2 for climate-types 3-5
c
      g0=0.0184855424
      eradi=6378.135
      dtr=0.017453292
      thetar=thetad*dtr
      h_O2=6.0
      hw0=1.6
      hw=hw0*1.044806358
      h0=h_O2-gs_alt
      if (iclim .EQ. 0) then
       atmsph=0.0
       return
      else if (iclim .EQ. 1) then
       rho=10.0
      else if (iclim .EQ. 2) then
       rho=5.0
      else if ((iclim .GE. 3) .AND. (iclim .LE. 5)) then
       rho=2.0
      endif
      gw=(0.0021*rho+0.102470921)*0.09*rho
c
c use different model for thetad>7deg
      if (thetad .LT. 7.0) then
       arg1=tan(thetar)*sqrt(eradi/h0)
       arg2=tan(thetar)*sqrt(eradi/hw)
       atmsph=g0*sqrt(h0)*Fun(arg1)+gw*sqrt(hw)*Fun(arg2)
       atmsph=atmsph*sqrt(eradi)/cos(thetar)
      else
       atmsph=(h0*g0+hw*gw)/sin(thetar)
      endif
      return
      end
c
```

ATTACHMENT J

Interference Analysis - Non-GSO MSS Feeder Link Earth Station Transmitter into LMDS Receivers

1	Working Group 2: Computation and Modeling Ad Hoc Committee 9/19/94										
2											
3	LMDS System Parameters										
4	System Proponent		Suite 12				Suite 12				
5	Link		Hub to Sub				Sub to Hub				
6	Modulation		FM				QPSK or AM				
7	Digital Data Rate		N/A				64 kbps				
8	Channel Bandwidth		18 MHz				40 kHz				
9	Antenna Pattern Used		Proponent				Proponent				
10	Date/Revision of System Parameters	WG 1/52	9/16/94 Rev 3				9/16/94 Rev 3				
11											
12	Feeder Link System		IRIDIUM				IRIDIUM				
13											
14	Required Separation (clear sky, incl. 100 km radio horizon)										
15	ES angle from boresight		5	10	20	48	5	10	20	48	
16	LMDS receiver pointing angle										
17	Boresight	km	55.0	27.0	10.3	2.2	96.9	55.6	24.8	6.0	
18	5 Degree Sidelobe	km	11.4	4.4	1.4	0.3	96.9	55.6	24.8	6.0	
19	45 Degree Sidelobe	km	6.1	2.3	0.7	0.1	96.9	55.6	24.8	6.0	
20	180 Degree Backlobe	km	0.3	0.1	0.0	0.0	96.9	55.6	24.8	6.0	
21											
22	Calculations										
23											
24	LMDS Signal Link Carrier Level at Cell Edge		Clear Sky		Rain Conditions		Clear Sky		Rain Conditions		
25	Transmitted Power	dBW/channel	-5		-5		-34.9		-34.9		
26	Transmitter Antenna Gain	dBi	12		12		31		31		
27	EIRP (clear sky)	dBWi/channel	7		7		-3.9		-3.9		
28	Power Control (rain)	dB	0		0		0		13		
29	Distance to Cell Edge	km	4.83		4.83		4.83		4.83		
30	Rain Attenuation (cell edge)	dB	0		-13		0		-13		
31	Free Space Path Loss (cell edge)	dB	-135.5		-135.5		-135.5		-135.5		
32	Receiver Antenna Gain	dBi	31		31		12		12		
33	Carrier Level at Cell Edge	dBW/channel	-97.5		-110.5		-127.4		-127.4		
34	Notes:										
35	Rain attenuation from WG1/52 (rev. 3)										
36	Power control is the minimum necessary to overcome rain fade without exceeding maximum										
37											
38											
39	Interference Density Into LMDS		Clear Sky		Rain Conditions		Clear Sky		Rain Conditions		
40	k (Boltzmann's Constant)	dBW/K/Hz	-228.6		-228.6		-228.6		-228.6		
41	Receiver Noise Figure	dB	6		6		3		3		
42	Receiver Noise Temperature	K	1155		1155		579		579		
43	Channel Bandwidth	MHz	18		18		0.04		0.04		
44	Receiver Noise Floor	dBW/channel	-125.4		-125.4		-155.0		-155.0		
45	Minimum Required C/(N + I)	dB per channel	20		13		19		19		
46	Cell Edge C/N	dB	27.9		14.9		27.6		27.6		
47	Cell Edge C/N	linear	621		31		571		571		
