Miller, Edward	Teledesic
Nelson, Robert	GE Americom
Nilson, Kaye	Compass Rose International
Pattan, Bruno	Federal Communications Commission
Raish, L. Robert	Fletcher, Heald & Hildreth
Rinker, Alan	NASA
Schill, Jon	University of Texas System
Seidel, Scott	Bellcore
Serafini, Tony	Federal Communications Commission
Sincavage, Beverly	Leslie Taylor Associates
Smith, Thomas	Endgate Technology Corporation
Sonnenfeldt, Walter	Walter Sonnenfeldt & Associates
Stone, Richard	Motorola Satellite Communications, Inc.
Sutliff, Larrie	Bellcore
Taylor, Leslie	Leslie Taylor Associates
Tycz, Thomas	Federal Communications Commission

Appendix B

DOCUMENTS SUBMITTED TO THE LMDS/FSS 28 GHz NEGOTIATED RULEMAKING WORKING GROUP 2 9-17-94

Number	Title	Source
WG2/1	Characteristics of Teledesic's Ka Band Low Earth Orbit, FSS Network to Provide Global Voice, Data and Video Communications (Slide Presentation) Date: 7/26/94	Teledesic
WG2/2	Characteristics of Teledesic's Ka Band Low Earth Orbit, FSS Network to Provide Global Voice, Data and Video Communications (Narrative) Date: 7/26/94	Teledesic
WG2/3	Technical Characteristics of Teledesic Network	Teledesic
WG2/4	Characteristics of Spaceway System	Hughes
WG2/5	Motorola's Iridium - Personal Communications for the World (Slide Presentation)	Motorola
WG2/6	20/30 GHz Technical Characteristics of the Iridium (R) Network	Motorola
WG2/6 (Rev. 1)	"	Motorola
WG2/7	IEEE Potentials - "Plugging into the Future"	Motorola
WG2/8	The LMDS System Does Not Interfere with NASA ACTS Satellites -- Supplemental Rebuttal (Covering Letter Dated: January 6, 1994)	Suite-12
WG2/9	Interference From Ka-Band LMDS Video Signals	Suite-12

	to Ka-Band Satellites (Dated: Jan. 4, 1994) (Covering Letter Dated: January 10, 1994)	
WG2/10	Satellite Earth Stations Operating in the 28 GHz Band will not Interfere with LMDS Receivers	Suite-12
WG2/11	Reply of Suite 12 Group to Motorola Satellite Communications, Inc.'s "Supplemental Comments" (Covering Letter Dated: 1-5-94)	Suite-12
WG2/12	Frequency Reuse in the Cellular LMDS	Suite-12
WG2/13	LMDS Does Not Interfere with NASA ACTS - LMDS is Both Practical and Economically Viable	Suite-12
WG2/14	Video/Phone LMDS System	Video/Phone
WG2/ 15	ACTS Technical Characteristics	NASA
WG2/16	Analysis of Sharing Possibilities and Potential Interference between the Teledesic Network and Suite 12 LMDS at 27.5 to 29.5 GHz (Slide Presentation)	Teledesic
WG2/17	Analysis of Sharing Possibilities and Potential Interference between the Teledesic Network and Suite 12 LMDS at 27.5 to 29.5 GHz (Narrative)	Teledesic
WG2/18	Spaceway Interference into LMDS	Hughes
WG2/19	Spaceway Interference into LMDS (Chart)	Hughes
WG2/20	Fig. 1 - Top 318 City Areas and Populations U.S. Department of Commerce Bureau of the Census	Steve Copold
WG2/21	Additional Technical Parameters to be Shared in System Characterizations	Tim Campbell
WG2/22	ACTS system Capability and Performance	NASA

WG2/23	Analysis of ACTS Low Burst Rate (LBR) Terminal Interference Into LMDS Suite-12 Receivers	NASA
WG2/24	Video/Phone - Draft-Technical Charactersitics of 20/30 Terrestrial Systems	Video/Phone
WG2/25	Design Issues Affecting LMDS and FSS Spectrum Allocation	TX Instruments
WG2/26	Terms of Reference Joint Technical Sub-Group LMDS/FSS NRM Informal Working Groups 1 & 2	W. Sonnenfeldt
WG2/27	The CellularVision Modulation Choice	Suite 12
WG2/28	Telephone & Other Secondary Service Available Through Suite's 12 LMDS Frequency Plan	Suite 12
WG2/29	LMDS/FSS 28 GHz Negotiated Rulemaking Committee Work Program For Working Group 2	R. James
WG2/29 (Rev. 1)	"	
WG2/30	Representative System Technical Characteristics	TX Instruments
WG2/31	Meeting Report - First Meeting of the Joint Technical Sub-Group (JTSG) LMDS/FSS NRM Informal Working Groups 1 and 2	John Knudsen
WG2/32	Technical Characteristics of the Constellation System Ka-Band Earth-to-Space Feeder Links (Nominal)	Constellation
WG2/33	Representative 20/30 GHz Band Technical Characteristics: TRW Inc. ODYSSEY System	TRW
WG2/34	20/30 GHz Technical Characteristics of the SPACEWAY System	Hughes
WG2/35	CellularVision Services	Suite 12
WG2/36	Technical Factors for Inclusion in LMDS/MSS Sharing Analysis for WG2 (LMDS into MSS Space Stations)	R. James
WG2/36 (Rev. 1)	"	

