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10. ENGINEERING CERTIFICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's Rules, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge and belief.

By: Daniel P. Sullivan

Daniel P. Sullivan, Ph.D.
Vice President, Engineering
Hughes Communications, Inc.
September 22, 1997

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11. WAIVER AND CERTIFICATIONS

In accordance with Section 304 of the Communications Act of 1934, as amended, 47 U.S.C. 304, HCI hereby waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

HCI certifies that neither the Applicant nor any of its shareholders, nor any of its officers or directors, nor any party to this application is subject to a denial of Federal benefits pursuant to authority granted in Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. § 862.

The undersigned certifies individually and for HCI that all of the statements made in this Application are true, complete, and accurate to the best of his information, belief and knowledge, and are made in good faith.

Respectfully submitted,

Hughes Communications, Inc.

By: _____

Jerald F. Farrell

President

September 22, 1997

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Conclusion

12. CONCLUSION

For the reasons set forth in this Application, HCI respectfully requests that the Commission promptly grants this application to enable HCI to bring to the public the significant benefits described above at the earliest possible time.

Respectfully submitted,

Hughes Communications, Inc.

By: _____

Jerald F. Farrell

President

September 22, 1997

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Appendix A
Transmission Characteristics

APPENDIX A: TRANSMISSION CHARACTERISTICS

Expressway™ link budget information is provided in Tables A-1a through A-5. The RF communication links include the following: V-band, Ku-band area coverage, Ku-band 6° coverage, satellite telemetry, and satellite command. A user terminal uses a 2.5 meter antenna. The Satellite Control Facilities (SCF) use 7-meter antennas for telemetry and command.

In all cases, link budget calculations place a desired terminal at the satellite antenna beam edge. Rain attenuation effects are estimated based on the Crane Global rain model as described in the NASA Reference publication 1082(04) 1989, *Propagation Effects Handbook for Satellite Systems Design*. Atmospheric attenuation is estimated based on the ITU's Recommendation 676-2. Cloud attenuation is estimated based on the ITU's Recommendation 840-1 for an average cloud thickness of 2 km. The representative link budgets show calculations for a satellite placed at an orbital position of 101° W. The elevation angle to the satellite was determined for each of the cities shown. All cases show a positive margin at the indicated average link availability values.

Tables A-1a and A-1b contain the representative wideband data service links operating at V-band. Table A-1a shows a New York uplink to Boston downlink. Table A-1b shows a Los Angeles uplink to a New York downlink. In both cases, a user terminal uses a 2.5 meter antenna and a 30 W HPA. This results in uplink EIRPs of 71.3 dBW and 73.8 dBW in clear and rain conditions, respectively. The satellite minimum EIRP per each 155 Mbps carrier is 56 dBW. The link margin of

0.0 dB for clear-sky uplink and rainy downlink conditions indicates that the specified link availabilty objective can be met; the same is true for all link budgets presented in this Appendix.

Tables A-2a and A-2b contain link budgets for the Ku-band data service for the northern hemisphere using 1° x 3° elliptical beams. A New York uplink to Boston downlink is shown in Table A-2a as a representative case of higher link performance for a low rain rate region. A Miami uplink to Boston downlink is shown in Table A-2b as a representative case of a link in a challenging rain area.

The satellite minimum EIRP is 47.0 dBW for a single 155 Mbps carrier. An uplink terminal uses a 2.5 meter antenna with a 100 W HPA. This corresponds to an EIRP of 67.5 dBW for the clear sky condition and 68.5 dBW for the rain condition. The resulting link average availability depends on the location of interest (typically better than 99.70%).

Tables A-3a through A-3d contain link budgets for the Ku band data service for a 6° hemispherical beam from a 101° W orbital position. Tables A-3a and A-3b show Boston to Bogota, Colombia links as representative cases in a challenging rain area. Tables A-3c and A-3d show Los Angeles to Bogota links for higher performance in a low rain rate region. For the 6° hemispherical beam, the satellite minimum EIRP is 45.3 dBW. An uplink terminal uses a 2.5 meter antenna with a 200 W HPA. This corresponds to an EIRP of 69.5 dBW for the clear sky condition and 71.5 dBW for the rain condition.

Tables A-4 and A-5 contain the information regarding the satellite telemetry and command links. Dry geographical regions are selected along with favorable

elevation angles for satellite operational control facilities to provide high reliability TT&C links.