48	Required C/(N + I)	linear	398		20		79		79		
49	Maximum Acceptable Interference	dBW/channel	-127.9		-127.9		-147.0		-147.0		
50	Maximum Acceptable Interference Density	dBW/Hz	-200.5		-200.5		-193.1		-193.1		
51	Notes:										
52											
53											
54	Interference Density Generated										
55	IRIDIUM Feeder Links Into LMDS Receivers										

1	Working Group 2: Computation and Modeling Ad Hoc Committee 9/19/94										
2											
3	LMDS System Parameters										
4	System Proponent		Suite 12				Suite 12				
5	Link		Hub to Sub				Sub to Hub				
6	Modulation		FM				QPSK or AM				
7	Digital Data Rate		N/A				64 kbps				
8	Channel Bandwidth		18 MHz				40 kHz				
9	Antenna Pattern Used		Proponent				Proponent				
10	Date/Revision of System Parameters	WG 1/52	9/16/94 Rev 3				9/16/94 Rev 3				
11											
12	Feeder Link System		IRIDIUM				IRIDIUM				
13											
56											
57	ES angle from boresight	degrees	5	10	20	48	5	10	20	48	
58	Earth Station Output Power (no rain)	dBW/channel	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	
59	Slant Path Length	km	2741.1	2325.7	1732.4	1006.9	2741.1	2325.7	1732.4	1006.9	
60	Power Control (slant path)	dB	1.5	0.0	-2.5	-7.2	1.5	0.0	-2.5	-7.2	
61	Antenna Gain	dBi	14.5	7.0	-0.5	-10.0	14.5	7.0	-0.5	-10.0	
62	Single Channel BW	MHz	4.375	4.375	4.375	4.375	4.375	4.375	4.375	4.375	
63	Number of Interfering Channels	dB	0	0	0	0	0	0	0	0	
64	LMDS Receiver Bandwidth	MHz	18	18	18	18	0.04	0.04	0.04	0.04	
65	Interference Density Subtotal (clear sky)	dBW/Hz	-69.4	-70.3	-88.4	-102.6	-42.8	-51.8	-61.9	-76.1	
66	Rain Rate	mm/hr	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
67	Length of rain cell	km	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
68	Path Length through rain	km	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
69	Rain Attenuation	dB	15	15	15	15	15	15	15	15	
70	Power Control (rain)	dB	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
71	Interference Density Subtotal (rain on signal path)	dBW/Hz	-54.4	-63.3	-73.4	-87.6	-27.8	-36.8	-46.9	-61.1	
72	Notes:										
73	Antenna Gain is the maximum elevation pattern gain in the direction of the LMDS receiver which occurs when the azimuth of										
74	the earth station is pointing in the direction of the LMDS receiver										
75	Antenna Gain is 32-25*log(theta)										
76	Power Control (slant path) is the difference in EIRP required to offset the path loss along the slant path in order to maintain a constant										
77	Eb/No at the satellite receiver										
78	The default slant path (0 dB power control) is for a 10 degree elevation angle										
79	Total Power Control (rain plus slant path) cannot exceed 24.8 dB										
80	Interference Density Subtotal calculated based on AWGN assumption										
81	may be a low estimate of interference										
82	Lin Model used for rain attenuation on interference path										
83	Assume rain fade of 15 dB on satellite signal path										
84	Maximum rain cell 4 km long										
85											
86											
87	LMDS Receiver Antenna Gain										
88	Boresight	dBi	31				21				
89	5 Degree Sidelobe	dBi	13				21				
90	45 Degree Sidelobe	dBi	7				21				
91	180 Degree Backlobe	dBi	-19				21				
92	Note:										