WG2/37	Technical Factors for Inclusion in LMDS/MSS Sharing Analysis for WG2 (Feeder Links into LMDS Receivers)	R. James
WG2.37 (Rev. 1)	"	
WG2/38	Preliminary Sharing Analysis (Interference Sharing Scenario #6, LMDS Hubs into the Iridium Satellites) August 16, 1994	John Knudsen
WG2/38 (Rev. 1)	" Dated: August 18, 1994	
WG2/39	TI LMDS (August 17, 1994)	H. Chalkley
WG2/39 (Rev. 1)	"	H . Chalkley
WG2/40	Sharing Studies Between LMDS Receivers and Iridium Gateway Transmitters in the 20/30 GHz FSS Bands (August17, 1994)	Ken Engle
WG2/41	Statement to the Negotiated Rulemaking Committee Regarding Terrestrial Fixed Microwave Telecommunications (August 23, 1994)	L. R. Raish
WG2/42	Working Group 2 Computational Subgroup Preliminary Report (August 23, 1994)	S. Seidel
WG2/43	EIRP Spectral Area Density (August 23, 1994)	Ken Engle
WG2/44	Ellipso System - Feeder Links Ka Band (August 26, 1994)	Ken Manning
WG2/45	Preliminary Analysis of LMDS Interference into an Earth Coverage MSS Leo Satellite Receeiving Beam (August26, 1994)	R. Lepkowski
WG2/46	Mitigation Opportunities (August 26, 1994)	L. Sutliff
WG2/47	Texas Instruments LMDS/FSS-MSS Interference Analysis, Mitigation and Recommendations (September 1, 1994)	H. Chalkley
WG2/47 (Add. 1)	" (September 7, 1994)	
WG2/48	Working Group 2 Computation and Modeling Ad Hoc Committee Report of Meeting of 8/23/94 (September 1, 1994)	S. Seidell

WG2/48 (Rev. 1)	" (September 8, 1994)	
WG2/49	WG2 Report Outline (September 1, 1994)	R. James
WG2/50	LMDS and FSS-MSS Systems Inteference and Co-Share Techniques in the 28 GHz Band	H. Chalkley
WG2/50 (Rev. A)	" (September 13, 1994)	
WG2/51	Motorola Satellite Communications, Inc. - Suite 12 Jointly Proposed Rules on Co-Frequency Sharing between LMDS and Non-GSO MSS Feeder Links (September 8, 1994)	Motorola-Suite 12/CVNY
WG2/51 (Add 1)	"	Larrie Sutliff
WG2/51 (Add 2)	"	H. Chalkley
WG2/51 (Add. 3)	Joint Submission of Constellation Communications Inc., Loral QUALCOMM Partnership, L.P. and Mobile Communications Holdings, Inc.	Constellation, Loral, & Mobile Communications
WG2/52	Rational for Rules on Co-Frequency Sharing between LMDS and Non-GSO MSS Feeder Links Proposed by Motorola Satellite Communications, Inc. and Suite 12 Group/CVNY (September 10, 1994)	Motorola/Suite 12
WG2/53	Top 100 MSA's with a 75 Nautical Mile Boundary (September 8, 1994)	Steve Copold
WG2/54	Preliminary Sharing Assessment TI into Iridium Hub into Satellite (September 10, 1994)	John Knudsen
WG2/55	Preliminary Sharing Assessment VideoPhone into Iridium Hub to Satellite (September 10, 1994)	John Knudsen
WG2/56	Preliminary Sharing Assessment VideoPhone into Iridium Subscriber to Satellite	John Knudsen
WG2/57	Draft Section II: Descriptive Systems Characteristics	Melvin Barmat
WG2/58	Draft Section III: Description of Interference/Sharing Scenarios	Don Jansky
WG2/59	Final Report Section IV	K Engle & J Knudsen
WG2/60	Loral QUALCOMM Partnership, L.P. Information on Feederlink and Gateway Earth	Leslie Taylor

	Station Requirements	
WG2/61	Draft Section VI: Conclusion and Regulatory Proposals	Motolora/Suite-12
WG2/62	EIRPlmtA.xls Spreadsheet	Ken Engle
WG2/63	Power Flux Density Limits Should not be Imposed on Non-GSO MSS Feeder Link Transmission	John Knudsen
WG2/64	Mitigation Opportunities Status Report	Larrie Sutliff/ S Seidell