Table A-1a V-Band - New York U/L to Boston D/L

SUMMARY of Uplink Budget	Clear		Rain	Units
Terminal Location:	New York			
Site Elevation Angle	35.4			deg
Site Altitude (ASL)	0.0			km
Frequency	48.7			GHz
Link Availability			98.60	%
Application Data Rate	155			Mbps
Station Transmitter Power	30.0			W
Transmitter Pwr (dBW)	14.8			dBW
Uplink Power Back-off	3		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.5			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Operating EIRP per carrier		71.3	73.8	dBW
Space Loss		217.8	217.8	dB
Atm. (Gas + Cloud) Att.		5.1	5.4	dB
Rain Attenuation			5.2	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	49.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		20.4	20.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		13.8	10.9	dB
Total U/L C/I	13.9			dB
U/L C/(Io)		97.0	97.0	dB/Hz
Thermal U/L C/(No)		96.8	93.9	dB/Hz
Total D/L C/I	14.2			dB
D/L C/(Io)		97.2	97.2	dB/Hz
Thermal D/L C/(No)		95.4	91.7	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget	Clear		Rain	Units
Terminal Location:	Boston			
Site Elevation Angle	32.5			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			98.00	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2			dB
# of Amplified Carriers	10			
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	49.0			dBi
Total EIRP of D/L	66.0			dBW
Operating EIRP/carrier		56.0	56.0	dBW
Space Loss		216.4	216.4	dB
Atm. (Gas + Cloud) Attenuation		3.1	3.3	dB
Rain Attenuation			2.6	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	58.0			dBi
System Noise Temp	468.4		581.8	°K
System Noise Temp	26.7		27.6	dBK
Station G/T		30.8	29.9	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		12.4	8.7	dB
Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	96.8	93.9	96.8	dB/Hz
U/L C/(Io) (dB/Hz)	97.0	97.0	97.0	dB/Hz
U/L C/(No+Io) (dB/Hz	93.9	92.1	93.9	dB/Hz
D/L C/(No) (dB/Hz)	95.4	95.4	91.7	dB/Hz
D/L C/(Io) (dB/Hz)	97.2	97.2	97.2	dB/Hz
D/L C/(No+Io) (dB/Hz	93.2	93.2	90.6	dB/Hz
Total C/(No+Io) (dB/Hz)	90.5	89.6	88.9	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	1.6	0.7	0.0	dB

Table A-1b V-Band - Los Angeles U/L to New York D/L

SUMMARY of Uplink Budget	Clear		Rain	Units
Terminal Location:	Los Angeles			
Site Elevation Angle	46.5			deg
Site Altitude (ASL)	0.1			km
Frequency	48.7			GHz
Link Availability			99.70	%
Application Data Rate	155			Mbps
Station Transmitter Power	30.0			W
Transmitter Pwr (dBW)	14.8			dBW
Uplink Power Back-off	3		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.5			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Operating EIRP per carrier		71.3	73.8	dBW
Space Loss		217.6	217.6	dB
Atm. (Gas + Cloud) Att.		3.8	3.9	dB
Rain Attenuation			6.6	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	49.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		20.4	20.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		15.3	11.2	dB
Total U/L C/I	13.9			dB
U/L C/(Io)		97.0	97.0	dB/Hz
Thermal U/L C/(No)		98.3	94.2	dB/Hz
Total D/L C/I	14.2			dB
D/L C/(Io)		97.2	97.2	dB/Hz
Thermal D/L C/(No)		95.8	91.3	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget	Clear		Rain	Units
Terminal Location:	New York			
Site Elevation Angle	35.4			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			98.30	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2			dB
# of Amplified Carriers	10			
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	49.0			dBi
Total EIRP of D/L	66.0			dBW
Operating EIRP/carrier		56.0	56.0	dBW
Space Loss		216.3	216.3	dB
Atm. (Gas + Cloud) Attenuation		2.9	3.0	dB
Rain Attenuation			3.2	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	58.0			dBi
System Noise Temp	459.3		588.7	°K
System Noise Temp	26.6		27.7	dBK
Station G/T		30.9	29.8	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		12.8	8.3	dB
Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	98.3	94.2	98.3	dB/Hz
U/L C/(Io) (dB/Hz)	97.0	97.0	97.0	dB/Hz
U/L C/(No+Io) (dB/Hz	94.6	92.3	94.6	dB/Hz
D/L C/(No) (dB/Hz)	95.8	95.8	91.3	dB/Hz
D/L C/(Io) (dB/Hz)	97.2	97.2	97.2	dB/Hz
D/L C/(No+Io) (dB/Hz	93.4	93.4	90.3	dB/Hz
Total C/(No+Io) (dB/Hz)	91.0	89.8	88.9	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	2.0	0.9	0.0	dB