93	Negative margin indicates C/(N + I) objective not met at 1 km separation										
94	All path loss values indicate positive loss (negative gain) regardless of sign										
95	LMDS Signal: clear sky, Satellite Signal: clear sky										
96	ES angle from boresight		5	10	20	48	5	10	20	48	
97	*LMDS Boresight*										

1	Working Group 2: Computation and Modeling Ad Hoc Committee 9/19/94										
2											
3	LMDS System Parameters										
4	System Proponent		Suite 12				Suite 12				
5	Link		Hub to Sub				Sub to Hub				
6	Modulation		FM				QPSK or AM				
7	Digital Data Rate		N/A				64 kbps				
8	Channel Bandwidth		18 MHz				40 kHz				
9	Antenna Pattern Used		Proponent				Proponent				
10	Date/Revision of System Parameters	WG 1/52	9/16/94 Rev 3				9/16/94 Rev 3				
11											
12	Feeder Link System		IRIDIUM				IRIDIUM				
13											
98	Required Path Loss	dB	-162.1	-153.2	-143.1	-128.9	-171.2	-162.3	-152.2	-138.0	
99	Margin at 1 km (clear sky)	dB	-40.2	-31.2	-21.2	-6.9	-49.3	-40.4	-30.3	-16.1	
100	Required Separation (clear sky, no radio horizon)	km	55.0	27.0	10.3	2.2	96.9	55.6	24.8	6.0	
101	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	-36.5	-27.5	-17.5	-3.2	-45.6	-36.7	-26.6	-12.4	
102	Required Separation (21 mm/hr rain on interference up to 4 km)	km	16.1	6.4	3.1	1.3	36.5	16.4	5.8	2.3	
103	Path Loss Allocation:										
104	Free Space	dB	146.0	138.0	131.6	124.0	153.0	146.1	137.1	129.2	
105	Atmosphere	dB	1.6	0.6	0.3	0.1	3.6	1.6	0.6	0.2	
106	Rain	dB	14.5	14.5	11.2	4.7	14.5	14.5	14.5	8.6	
107	*LMDS 5 degree Sidelobe*										
108	Required Path Loss	dB	-144.1	-135.2	-125.1	-110.9	-171.2	-162.3	-152.2	-138.0	
109	Margin at 1 km (clear sky)	dB	-22.2	-13.2	-3.2	11.1	-49.3	-40.4	-30.3	-16.1	
110	Required Separation (clear sky, no radio horizon)	km	11.4	4.4	1.4	0.3	96.9	55.6	24.8	6.0	
111	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	-18.5	-9.5	0.5	14.8	-45.6	-36.7	-26.6	-12.4	
112	Required Separation (21 mm/hr rain on interference up to 4 km)	km	3.2	2.0	1.0	0.3	36.5	16.4	5.8	2.3	
113	Path Loss Allocation:										
114	Free Space	dB	132.0	127.7	121.4	109.9	153.0	146.1	137.1	129.2	
115	Atmosphere	dB	0.3	0.2	0.1	0.0	3.6	1.6	0.6	0.2	
116	Rain	dB	11.8	7.2	3.5	0.9	14.5	14.5	14.5	8.6	
117	*LMDS 45 degree Sidelobe*										
118	Required Path Loss	dB	-138.1	-129.2	-119.1	-104.9	-171.2	-162.3	-152.2	-138.0	
119	Margin at 1 km (clear sky)	dB	-16.2	-7.2	2.8	17.1	-49.3	-40.4	-30.3	-16.1	
120	Required Separation (clear sky, no radio horizon)	km	6.1	2.3	0.7	0.1	96.9	55.6	24.8	6.0	
121	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	-12.5	-3.5	6.6	20.8	-45.6	-36.7	-26.6	-12.4	
122	Required Separation (21 mm/hr rain on interference up to 4 km)	km	2.4	1.3	0.6	0.1	36.5	16.4	5.8	2.3	
123	Path Loss Allocation:										
124	Free Space	dB	129.2	124.2	116.9	104.3	153.0	146.1	137.1	129.2	
125	Atmosphere	dB	0.2	0.1	0.1	0.0	3.6	1.6	0.6	0.2	
126	Rain	dB	8.6	4.8	2.1	0.5	14.5	14.5	14.5	8.6	
127	*LMDS 180 degree Backlobe*										
128	Required Path Loss	dB	-112.1	-103.2	-93.1	-78.9	-171.2	-162.3	-152.2	-138.0	
129	Margin at 1 km (clear sky)	dB	9.8	18.8	28.8	43.1	-49.3	-40.4	-30.3	-16.1	
130	Required Separation (clear sky, no radio horizon)	km	0.3	0.1	0.0	0.0	96.9	55.6	24.8	6.0	