ATTACHMENT C

Motorola's Modified NRMC-21 Interference Simulation Model

```
c
c The feasibility of sharing the 29 GHz band among various radio
c services is a complex issue.  This is due to the dynamic nature of
c orbit position for low earth orbit (LEO) satellites, and to the
c potentially vast population of LMDS hubs.
c
c In this vast and dynamic environment, interference assessment based
c on a single LMDS hub transmitter may not be adequate to quantify the
c impact of LMDS on the LEO satellite (LEOsat).  A summation of all
c individual LMDS hub interference provides an upper bound (worst
c case) estimate of the potential interference into a LEOsat receiver.
c This iterative process is best accomplished by computer simulation.
c
c The folowing method has been implemented in this program to
c simulate a LMDS environment interfering into a LEOsat receiver
c at a given altitude.  The visible area of the Earth from a LEOsat
c is assumed to be populated with a uniform density of LMDS hubs.
c Each LMDS hub is assumed to be a typical station with the same
c transmitter power, antenna characteristics, service area size and
c co-frequency with the LEOsat receiver.  For each LMDS hub,
c the interference-to-noise density ratio is calculated using the
c antenna discrimination afforded by the hub antenna toward the
c LEOsat and the satellite antenna toward the hub.
c
c The process is repeated for half of all visible LMDS hubs. The
c division of the LMDS population is along the sub-satellite point
c on Earth.
c
c The return transmissions from the customer units back to the hubs
c have not been included in this analysis.
c
c ***********************************************************************
c NOTE: all Earth surface longitudes are in great-circle-distance (GCD)
c degrees.
c ***********************************************************************
c
c Program option and output:
c
c The program begins by requesting the name of the data file which
c contains the input parameters, and the output file name. The program
c echos the input data on the screen and displays a few preliminary
c visibility statistics so the user can decide whether to proceed with
c the analysis.
c
c The input file provides the user the following options:
c
c The LMDS hub antenna is simulated by a (sinx/x)square function, a
c shaping factor (1/(1+x^N)) and a constant sidelobe suppression.
c The user is able to select, via the input data file:
c  - the null-to-null spacing of the sinx/x function;
c  - the shaping exponent; and
c  - the overall sidelobe attenuation.
c
c For the LEOsat receiving antenna, the program implements the
c ITU RR Appendix 30B's fast roll-off antenna pattern.  The user is
```

```
c able to select the shape of the mainlobe.  The minimum value for
c the mainlobe shaping is 0.8.
c
c The minimum relative gain "antmingn" of both antennas is preset
c to -45 dB within the program.
c
c
c The program displays the result on the screen and saves the
c information on the hard disk.  The output contains three parts:
c
c 1) the input parameters, visibility statistics & aggregate Io/No ratio
c
c 2) the aggregate Io/No statistics in terms of
c the LMDS hub site elevation angle towards the LEO satellite
c
c 3) the aggregate Io/No statistics in terms of
c the LEO satellite antenna off-axis angle towards the LMDS hub site
c
c
c Other information:
c
c For computational purpose, the sub-satellite point is assumed to be
c at 90xE longitude at the equator.
c
c For screen and output display purposes, the sub-satellite point is
c assumed to be at 0.0 degree great-circle-distance longitude.
c
c
c
      parameter (size=15)
      parameter (f_GHz=29.4) !frequency of operation
      parameter (G0_leo=30.1) !on-axis gain of LEOsat antenna (dBi)
      parameter (Tsys=1295.4) !LEOsat receiver system temperature (xK)
c
      real Io_e, Io_p, Io_total, Ioi, Ix, itntotal, itne, itnp
      real No, logk, Lpi
c
      dimension Ne(size),Io_e(size),itne(size),
     #          Np(size),Io_p(size),itnp(size)
c
      common/const/ pi,antmingn
c
      character*15 leonam
      character*12 fnami,fnamo
      character*1  yestext
      character*11 testtext
      logical exfi
c
      data eradi/6.378165E3/ !Earth equatorial radius (km)
      data logk/-228.6/ !log10(Boltzmann's constant)
      data pi/3.141592654/,halfpi/1.570796327/
      data rtd/5.729577951E1/,dtr/1.74532925E-2/
      data antmingn/-45.0/ !minimum relative gain of any antenna (dB)
c
   10 format (a,a)
 1000 format (//,10x,'*****************************'
```

```
     #'**********************',
     #/10x,'*',50x,'*'
     #/10x,'*',50x,'*'
     #/10x,'*',5x,'LMDS-to-LEO/FSS Interference Calculation',5x,'*'
     #/10x,'*',50x,'*'
     #/10x,'*',36x,'by Harry Ng    *'
     #/,10x,'*****************************************************',