Table A-2a Ku-Band - New York U/L to Boston D/L

SUMMARY of Uplink Budget				
	Clear		Rain	Units
Terminal Location:	**New York**			
Site Elevation Angle	35.4			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.90	%
Application Data Rate	**155**			Mbps
Station Transmitter Power	**100.0**			W
Transmitter Pwr (dBW)	20.0			dBW
Uplink Power Back-off	1		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	**48.8**			dBi
Operating EIRP per carrier		**67.5**	**68.5**	dBW
Space Loss		**206.3**	**206.3**	dB
Atm. (Gas + Cloud) Att.		**0.3**	**0.4**	dB
Rain Attenuation			**3.6**	dB
Pointing and Pol. Loss		**0.4**	**0.4**	dB
Sat. Antenna Gain	**33.5**			dBi
System Noise Temp	365.1			°K
System Noise Temp	**25.6**			dBK
Satellite G/T		**7.4**	**7.4**	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**13.3**	**10.7**	dB
Total U/L C/I	**14.1**			dB
U/L C/(Io)		**97.1**	**97.1**	dB/Hz
Thermal U/L C/(No)		**96.3**	**93.7**	dB/Hz
Total D/L C/I	**10.1**			dB
D/L C/(Io)		**93.1**	**93.1**	dB/Hz
Thermal D/L C/(No)		**97.2**	**94.2**	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		**88.9**	**88.9**	dB/Hz

SUMMARY of Downlink Budget				
	Clear		Rain	Units
Terminal Location:	**Boston**			
Site Elevation Angle	32.5			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.70	%
Link Data Rate	**155**			Mbps
Satellite TWTA Rating	**25**			W
Sat. Transmit Power	14.0			dBW
Sat. HPA Backoff	0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.5			dB
Sat Min. Ant. Gain	**33.5**			dBi
Total EIRP of D/L	47.0			dBW
Operating EIRP/carrier		**47.0**	**47.0**	dBW
Space Loss		**205.0**	**205.0**	dB
Atm. (Gas + Cloud) Attenuation		**0.3**	**0.3**	dB
Rain Attenuation			**1.0**	dB
User Ant. Pointing Losses		**0.4**	**0.4**	dB
Recvr. Antenna Gain	**47.3**			dBi
System Noise Temp	94.5		147.2	°K
System Noise Temp	19.8		21.7	dBK
Station G/T		**27.3**	**25.3**	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**14.2**	**11.2**	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	**96.3**	**93.7**	**96.3**	dB/Hz
U/L C/(Io) (dB/Hz)	97.1	97.1	97.1	dB/Hz
U/L C/(No+Io) (dB/Hz	**93.7**	**92.1**	**93.7**	dB/Hz
D/L C/(No) (dB/Hz)	97.2	97.2	94.2	dB/Hz
D/L C/(Io) (dB/Hz)	93.1	93.1	93.1	dB/Hz
D/L C/(No+Io) (dB/Hz	**91.7**	**91.7**	**90.6**	dB/Hz
Total C/(No+Io) (dB/Hz)	**89.6**	**88.9**	**88.9**	dB/Hz
Required C/No (dB/Hz)	**88.9**	**88.9**	**88.9**	dB/Hz
Margin (dB)	**0.7**	**0.0**	**0.0**	dB

Table A-2b Ku-Band - Miami U/L to Boston D/L

SUMMARY of Uplink Budget				
	Clear		Rain	Units
Terminal Location:	**Miami**			
Site Elevation Angle	52.0			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.70	%
Application Data Rate	**155**			Mbps
Station Transmitter Power	**100.0**			W
Transmitter Pwr (dBW)	20.0			dBW
Uplink Power Back-off	1		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	**48.8**			dBi
Operating EIRP per carrier		**67.5**	**68.5**	dBW
Space Loss		**206.1**	**206.1**	dB
Atm. (Gas + Cloud) Att.		**0.3**	**0.3**	dB
Rain Attenuation			**3.9**	dB
Pointing and Pol. Loss		**0.4**	**0.4**	dB
Sat. Antenna Gain	**33.5**			dBi
System Noise Temp	365.1			°K
System Noise Temp	**25.6**			dBK
Satellite G/T		**7.4**	**7.4**	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**13.7**	**10.8**	dB
Total U/L C/I	**14.1**			dB
U/L C/(Io)		**97.1**	**97.1**	dB/Hz
Thermal U/L C/(No)		**96.7**	**93.8**	dB/Hz
Total D/L C/I	**10.1**			dB
D/L C/(Io)		**93.1**	**93.1**	dB/Hz
Thermal D/L C/(No)		**97.2**	**94.2**	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		**88.9**	**88.9**	dB/Hz