131	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	13.5	22.5	32.5	46.8	-45.6	-36.7	-26.6	-12.4	
132	Required Separation (21 mm/hr rain on interference up to 4 km).	km	0.3	0.1	0.0	0.0	36.5	16.4	5.8	2.3	
133	Path Loss Allocation:										
134	Free Space	dB	111.0	102.7	92.9	78.8	153.0	146.1	137.1	129.2	
135	Atmosphere	dB	0.0	0.0	0.0	0.0	3.6	1.6	0.6	0.2	
136	Rain	dB	1.1	0.4	0.1	0.0	14.5	14.5	14.5	8.6	
137											
138											
139	LMDS Signal: rain Satellite Signal: rain										

1	Working Group 2: Computation and Modeling Ad Hoc Committee 9/19/94										
2											
3	LMDS System Parameters										
4	System Proponent		Suite 12				Suite 12				
5	Link		Hub to Sub				Sub to Hub				
6	Modulation		FM				QPSK or AM				
7	Digital Data Rate		N/A				64 kbps				
8	Channel Bandwidth		18 MHz				40 kHz				
9	Antenna Pattern Used		Proponent				Proponent				
10	Date/Revision of System Parameters	WG 1/52	9/16/94 Rev 3				9/16/94 Rev 3				
11											
12	Feeder Link System		IRIDIUM				IRIDIUM				
13											
140	ES angle from boresight		5	10	20	48	5	10	20	48	
141	*LMDS Boresight*										
142	Required Path Loss	dB	-177.1	-168.2	-158.1	-143.9	-186.2	-177.3	-167.2	-153.0	
143	Margin at 1 km (clear sky)	dB	-55.2	-46.2	-36.2	-21.9	-64.3	-55.4	-45.3	-31.1	
144	Required Separation (clear sky, no radio horizon)	km	130.1	81.4	40.7	11.1	188.9	131.1	76.7	26.6	
145	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	-51.5	-42.5	-32.5	-18.2	-60.6	-51.7	-41.6	-27.4	
146	Required Separation (21 mm/hr rain on interference up to 4 km)	km	56.8	28.2	10.8	3.2	99.4	57.4	25.9	6.3	
147	Path Loss Allocation:										
148	Free Space	dB	156.9	150.8	142.5	131.9	161.8	157.0	150.1	137.8	
149	Atmosphere	dB	5.7	2.8	1.1	0.3	9.9	5.7	2.6	0.6	
150	Rain	dB	14.5	14.5	14.5	11.6	14.5	14.5	14.5	14.5	
151	*LMDS 5 degree Sidelobe*										
152	Required Path Loss	dB	-159.1	-150.2	-140.1	-125.9	-186.2	-177.3	-167.2	-153.0	
153	Margin at 1 km (clear sky)	dB	-37.2	-28.2	-18.2	-3.9	-64.3	-55.4	-45.3	-31.1	
154	Required Separation (clear sky, no radio horizon)	km	44.1	20.6	7.5	1.6	188.9	131.1	76.7	26.6	
155	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	-33.5	-24.5	-14.5	-0.2	-60.6	-51.7	-41.6	-27.4	
156	Required Separation (21 mm/hr rain on interference up to 4 km)	km	12.0	4.7	2.6	1.0	99.4	57.4	25.9	6.3	
157	Path Loss Allocation:										
158	Free Space	dB	143.4	135.2	130.2	122.0	161.8	157.0	150.1	137.8	
159	Atmosphere	dB	1.2	0.5	0.3	0.1	9.9	5.7	2.6	0.6	
160	Rain	dB	14.5	14.5	9.8	3.8	14.5	14.5	14.5	14.5	
161	*LMDS 45 degree Sidelobe*										
162	Required Path Loss	dB	-153.1	-144.2	-134.1	-119.9	-186.2	-177.3	-167.2	-153.0	
163	Margin at 1 km (clear sky)	dB	-31.2	-22.2	-12.2	2.1	-64.3	-55.4	-45.3	-31.1	
164	Required Separation (clear sky, no radio horizon)	km	26.9	11.5	3.9	0.8	188.9	131.1	76.7	26.6	
165	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	-27.5	-18.5	-8.5	5.8	-60.6	-51.7	-41.6	-27.4	
166	Required Separation (21 mm/hr rain on interference up to 4 km)	km	6.4	3.2	1.8	0.6	99.4	57.4	25.9	6.3	
167	Path Loss Allocation:										
168	Free Space	dB	137.9	132.0	127.1	117.5	161.8	157.0	150.1	137.8	
169	Atmosphere	dB	0.6	0.3	0.2	0.1	9.9	5.7	2.6	0.6	
170	Rain	dB	14.5	11.8	6.8	2.3	14.5	14.5	14.5	14.5	
171	*LMDS 180 degree Backlobe*										