     #/////)
 1001 format(' The name of the input file (DOS format)...........: '\)
 1002 format(/' The name of the output file (DOS format)..........: '\)
 1004 format(' Enter climate type 0..5 (0 for no atmospheric attenua'
     #'tion): ')
 1005 format(' The name of the input file.......................: ',
     #A12)
 1010 format(' The name of this data file.......................: ',
     #A12)
 1011 format(' The name of the LEO satellite system.............: ',
     #A15)
 1015 format(' The LEOsat orbital altitude (km)..................: ',
     #F9.2)
 1020 format(' The LEOsat antenna half-power beamwidth (deg)....: ',
     #F9.2)
 1025 format(' The LEOsat ant main-lobe shape factor (0.8-3.2)..: ',
     #F9.2)
 1030 format(' The LEOsat ant boresight elevation angle (deg)...: ',
     #F9.2)
 1035 format(' The atmospheric-attenuation index (climate; 1-5).: ',
     #I9)
 1045 format(' The LMDS hub e.i.r.p. density (dBWi/xHz).........: ',
     #F9.2)
 1046 format(' The LMDS hub ant mainbeam depression angle (deg).: ',
     #F9.2)
 1050 format(' The LMDS hub ant pattern shape factor (0.0, 1. ).: ',
     #F9.2)
 1055 format(' The LMDS hub antenna main-lobe null angle (deg)..: ',
     #F9.2)
 1060 format(' The LMDS hub antenna sidelobe attenuation (dB)...: ',
     #F9.2)
 1070 format(' The LMDS inter-[co-frequency]hub spacing (km)....: ',
     #F9.2)
 1071 format(' The polarization attenuation at LEO of LMDS(dB)..: ',
     #F9.2)
 1072 format(/,' The LEO sub-satellite longitude (deg. GCD).......: ',
     #F6.2)
 1074 format(' The LEO ant aim-point long & elev (deg.GCD & deg): ',
     #2F6.2)
 1075 format(' The edge of the HPBW long & elev (deg.GCD & deg).: ',
     #2F6.2)
 2075 format(' The edge of the HPBW long & elev (deg.GCD & deg).:  ',
     #A11)
 1076 format(' The LEOsat maximum observed longitude (deg.GCD)..: ',
     #F6.2)
 1078 format(' The number of LMDS hubs per longitude swath......: ',
     #I6)
C
 1081 format(' There are ',I6,' LMDS cells and the aggregate '
```

```
     #'Io/No is',F5.1,' dB.')
 1086 format(/,' ***** Io/No for various LEO satellite antenna off-'
     #'axis angles',/,
     #'        Number  Off-axis angle    Io/No')
c     *****    **.* - **.*      **.*
 1088 format(/,' ***** Io/No for various LMDS site elev angles toward'
     #' the LEO sat ',/,
     #'        Number  Elevation angle   Io/No')
 1101 format(7x,I5,4x,' 0.0 -  5.0',5x,F5.1)
 1102 format(7x,I5,4x,' 5.0 - 10.0',5x,F5.1)
 1103 format(7x,I5,4x,'10.0 - 15.0',5x,F5.1)
 1104 format(7x,I5,4x,'15.0 - 20.0',5x,F5.1)
 1105 format(7x,I5,4x,'20.0 - 25.0',5x,F5.1)
 1106 format(7x,I5,4x,'25.0 - 30.0',5x,F5.1)
 1107 format(7x,I5,4x,'30.0 - 35.0',5x,F5.1)
 1108 format(7x,I5,4x,'35.0 - 40.0',5x,F5.1)
 1109 format(7x,I5,4x,'40.0 - 45.0',5x,F5.1)
 1110 format(7x,I5,4x,'45.0 - 50.0',5x,F5.1)
 1111 format(7x,I5,4x,'50.0 - 55.0',5x,F5.1)
 1112 format(7x,I5,4x,'55.0 - 60.0',5x,F5.1)
 1113 format(7x,I5,4x,'60.0 - 70.0',5x,F5.1)
 1114 format(7x,I5,4x,'70.0 - 80.0',5x,F5.1)
 1115 format(7x,I5,4x,'80.0 - 90.0',5x,F5.1)
c
 1301 format(' The LEO receiver has Tsys=',F6.1,' xK and No=',F8.2,
     #'dBW/Hz')
c
      call eras
      write(*,1000)
  100 write(*,1001)
      read(*,10) fnami
      inquire(file=fnami,exist=exfi)
      if(.NOT. exfi) then
        write(*,'(a)') ' There is no file with this name!'
        goto 100
      endif
  200 write(*,1002)
      read(*,10) fnamo
      inquire(file=fnamo,exist=exfi)
      if(exfi) then
        write(*,'(a)') ' There is a file with this name!'
        goto 200
      endif
c
  300 open(1,file=fnami)
      read(1,500) leonam,altitude,hpbw,phezero,elevat,iclim,
     #            eirplmds,depreang,shapelmd,ahornull,sideattn,
     #            diameter,xpol
c
  500 format(A15,F7.1,3F5.1,I5,7F5.1)
c
c altitude=the leo satellite altitude (km)
c hpbw=leo satellite antenna half-power beamwidth (deg)
c phe0=the LEO antenna mainbeam shape factor (see WARC-88 pattern)
c     =0.8 ... a normal horn antenna
c                -12(phe/phe0)          for 0<(phe/phe0)<1.45
```

```
c                 -(22+20log10(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!!!!! where "(phe/phe0)" is assumed to be (pheid/hpbw) !!!!!!!!!!!!!!!
c elevat=the elevation angle at the center of the hpbw (deg)
c  iclim=atmospheric-attenuation index (standard climate type from Radio
c         regulations, vol. 2, Table IV, pg A28-25)
c eirplmds=LMDS e.i.r.p. density, dBW/xHz
c depreang=LMDS hub antenna mainbeam depression angle
c shapelmd=LMDS hub antenna shape factor (0., or any number)
c         = 0.0 : no modification to [sin(x)/x]^2
c         = E   : [sin(x/N)/(x/N)]^2 is modified by 1/(1+(x/N)^E)
c                    x=(the elevation angle at the hub)*pi
c                    N=ahornull