SUMMARY of Downlink Budget				
	Clear		Rain	Units
Terminal Location:	**Boston**			
Site Elevation Angle	32.5			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.70	%
Link Data Rate	**155**			Mbps
Satellite TWTA Rating	**25**			W
Sat. Transmit Power	14.0			dBW
Sat. HPA Backoff	0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.5			dB
Sat Min. Ant. Gain	**33.5**			dBi
Total EIRP of D/L	47.0			dBW
Operating EIRP/carrier		**47.0**	**47.0**	dBW
Space Loss		**205.0**	**205.0**	dB
Atm. (Gas + Cloud) Attenuation		**0.3**	**0.3**	dB
Rain Attenuation			**1.0**	dB
User Ant. Pointing Losses		**0.4**	**0.4**	dB
Recvr. Antenna Gain	**47.3**			dBi
System Noise Temp	94.5		147.2	°K
System Noise Temp	19.8		21.7	dBK
Station G/T		**27.3**	**25.3**	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**14.2**	**11.2**	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	**96.7**	**93.8**	**96.7**	dB/Hz
U/L C/(Io) (dB/Hz)	97.1	97.1	97.1	dB/Hz
U/L C/(No+Io) (dB/Hz	**93.9**	**92.1**	**93.9**	dB/Hz
D/L C/(No) (dB/Hz)	97.2	97.2	94.2	dB/Hz
D/L C/(Io) (dB/Hz)	93.1	93.1	93.1	dB/Hz
D/L C/(No+Io) (dB/Hz	**91.7**	**91.7**	**90.6**	dB/Hz
Total C/(No+Io) (dB/Hz)	**89.6**	**88.9**	**88.9**	dB/Hz
Required C/No (dB/Hz)	**88.9**	**88.9**	**88.9**	dB/Hz
Margin (dB)	**0.7**	**0.0**	**0.0**	dB

Table A-3a Ku-Band 6' - Boston U/L to Bogota D/L

SUMMARY of Uplink Budget	Clear		Rain	Units
Terminal Location:	**Boston**			
Site Elevation Angle	32.5			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.95	%
Application Data Rate	100			Mbps
Station Transmitter Power	100.0			W
Transmitter Pwr (dBW)	20.0			dBW
Uplink Power Back-off	2		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	48.8			dBi
Operating EIRP per carrier		66.5	68.5	dBW
Space Loss		206.4	206.4	dB
Atm. (Gas + Cloud) Att.		0.4	0.4	dB
Rain Attenuation			5.8	dB
Pointing and Pol. Loss		0.4	0.4	dB
Sat. Antenna Gain	33.5			dBi
System Noise Temp	365.1			°K
System Noise Temp	25.6			dBK
Satellite G/T		7.4	7.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		81.1	81.1	dBHz
C/N (Thermal)		14.2	10.3	dB
Total U/L C/I	14.1			dB
U/L C/(Io)		95.2	95.2	dB/Hz
Thermal U/L C/(No)		95.3	91.4	dB/Hz
Total D/L C/I	11.6			dB
D/L C/(Io)		92.7	92.7	dB/Hz
Thermal D/L C/(No)		96.3	90.6	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	112			Mbps
Data Rate (dB)	80.5			dB (bps)
Required C/(No+Io)		87.0	87.0	dB/Hz

SUMMARY of Downlink Budget	Clear		Rain	Units
Terminal Location:	**Bogota**			
Site Elevation Angle	58.2			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.65	%
Link Data Rate	100			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.5			dB
Sat Min. Ant. Gain	25.8			dBi
Total EIRP of D/L	45.3			dBW
Operating EIRP/carrier		45.3	45.3	dBW
Space Loss		204.5	204.5	dB
Atm. (Gas + Cloud) Attenuation		0.2	0.2	dB
Rain Attenuation			2.3	dB
User Ant. Pointing Losses		0.4	0.4	dB
Recvr. Antenna Gain	47.3			dBi
System Noise Temp	89.6		191.2	°K
System Noise Temp	19.5		22.8	dBK
Station G/T		27.5	24.2	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		81.1	81.1	dBHz
C/N (Thermal)		15.2	9.5	dB
Uplink Conditions	clear	rain	clear	rain
Downlink Conditions	clear	clear	rain	rain
U/L C/(No) (dB/Hz)	95.3	91.4	95.3	dB/Hz
U/L C/(Io) (dB/Hz)	95.2	95.2	95.2	dB/Hz
U/L C/(No+Io) (dB/Hz	92.2	89.9	92.2	dB/Hz
D/L C/(No) (dB/Hz)	96.3	96.3	90.6	dB/Hz
D/L C/(Io) (dB/Hz)	92.7	92.7	92.7	dB/Hz
D/L C/(No+Io) (dB/Hz	91.1	91.1	88.5	dB/Hz
Total C/(No+Io) (dB/Hz)	88.6	87.5	87.0	dB/Hz
Required C/No (dB/Hz)	87.0	87.0	87.0	dB/Hz
Margin (dB)	1.6	0.5	0.0	dB