172	Required Path Loss	dB	-127.1	-118.2	-108.1	-93.9	-186.2	-177.3	-167.2	-153.0	
173	Margin at 1 km (clear sky)	dB	-5.2	3.8	13.8	28.1	-64.3	-55.4	-45.3	-31.1	
174	Required Separation (clear sky, no radio horizon)	km	1.8	0.7	0.2	0.0	188.9	131.1	76.7	26.6	
175	Margin at 1 km (3.7 dB rain attenuation on interference)	dB	-1.5	7.5	17.5	31.8	-60.6	-51.7	-41.6	-27.4	
176	Required Separation (21 mm/hr rain on interference up to 4 km)	km	1.1	0.5	0.2	0.0	99.4	57.4	25.9	6.3	
177	Path Loss Allocation:										
178	Free Space	dB	122.8	116.2	107.4	93.7	161.8	157.0	150.1	137.8	
179	Atmosphere	dB	0.1	0.1	0.0	0.0	9.9	5.7	2.6	0.6	
180	Rain	dB	4.2	1.9	0.7	0.1	14.5	14.5	14.5	14.5	

1	Working Group 2: Computation and Modeling Ad Hoc Committee 9/19/94									
2										
3	LMDS System Parameters									
4	System Proponent		Suite 12				Video/Phone			
5	Link		Sub to Hub				Hub to Sub			
6	Modulation		QPSK or AM				FM			
7	Digital Data Rate		1.544 Mbps				N/A			
8	Channel Bandwidth		1 MHz				20 MHz			
9	Antenna Pattern Used		Proponent				Proponent			
10	Date/Revision of System Parameters	WG 1/52	9/16/94 Rev 3				9/16/94 Rev 3			
11										
12	Feeder Link System		IRIDIUM				IRIDIUM			
13										
14	Required Separation (clear sky, incl. 100 km radio horizon)									
15	ES angle from boresight		5	10	20	48	5	10	20	48
16	LMDS receiver pointing angle									
17	Boresight	km	97.3	55.9	25.0	6.1	4.0	1.5	0.5	0.1
18	5 Degree Sidelobe	km	97.3	55.9	25.0	6.1	0.2	0.1	0.0	0.0
19	45 Degree Sidelobe	km	97.3	55.9	25.0	6.1	0.0	0.0	0.0	0.0
20	180 Degree Backlobe	km	97.3	55.9	25.0	6.1	0.0	0.0	0.0	0.0
21										
22	Calculations									
23										
24	LMDS Signal Link Carrier Level at Cell Edge		Clear Sky		Rain Conditions		Clear Sky		Rain Conditions	
25	Transmitted Power	dBW/channel	-21		-21		-10.9		-10.9	
26	Transmitter Antenna Gain	dBi	31		31		29.7		29.7	
27	EIRP (clear sky)	dBW/channel	10		10		18.8		18.8	
28	Power Control (rain)	dB	0		13		0		5.8	
29	Distance to Cell Edge	km	4.83		4.83		1.61		1.61	
30	Rain Attenuation (cell edge)	dB	0		-13		0		-5.8	
31	Free Space Path Loss (cell edge)	dB	-135.5		-135.5		-125.9		-125.9	
32	Receiver Antenna Gain	dBi	12		12		38		38	
33	Carrier Level at Cell Edge	dBW/channel	-113.5		-113.5		-69.1		-69.1	
34	Notes:									
35	Rain attenuation from WG1/52 (rev. 3)									
36	Power control is the minimum necessary to overcome rain fade without exceeding maximum						Video/Phone max power control: 11 dB			
37										
38										
39	Interference Density into LMDS		Clear Sky		Rain Conditions		Clear Sky		Rain Conditions	
40	k (Boltzmann's Constant)	dBW/K/Hz	-228.6		-228.6		-228.6		-228.6	
41	Receiver Noise Figure	dB	3		3		7.5		7.5	
42	Receiver Noise Temperature	K	579		579		1631		1631	
43	Channel Bandwidth	MHz	1		1		20		20	
44	Receiver Noise Floor	dBW/channel	-141.0		-141.0		-123.5		-123.5	
45	Minimum Required C/(N + I)	dB per channel	19		19		24		24	
46	Cell Edge C/N	dB	27.5		27.5		54.3		54.3	
47	Cell Edge C/N	linear	561		561		270346		270346	
48	Required C/(N + I)	linear	79		79		251		251	
49	Maximum Acceptable Interference	dBW/channel	-133.2		-133.2		-93.2		-93.2	
50	Maximum Acceptable Interference Density	dBW/Hz	-193.2		-193.2		-166.2		-166.2	
51	Notes:									
52										