c ahornull=LMDS antenna's above-horizon mainbeam null angle (deg)
c sideattn=LMDS antenna overall sidelobe attenuation level (dB)
c diameter=the inter-hub spacing of the co-frequency LMDS hubs (km)
c     xpol=the cross-polarization-caused attenuation at the LEOsat receiver
c          of LMDS emissions, for mainlobe-to-mainlobe coupling only (dB)
c
c
      do 50 i=1,15
       Ne(i)=0
       Np(i)=0
       Io_e(i)=1.0E-30
       IO_p(i)=1.0E-30
   50 continue
c
      Ncell=0
      Io_total=1.0E-30
      logf=20.0*log10(f_GHz)
c
c
c ***********************************************************************
      rplush=eradi+altitude
      rover=eradi/rplush
      rhover=rplush/eradi
      eradisq=eradi*eradi
      rhsq=rplush*rplush
      betamax=asin(rover)
      alphamax=halfpi-betamax
      betamaxd=betamax*rtd
      elevatr=elevat*dtr
      aimbeta=asin(rover*cos(elevatr))
      aimalpha=halfpi-aimbeta-elevatr
      aimdist=eradi*(sin(aimalpha)/sin(aimbeta))
      aimdists=aimdist*aimdist
      aimlong=halfpi+aimalpha
      aimlat=0.0
      aimx=eradi*cos(aimlong)*cos(aimlat)
      aimy=eradi*sin(aimlong)*cos(aimlat)
      aimz=eradi*sin(aimlat)
c The sub-satellie point (sublong, sublat)****************************
      sublong=halfpi
      sublat=0.0
c For DISPLAY PURPOSE ************************************************
```

```
      sublongd=0.0
      aimlongd=aimalpha*rtd
c compute the edge of the HPBW and if the edge is 'Over the horizon'***
      ahpbwbet=aimbeta+hpbw*dtr/2.0
      if(ahpbwbet .GT. betamax) then
       testtext='OverHorizon'
       goto 400
      endif
      acoselev=rhover*sin(ahpbwbet)
      elevathp=acos(acoselev)
      alphahp=halfpi-ahpbwbet-elevathp
      ahpbwele=elevathp*rtd
      ahpbwlon=alphahp*rtd
c The most eastern longitude*****'eastlond' is for output purpose!!!***
  400 eastlong=halfpi+alphamax
      eastlond=alphamax*rtd
      subx=rplush*cos(sublong)*cos(sublat)
      suby=rplush*sin(sublong)*cos(sublat)
      subz=rplush*sin(sublat)
      samwidth=diameter/eradi
      Nslat=int(alphamax/samwidth) !number of latitudinal sampling points
      Nslong=Nslat+1               !number of longitudinal sampling points
c
      x=0.5*(1.0-0.8/phezero)
      satlobe=1.16/phezero+x
      satlobe=hpbw*satlobe
c
c compute the LEO satellite receiver's noise-spectral density floor
c No=10.0*log10(k*Tsys); 10.0*log10(k)=-228.6
      No=logk+10.0*log10(Tsys)
c
      call eras
      write(*,1005) fnami
      write(*,1010) fnamo
      write(*,1011) leonam
      write(*,1015) altitude
      write(*,1020) hpbw
      write(*,1025) phezero
      write(*,1030) elevat
      write(*,1035) iclim
      write(*,1045) eirplmds
      write(*,1046) depreang
      write(*,1050) shapelmd
      write(*,1055) ahornull
      write(*,1060) sideattn
      write(*,1070) diameter
      write(*,1071) xpol
      write(*,1072) sublongd
      write(*,1074) aimlongd,elevat
      if(testtext.EQ.'OverHorizon') then
       write(*,2075) testtext
      else
       write(*,1075) ahpbwlon,ahpbwele
      endif
      write(*,1076) eastlond
      write(*,1078) Nslong
```

```
      write(*,1301) Tsys,No
c
      write(*,'(a)') '          ***** To continue enter "y" *****'
      read(*,10) yestext
      if(yestext .NE. 'y') goto 9999
c
      open(2,file=fnamo,status='new')
      write(2,1010) fnamo
      write(2,1011) leonam
      write(2,1015) altitude
      write(2,1020) hpbw
      write(2,1025) phezero
      write(2,1030) elevat
      write(2,1035) iclim
      write(2,1045) eirplmds
      write(2,1046) depreang
      write(2,1050) shapelmd
      write(2,1055) ahornull
      write(2,1060) sideattn
      write(2,1070) diameter
      write(2,1071) xpol
      write(2,1072) sublongd
      write(2,1074) aimlongd,elevat
      if(testtext.EQ.'OverHorizon') then
       write(2,2075) testtext
      else
       write(2,1075) ahpbwlon,ahpbwele
      endif
      write(2,1076) eastlond
      write(2,1078) Nslong
      write(2,1301) Tsys,No
c
c     The latitude increments toward the north, starting at the equator
      do 2000 i=1,Nslat
       elati=(i-1)*samwidth+samwidth/2.0
       sinelati=sin(elati)
       coselati=cos(elati)
c     The longitude increments toward the sub-satellite point
c     starting at the most eastern end of the equator
       do 2001 j=1,Nslong
        elongi=eastlong-(j-1)*samwidth
        xi=eradi*cos(elongi)*coselati
        yi=eradi*sin(elongi)*coselati
        zi=eradi*sinelati
        dx=subx-xi
        dy=suby-yi
        dz=subz-zi
        disti=sqrt(dx*dx+dy*dy+dz*dz)
        coseleva=(disti*disti+eradisq-rhsq)/(2.0*disti*eradi)
        elevai=acos(coseleva)-halfpi
c If the elevation angle at the LMDS site < 0 (below the horizon)
        if(elevai .LT. 0.0) goto 2099
c
        elevaid=elevai*rtd
        Ncell=Ncell+1
c
```