Table A-3b Ku-Band 6' - Bogota U/L to Boston D/L

SUMMARY of Uplink Budget	Clear		Rain	Units
Terminal Location:	**Bogota**			
Site Elevation Angle	58.2			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.60	%
Application Data Rate	100			Mbps
Station Transmitter Power	200.0			W
Transmitter Pwr (dBW)	23.0			dBW
Uplink Power Back-off	2		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	48.8			dBi
Operating EIRP per carrier		69.5	71.5	dBW
Space Loss		206.0	206.0	dB
Atm. (Gas + Cloud) Att.		0.3	0.3	dB
Rain Attenuation			3.1	dB
Pointing and Pol. Loss		0.4	0.4	dB
Sat. Antenna Gain	26.2			dBi
System Noise Temp	365.1			°K
System Noise Temp	25.6			dBK
Satellite G/T		0.1	0.1	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		81.1	81.1	dBHz
C/N (Thermal)		10.4	9.3	dB
Total U/L C/I	14.1			dB
U/L C/(Io)		95.2	95.2	dB/Hz
Thermal U/L C/(No)		91.5	90.4	dB/Hz
Total D/L C/I	11.6			dB
D/L C/(Io)		92.7	92.7	dB/Hz
Thermal D/L C/(No)		97.2	93.8	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	112			Mbps
Data Rate (dB)	80.5			dB (bps)
Required C/(No+Io)		87.0	87.0	dB/Hz

SUMMARY of Downlink Budget	Clear		Rain	Units
Terminal Location:	**Boston**			
Site Elevation Angle	32.5			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.75	%
Link Data Rate	100			Mbps
Satellite TWTA Rating	25			W
Sat. Transmit Power	14.0			dBW
Sat. HPA Backoff	0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.5			dB
Sat Min. Ant. Gain	33.5			dBi
Total EIRP of D/L	47.0			dBW
Operating EIRP/carrier		47.0	47.0	dBW
Space Loss		205.0	205.0	dB
Atm. (Gas + Cloud) Attenuation		0.3	0.3	dB
Rain Attenuation			1.2	dB
User Ant. Pointing Losses		0.4	0.4	dB
Recvr. Antenna Gain	47.3			dBi
System Noise Temp	94.5		154.6	°K
System Noise Temp	19.8		21.9	dBK
Station G/T		27.3	25.1	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		81.1	81.1	dBHz
C/N (Thermal)		16.1	12.7	dB
Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	91.5	90.4	91.5	dB/Hz
U/L C/(Io) (dB/Hz)	95.2	95.2	95.2	dB/Hz
U/L C/(No+Io) (dB/Hz	90.0	89.1	90.0	dB/Hz
D/L C/(No) (dB/Hz)	97.2	97.2	93.8	dB/Hz
D/L C/(Io) (dB/Hz)	92.7	92.7	92.7	dB/Hz
D/L C/(No+Io) (dB/Hz	91.4	91.4	90.2	dB/Hz
Total C/(No+Io) (dB/Hz)	87.6	87.1	87.1	dB/Hz
Required C/No (dB/Hz)	87.0	87.0	87.0	dB/Hz
Margin (dB)	0.6	0.1	0.1	dB

Table A-3c Ku-Band 6° - Los Angeles U/L to Bogota D/L

SUMMARY of Uplink Budget	Clear	Rain	Units
Terminal Location:	**Los Angeles**		
Site Elevation Angle	46.5		deg
Site Altitude (ASL)	0.1		km
Frequency	13.0		GHz
Link Availability		99.97	%
Application Data Rate	155		Mbps
Station Transmitter Power	100.0		W
Transmitter Pwr (dBW)	20.0		dBW
Uplink Power Back-off	1	0	dB
# of Amplified Carriers	1		
Station Transmitter Losses	0.3		dB
Station Antenna Diameter	2.50		m
Station Peak Antenna Gain	48.8		dBi
Operating EIRP per carrier	67.5	68.5	dBW
Space Loss	206.2	206.2	dB
Atm. (Gas + Cloud) Att.	0.2	0.3	dB
Rain Attenuation		3.0	dB
Pointing and Pol. Loss	0.4	0.4	dB
Sat. Antenna Gain	33.5		dBi
System Noise Temp	365.1		°K
System Noise Temp	25.6		dBK
Satellite G/T	7.4	7.4	dB/K
Boltzmann's Constant	-228.6	-228.6	dBW/K-Hz
Noise BW	83.0	83.0	dBHz
C/N (Thermal)	13.6	11.6	dB
Total U/L C/I	14.1		dB
U/L C/(Io)	97.1	97.1	dB/Hz
Thermal U/L C/(No)	96.6	94.6	dB/Hz
Total D/L C/I	11.6		dB
D/L C/(Io)	94.6	94.6	dB/Hz
Thermal D/L C/(No)	96.3	92.7	dB/Hz
Required Eb/No	6.5		dB
Effective Data Rate	174		Mbps
Data Rate (dB)	82.4		dB (bps)
Required C/(No+Io)	88.9	88.9	dB/Hz