53										
54	Interference Density Generated									
55	IRIDIUM Feeder Links into LMDS Receivers									

1	Working Group 2: Computation and Modeling Ad Hoc Committee 9/19/94										
2											
3	LMDS System Parameters										
4	System Proponent		Suite 12				Video/Phone				
5	Link		Sub to Hub				Hub to Sub				
6	Modulation		QPSK or AM				FM				
7	Digital Data Rate		1.544 Mbps				N/A				
8	Channel Bandwidth		1 MHz				20 MHz				
9	Antenna Pattern Used		Proponent				Proponent				
10	Date/Revision of System Parameters	WG 1/52	9/16/94 Rev 3				9/16/94 Rev 3				
11											
12	Feeder Link System		IRIDIUM				IRIDIUM				
13											
56											
57	ES angle from boresight	degrees	5	10	20	48	5	10	20	48	
58	Earth Station Output Power (no rain)	dBW/channel	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	
59	Slant Path Length	km	2741.1	2325.7	1732.4	1006.9	2741.1	2325.7	1732.4	1006.9	
60	Power Control (slant path)	dB	1.5	0.0	-2.5	-7.2	1.5	0.0	-2.5	-7.2	
61	Antenna Gain	dBi	14.5	7.0	-0.5	-10.0	14.5	7.0	-0.5	-10.0	
62	Single Channel BW	MHz	4.375	4.375	4.375	4.375	4.375	4.375	4.375	4.375	
63	Number of Interfering Channels	dB	0	0	0	0	0	0	0	0	
64	LMDS Receiver Bandwidth	MHz	0.04	0.04	0.04	0.04	20	20	20	20	
65	Interference Density Subtotal (clear sky)	dBW/Hz	-42.8	-51.8	-61.9	-76.1	-69.8	-78.8	-88.9	-103.1	
66	Rain Rate	mm/hr	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
67	Length of rain cell	km	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
68	Path Length through rain	km	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
69	Rain Attenuation	dB	15	15	15	15	15	15	15	15	
70	Power Control (rain)	dB	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
71	Interference Density Subtotal (rain on signal path)	dBW/Hz	-27.8	-36.8	-46.9	-61.1	-54.8	-63.8	-73.9	-88.1	
72	Notes:										
73	Antenna Gain is the maximum elevation pattern gain in the direction of the LMDS receiver w										
74	the earth station is pointing in the direction of the LMDS receiver										
75	Antenna Gain is 32-25*log(theta)										
76	Power Control (slant path) is the difference in EIRP required to offset the path loss along th										
77	Eb/No at the satellite receiver										
78	The default slant path (0 dB power control) is for a 10 degree elevation angle										
79	Total Power Control (rain plus slant path) cannot exceed 24.8 dB										
80	Interference Density Subtotal calculated based on AWGN assumption										
81	may be a low estimate of interference										
82	Lin Model used for rain attenuation on interference path										
83	Assume rain fade of 15 dB on satellite signal path										
84	Maximum rain cell 4 km long										
85											
86											
87	LMDS Receiver Antenna Gain										
88	Boresight	dBi	21				38				
89	5 Degree Sidelobe	dBi	21				9.1				
90	45 Degree Sidelobe	dBi	21				-8				
91	180 Degree Backlobe	dBi	21				-14				
92	Note:										
93	Negative margin indicates C/(N+I) objective not met at 1 km separation										
94	All path loss values indicate positive loss (negative gain) regardless of sign										
95	LMDS Signal: clear sky, Satellite Signal: clear sky										
96	ES angle from boresight		5	10	20	48	5	10	20	48	
97	*LMDS Boresight*										