ATTACHMENT D

Explanation of Motorola's Quick Look Spreadsheet

Quick Look Spread Sheet

Given parameters are the footprint length and width, radius of earth and satellite altitude. The footprint is divided into 11 equidistant swaths. The width of one swath is the earth distance of 1° of the earth's circumference with a length of approximately 2°. 11 swaths approximate the major axis of the satellite footprint. See Figure 2 for plot of footprint projected on to the earth.

The no. of hubs in one swath is calculated by dividing the area of the swath by the area of one hub (area of one hub is considered to be the square of the hub-to-hub distance.) The no. of hubs that can actually interfere in a swath is the total no. divided by 2, since only half of the hubs can be on the same frequency as the feeder uplink channel.

First the spectral density of a single hub transmitter is to be calculated for a LMDS system like Suite 12:

Output power of single hub TWTA

- TWTA Back-off

-10*LOG(49) (49 channels in band)

= hub transmit power/channel

hub transmit power/channel

-antenna feed losses

-10*LOG(18 MHz) (18 MHz Video FM link)

+peaking factor since a FM NTSC video channel occupies 93% of 4.375 MHz BW)

=spectral density/hub

The next step is to calculate the power received at the satellite from each swath. To do this, the elevation angle and slant range from each swath to the satellite must be computed. The swath furthest from the satellite has an elevation angle of 0° at its far end. Given the geometry between the satellite and a 0° elevation angle, it is straightforward to calculate the nadir angle from the law of sines and the slant range from the Pythagorean theorem as shown in Figure 1. Then the interior angle can be calculated, which is the geocentric angle from the 0° elevation point to the satellite, and is 26° for a 780 km satellite altitude. However, to compute slant range and elevation for this furthest swath, -0.5° is subtracted from the 0° elevation interior angle to determine the elevation and slant range at the swath center, which approximates the mean values for this swath. For the next swath, the interior angle is decreased by 1° (since each swath is 1° in length) and the law of sines is used to calculate the nadir angle. From this the elevation angle of the next swath can be calculated. The law of cosines is used to calculate the slant range of this next swath. This process is also repeated for the subsequent swaths.

The elevation angle and slant range for each swath is needed to compute to the hub transmit antenna gain, atmospheric loss and path loss of that swath.