SUMMARY of Downlink Budget	Clear	Rain	Units
Terminal Location:	**Bogota**		
Site Elevation Angle	58.2		deg
Site Altitude (ASL)	0.0		km
Frequency	11.0		GHz
Link Availability		99.30	%
Link Data Rate	155		Mbps
Satellite TWTA Rating	100		W
Sat. Transmit Power	20.0		dBW
Sat. HPA Backoff	0		dB
# of Amplified Carriers	1		
Transmitter Total losses	0.5		dB
Sat Min. Ant. Gain	25.8		dBi
Total EIRP of D/L	45.3		dBW
Operating EIRP/carrier	45.3	45.3	dBW
Space Loss	204.5	204.5	dB
Atm. (Gas + Cloud) Attenuation	0.2	0.2	dB
Rain Attenuation		1.3	dB
User Ant. Pointing Losses	0.4	0.4	dB
Recvr. Antenna Gain	47.3		dBi
System Noise Temp	89.6	151.4	°K
System Noise Temp	19.5	21.8	dBK
Station G/T	27.5	25.2	dB/K
Boltzmann's Constant	-228.6	-228.6	dBW/K-Hz
Noise BW	83.0	83.0	dBHz
C/N (Thermal)	13.2	9.7	dB
Uplink Conditions	clear	rain	clear
Downlink Conditions	clear	clear	rain
U/L C/(No) (dB/Hz)	96.6	94.6	96.6	dB/Hz
U/L C/(Io) (dB/Hz)	97.1	97.1	97.1	dB/Hz
U/L C/(No+Io) (dB/Hz	93.9	92.7	93.9	dB/Hz
D/L C/(No) (dB/Hz)	96.3	96.3	92.7	dB/Hz
D/L C/(Io) (dB/Hz)	94.6	94.6	94.6	dB/Hz
D/L C/(No+Io) (dB/Hz	92.3	92.3	90.5	dB/Hz
Total C/(No+Io) (dB/Hz)	90.0	89.5	88.9	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	1.1	0.6	0.0	dB

Table A-3d Ku-Band 6° - Bogota U/L to Los Angeles D/L

SUMMARY of Uplink Budget	Clear	Rain	Units
Terminal Location:	**Bogota**		
Site Elevation Angle	58.2		deg
Site Altitude (ASL)	0.0		km
Frequency	13.0		GHz
Link Availability		99.55	%
Application Data Rate	100		Mbps
Station Transmitter Power	200.0		W
Transmitter Pwr (dBW)	23.0		dBW
Uplink Power Back-off	1	0	dB
# of Amplified Carriers	1		
Station Transmitter Losses	0.3		dB
Station Antenna Diameter	2.50		m
Station Peak Antenna Gain	48.8		dBi
Operating EIRP per carrier	70.5	71.5	dBW
Space Loss	206.0	206.0	dB
Atm. (Gas + Cloud) Att.	0.3	0.3	dB
Rain Attenuation		2.8	dB
Pointing and Pol. Loss	0.4	0.4	dB
Sat. Antenna Gain	26.2		dBi
System Noise Temp	365.1		°K
System Noise Temp	25.6		dBK
Satellite G/T	0.1	0.1	dB/K
Boltzmann's Constant	-228.6	-228.6	dBW/K-Hz
Noise BW	81.1	81.1	dBHz
C/N (Thermal)	11.4	9.6	dB
Total U/L C/I	14.1		dB
U/L C/(Io)	95.2	95.2	dB/Hz
Thermal U/L C/(No)	92.5	90.7	dB/Hz
Total D/L C/I	10.7		dB
D/L C/(Io)	91.8	91.8	dB/Hz
Thermal D/L C/(No)	97.8	94.0	dB/Hz
Required Eb/No	6.5		dB
Effective Data Rate	112		Mbps
Data Rate (dB)	80.5		dB (bps)
Required C/(No+Io)	87.0	87.0	dB/Hz