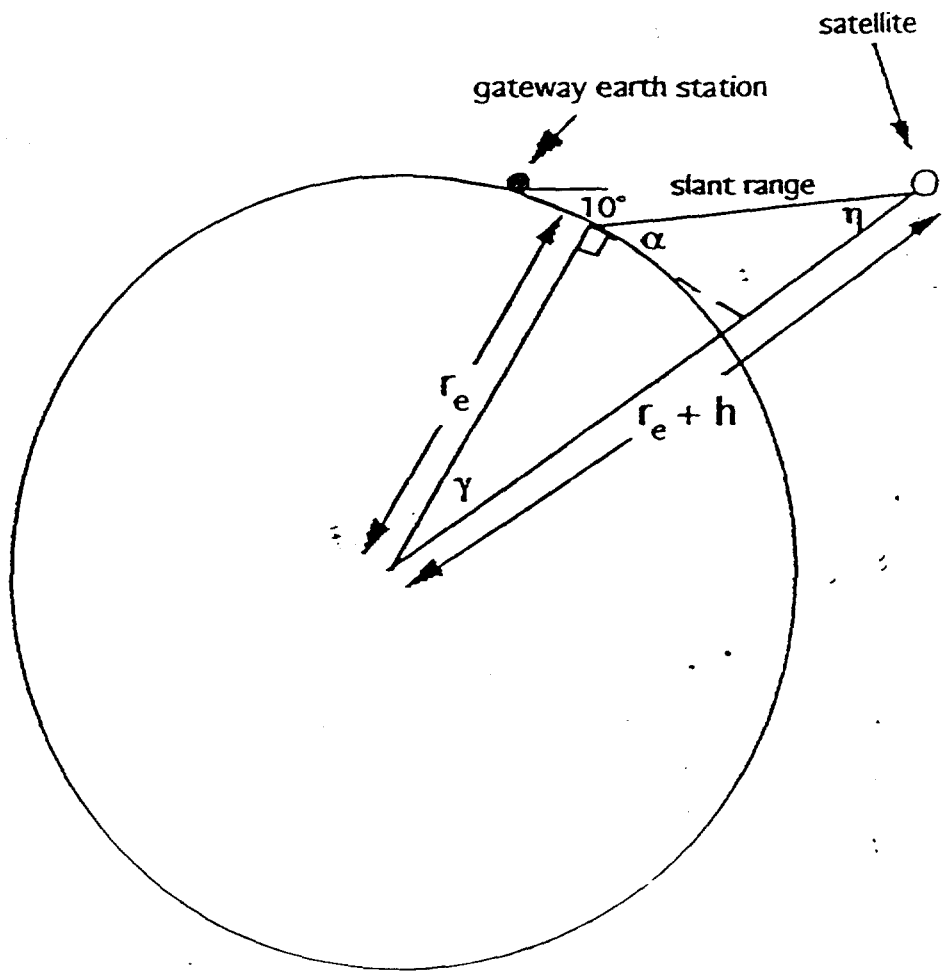
Now the power density received at the satellite by each swath is calculated:

xmit power/hub
+hub xmit gain/swath
-path loss/swath
-atmospheric loss/swath
+10*LOG(no. of hubs in each swath)
= received power density at satellite/swath

relation for hub antenna gain:
Insert desired antenna mask starting at 0.5° above horizon
relation for path loss:
=-92.45+20*LOG(slant range meters)+ (20*LOG(frequency in GHz))

The received power density from each swath, which is in dBW/Hz, is converted into W/Hz so the power received of each swath can be summed up into total receive power. This total receive power is then put back into dBW/Hz.

The satellite noise floor is 197.5 dBW/Hz. The total receive power is subtracted from the noise floor to calculate the raise in the satellite noise floor from the LMDS interference.



r_e	earth's radius
$r_e + h$	earth's radius & satellite altitude
a	elevation angle between point on earth and satellite $a = 90° - g - h$
g	interior angle or geocentric angle
lh	nadir angle

Figure 1 GEOMETRIES EMPLOYED IN RANGE CALCULATION

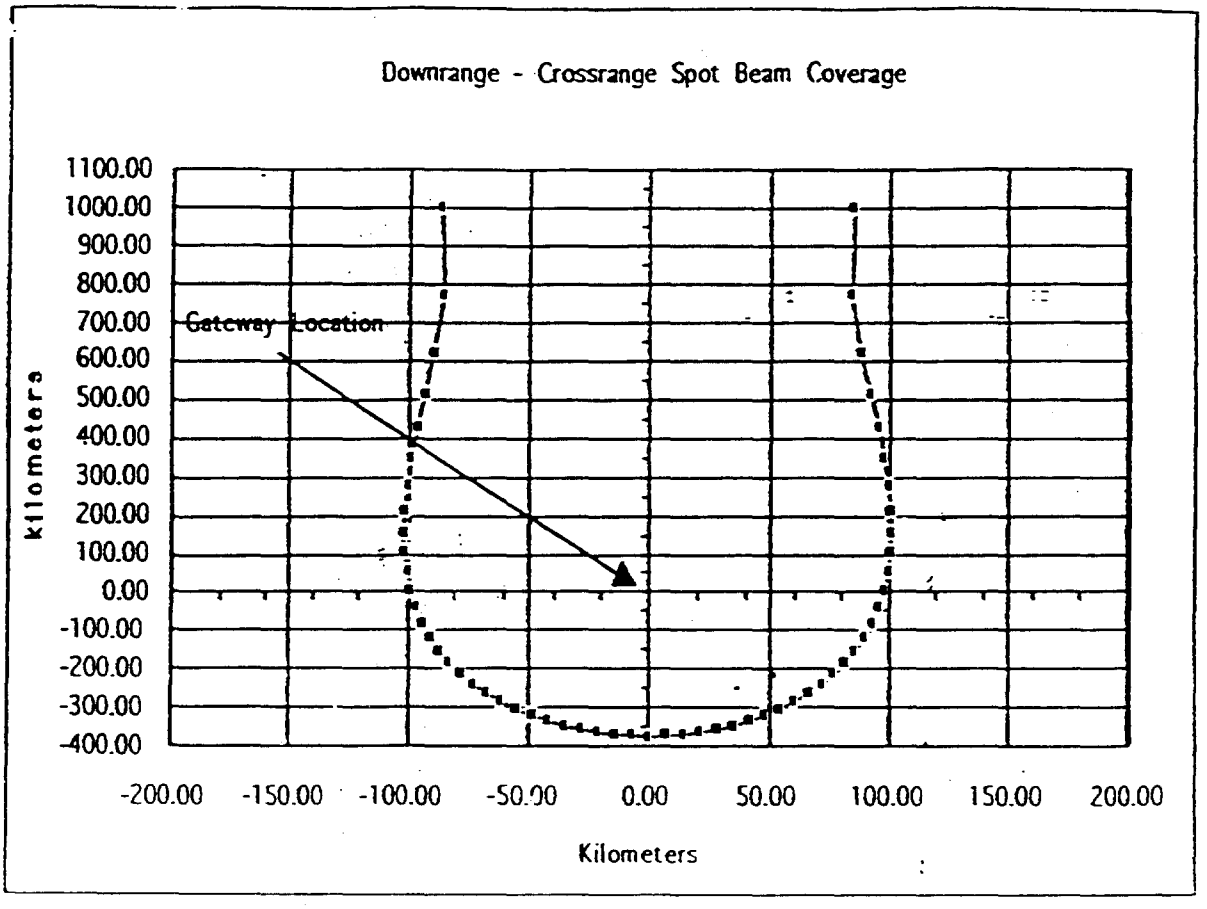


Fig 2 Satellite Footprint at 10°

ATTACHMENT E

Sample Calculation of Interference from a LMDS Backbone Transmitter into a Non-GSO MSS Feeder Link Space Station Receiver

EirplmtA.xls

6378	earth radius (km)				
7158	earth radius & sat. altitude (km)		PARAMETERS FOR A 0°		0.0
111.32	1° of circumference (km)		ELEV. ANGLE TO SATELLITE:		63.003
					27.0
					63.0
	Note: Peak EIRP density is -18 dbW/mhz + 42 dbi or 24 dbw/mhz				3249.3
type	Backbone Repeater station				
29	frequency of operation (GHz)				
20.0	TWTA Saturated Output (dBW)				
-13.0	TWTA Backoff (dBW)				
-16.9	Band split 49 channels (dB)				
-9.9	Xmtr Power/Channel (dBW)				
-1.0	Ant Feed Losses (dB)				
-10.9	Channel power to Antenna (dBW)				
-72.6	18 MHz Power Bandwidth (dBW-Hz)				
5.6	Peaking Factor (dB)				
-77.9	Xmtr spectral density/Hub (dBW/Hz)				

ATTACHMENT F

Interference Analysis - Suite 12 Hub Transmitters into Iridium™ Space Station Receivers

emitter elevation angle (°)	0.5	1.5	2.6	3.7	4.9	6.1	7.4	8.8	10.2		
nadir angle (°)	63.0	62.96	62.89	62.76	62.59	62.37	62.07	61.71	61.26		
interior angle (°)	26.5	25.5	24.5	23.5	22.5	21.5	20.5	19.5	18.5		
latitude angle (°)	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5		
slant range (km)	3194	3082	2971	2860	2749	2638	2528	2417	2308		
xmit power(dBW/Hz)	-77.9	-77.9	-77.9	-77.9	-77.9	-77.9	-77.9	-77.9	-77.9		
xmit gain (dBi)	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0		
path loss (dB)	-191.8	-191.5	-191.2	-190.8	-190.5	-190.1	-189.8	-189.4	-189.0		
atmosph loss (dB) Zones 3-5	-5.2	-3.4	-2.4	-1.9	-1.5	-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		
satellite receive gain (dBI)	28.3	28.6	28.8	29.0	29.2	29.4	29.6	29.8	30.0		
received power density (dBW/Hz)	-207.5	-205.1	-203.6	-202.6	-201.6	-200.8	-200.1	-199.3	-198.6		
received power density (W/Hz)	1.8E-21	3.1E-21	4.4E-21	5.5E-21	6.9E-21	8.4E-21	9.8E-21	1.2E-20	1.4E-20		
Io/No (dB)	-10.1	-7.7	-6.1	-5.1	-4.2	-3.3	-2.6	-1.8	-1.1		
Peak EIRP Density (dBW/mhz)	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1		
Reduction in Link margin(db)	0.4	0.7	0.9	1.2	1.4	1.7	1.9	2.2	2.5		
satellite noise floor (dBW/Hz)	-197.5										