SUMMARY of Downlink Budget	Clear	Rain	Units
Terminal Location:	**Los Angeles**		
Site Elevation Angle	46.5		deg
Site Altitude (ASL)	0.1		km
Frequency	11.0		GHz
Link Availability		99.95	%
Link Data Rate	100		Mbps
Satellite TWTA Rating	25		W
Sat. Transmit Power	14.0		dBW
Sat. HPA Backoff	0		dB
# of Amplified Carriers	1		
Transmitter Total losses	0.5		dB
Sat Min. Ant. Gain	33.5		dBi
Total EIRP of D/L	47.0		dBW
Operating EIRP/carrier	47.0	47.0	dBW
Space Loss	204.7	204.7	dB
Atm. (Gas + Cloud) Attenuation	0.2	0.2	dB
Rain Attenuation		1.4	dB
User Ant. Pointing Losses	0.4	0.4	dB
Recvr. Antenna Gain	47.3		dBi
System Noise Temp	89.1	155.0	°K
System Noise Temp	19.5	21.9	dBK
Station G/T	27.5	25.1	dB/K
Boltzmann's Constant	-228.6	-228.6	dBW/K-Hz
Noise BW	81.1	81.1	dBHz
C/N (Thermal)	16.7	12.9	dB
Uplink Conditions	clear	rain	clear
Downlink Conditions	clear	clear	rain
U/L C/(No) (dB/Hz)	92.5	90.7	92.5	dB/Hz
U/L C/(Io) (dB/Hz)	95.2	95.2	95.2	dB/Hz
U/L C/(No+Io) (dB/Hz	90.6	89.4	90.6	dB/Hz
D/L C/(No) (dB/Hz)	97.8	97.8	94.0	dB/Hz
D/L C/(Io) (dB/Hz)	91.8	91.8	91.8	dB/Hz
D/L C/(No+Io) (dB/Hz	90.8	90.8	89.8	dB/Hz
Total C/(No+Io) (dB/Hz)	87.7	87.0	87.2	dB/Hz
Required C/No (dB/Hz)	87.0	87.0	87.0	dB/Hz
Margin (dB)	0.7	0.0	0.2	dB

Table A-4. Ku-Band Telemetry Link

Parameter	Spot Antenna	Bicone Pipe	Comments
Minimum EIRP, dBW	8.0	0.0	Estimate
Path loss, dB/m^2	-162.5	-162.5	40° elevation
Atmospheric absorption, dB	-0.5	-0.5	Estimate; clear sky
Isotropic areas, dB-m^2	42.6	42.6	@11450 MHz
Ground station G/T, dB/K	34.9	34.9	7m antenna
Polarization mismatch, dB	0.0	0.0	
Boltzmann's constant, dBW/K-Hz	-228.6	-228.6	
Downlink C/No @ TM receiver, dB-Hz	65.9	57.9	
Minimum C/No @ TM receiver, dB-Hz	53	53	For 4 Kb/s stream
Clear weather C/No margin, dB	12.9	4.9	1.1 dB rain fade for 99.95% availability
S/No for ranging:			
Receiver baseband S/No, dB-Hz	60.7	52.7	
Carrier recovery:			
TM receiver loop bandwidth, dB-Hz	40.0	40.0	10 kHz PM demod PLL
Margin, dB	16.7	8.7	BW
Subcarrier recovery:			
TM receiver IF bandwidth, dB-Hz	57.0	57.0	500 kHz BW
Margin, dB	18.7	10.7	
BER			
Minimum Eb/No for $10e^{-6}$ BER dB	10.5	10.5	P.E. for coherent PSK =
Margin, dB	11.6	3.6	0.5* erfc (sqrt(Eb/No))

Table A-5. Ku-Band Command Links

On-Station Planar Array

Contribution	Value	Comment
Max Ground station EIRP, dBW	83.9	7 m antenna
Path loss, dB-m^2	-162.5	40° elevation
Clear sky loss, dB	-0.5	
Isotropic area, dB-m^2	43.6	12750 MHz
Pointing error, dB	-0.1	
BTA gain (sum path), dB	35.0	USDBS
Polarization loss, dB	-0.1	
Path Loss to CR, dB	-16.3	Ku band; includes SSMA
Power at TCR input, dBW	-104.2	
CR command threshold, dBW	-135.0	unit spec
Command margin, dB	30.8	
Command margin with rain fade, dB	28.5	99.95% availability

On-Station Pipe Antenna

Contribution	Value	Comment
Max Ground station EIRP, dBW	83.9	7 m antenna
Path loss, dB-m^2	-162.5	40° elevation
Clear sky loss, dB	-0.5	
Isotropic area, dB-m^2	43.9	13250 MHz
Pointing error, dB	-0.1	
Pipe antenna gain (sum path), dB	4.0	on-axis (Ku band)
Polarization loss, dB	-0.1	
Path Loss to CR, dB	-6.3	
Power at TCR input, dBW	-125.5	
CR command threshold, dBW	-135.0	unit spec
Command margin, dB	9.5	
Command margin with rain fade, dB	6.9	99.95% availability

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Appendix B
Interference Analysis

APPENDIX B: INTERFERENCE ANALYSIS

This appendix presents interference parameters, analyses, and results for scenarios involving Expressway™ and hypothetical GSO FSS systems.

Table B-1. Parameter List for V-band Expressway™ Interference Analysis

LINK PARAMETER	UP LINK		DOWN LINK		UNITS
	Other GSO	Own GSO	Other GSO	Own GSO	
Orbital Separation	2		2		deg.
Signal frequency	48.7	48.7	41	41	GHz
Tx Power (Earth/Satellite)	30	30	100	100	W
Amplifier Backoff	3	3	2	2	dB
Tx Losses	1	1	1	1	dB
Number of Carriers	1	1	10	10	
Slant Range	36000	36000	36000	36000	km
Earth-Station Tx Antenna Size	2.5	2.5			m
Earth-Station Rx Antenna Size			2.5	2.5	m
Earth-Station Tx Ant. Peak Gain	59.5	59.5			dBi
Earth-Station Rx Ant. Peak Gain			58.0	58.0	dBi
Satellite Tx Ant. Peak Gain			52	52	dBi
Satellite Rx Ant. Peak Gain	52	52			dBi
Signal Bandwidth	285	285	285	285	MHz
Rx Noise Temperature	650	650	460	460	°K

Table B-2. Parameter List for Ku-band (1° X 3° Beam) Interference Analysis

LINK PARAMETER	UP LINK		DOWN LINK		UNITS
	Other GSO	Own GSO	Other GSO	Own GSO	
Orbital Separation	2		2		deg.
Signal frequency	13	13	11	11	GHz
Tx Power (Earth/Satellite)	50	100	35	25	W
Amplifier Backoff	0	0	0	0	dB
Tx Losses	0.3	0.3	0.5	0.5	dB
Number of Carriers	1	1	1	1	
Slant Range	36000	36000	36000	36000	km
Earth-Station Tx Antenna Size	5	2.5			m
Earth-Station Rx Antenna Size			3	2.5	m
Earth-Station Tx Ant. Peak Gain	54.8	48.8			dBi
Earth-Station Rx Ant. Peak Gain			49.2	47.5	dBi
Satellite Tx Ant. Peak Gain			37	37	dBi
Satellite Rx Ant. Peak Gain	37	37			dBi
Signal Bandwidth	30	240	30	240	MHz
Rx Noise Temperature	1500	365	200	73	°K

Table B-3. Parameter List for Ku-band (Bogota - CONUS) Interference Analysis

LINK PARAMETER	UP LINK		DOWN LINK		UNITS
	Other GSO	Own GSO	Other GSO	Own GSO	
Orbital Separation	2		2		deg.
Signal frequency	13	13	11	11	GHz
Tx Power (Earth/Satellite)	50	200	35	25	W
Amplifier Backoff	0	0	0	0	dB
Tx Losses	0.3	0.3	0.5	0.5	dB
Number of Carriers	1	1	1	1	
Slant Range	36000	36000	36000	36000	km
Earth-Station Tx Antenna Size	5	2.5			m
Earth-Station Rx Antenna Size			2.5	2.5	m
Earth-Station Tx Ant. Peak Gain	54.8	48.8			dBi
Earth-Station Rx Ant. Peak Gain			47.5	47.5	dBi
Satellite Tx Ant. Peak Gain			37	37	dBi
Satellite Rx Ant. Peak Gain	37	30.2			dBi
Signal Bandwidth	30	138	30	138	MHz
Rx Noise Temperature	1500	365	200	73	°K

Table B-4. Parameter List for Ku-band (CONUS - Bogota) Interference Analysis

LINK PARAMETER	UP LINK		DOWN LINK		UNITS
	Other GSO	Own GSO	Other GSO	Own GSO	
Orbital Separation	2		2		deg.
Signal frequency	13	13	11	11	GHz
Tx Power (Earth/Satellite)	50	100	35	100	W
Amplifier Backoff	0	0	0	0	dB
Tx Losses	0.3	0.3	0.5	0.5	dB
Number of Carriers	1	1	1	1	
Slant Range	36000	36000	36000	36000	km
Earth-Station Tx Antenna Size	5	2.5			m
Earth-Station Rx Antenna Size			2.5	2.5	m
Earth-Station Tx Ant. Peak Gain	54.8	48.8			dBi
Earth-Station Rx Ant. Peak Gain			47.5	47.5	dBi
Satellite Tx Ant. Peak Gain			37	29.8	dBi
Satellite Rx Ant. Peak Gain	37	37			dBi
Signal Bandwidth	30	138	30	138	MHz
Rx Noise Temperature	1500	365	200	73	°K

A C/I analysis was performed to determine whether Expressway™ could share spectrum with a hypothetical GSO FSS system operating at V-band, referred to here as System-X. System-X has earth station and space station characteristics identical to those of Expressway™ except that its earth station antenna gain pattern

is modeled on the reference antenna radiation pattern of Appendix 29, Annex III of the international Radio Regulations. In the interference scenario, an Expressway™ satellite and a System-X satellite are spaced 2° apart on the geostationary arc. The earth stations for both systems are considered to be co-located. The interference calculations for this scenario, appearing below in Table B-5 indicate that 2° sharing is feasible under these conditions.