Table A-3. GSO Mobile V-Band Link

GSO Mobile Clear Conditions

SUMMARY of Uplink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	50.0			GHz
Link			99.0	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			5256	minutes
CDMA Chip Rate	81.9			Mcps
User Data Rate	8.2			Mbps
Coded Data Rate	13.7			Mcbps
Array Power	12.0			W
Transmitter Pwr	10.8			dBW
Power Back-off	1.0		1.0	dB
# of Amplified Carriers	1.0			
Transmitter Losses	0.5			dB
Antenna	0.6			m
Min. Antenna Gain	39.2			dBi
EIRP per carrier		48.5	48.5	dBW
Point./Pol. Loss		0.5	0.5	dB
GEO Slant Range	38182			km
Space Loss		218.1	218.1	dB
Atm. Gas Att.		3.6	3.8	dB
Cloud Att.		2.6	2.6	dB
Rain			8.4	dB
Sat. Antenna Gain	52.5			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		24.4	24.4	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		76.7	68.1	dB/Hz

SUMMARY of Downlink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	40.0			GHz
Link			99.0	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			5256	minutes
Chip Rate	81.9			Mcps
User Data Rate	8.2			Mbps
Coded Data Rate	13.7			Mcbps
Satellite TWTA	100.0			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2.0			dB
# of FDM Carriers/HPA	3.0			
# CDMA/FDMA Band	6.0			
Transmitter Losses	0.5			dB
Sat Min. Ant. Gain	53.0			dBi
EIRP of D/L Beam	70.5			dBW
EIRP/FDM carrier	65.7			
EIRP per CDMA User		57.9	57.9	dBW
GEO Slant Range	38182			km
Space Loss		216.1	216.1	dB
Atm. Gas Att.		1.0	2.9	dB
Cloud Att.		1.7	1.7	dB
Rain			6.9	dB
Ant. Pointing		0.5	0.5	dB
Peak Antenna Gain	37.5			dBi
Receiver Sys. Temp.	334.8		527.3	°K
Receiver Sys. Temp.	25.2		27.2	dBK
Station G/T		11.8	9.8	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		78.9	68.2	dB/Hz

Uplink	Clear		Rain	Units
Uplink Total C/I	7.1			dB
C/Io		86.6	86.6	dB/Hz
Available C/(No+Io)		76.3	68.0	dB/Hz
Available Eb/(No+Io)		7.2	-1.1	dB
Required Eb/No		6.0	6.0	dB
Total Uplink		1.2	-7.1	dB

Downlink	Clear		Rain	Units
Downlink Total C/I	7.1			dB
C/Io		86.7	79.6	dB/Hz
Available C/(No+Io)		78.3	67.9	dB/Hz
Available Eb/(No+Io)		9.1	-1.3	dB
Required Eb/No		6.0	6.0	dB
Total Downlink		3.1	-7.3	dB

Table A-4. MEO Portable V-Band Link

MEO Portable Clear Conditions

SUMMARY of Uplink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	50.0			GHz
Link			99.0	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			5256	minutes
CDMA Chip Rate	81.9			Mcps
User Data Rate	1.5			Mbps
Coded Data Rate	2.5			Mcbps
Array Power	10.0			W
Transmitter Pwr	10.0			dBW
Power Back-off	1.0		1.0	dB
# of Amplified Carriers	1.0			
Transmitter Losses	0.5			dB
Antenna	0.3			m
Min. Antenna Gain	33.2			dBi
EIRP per carrier		41.7	41.7	dBW
Point./Pol. Loss		0.5	0.5	dB
MEO Slant Range	12391			km
Space Loss		208.3	208.3	dB
Atm. Gas Att.		3.6	3.8	dB
Cloud Att.		2.6	2.6	dB
Rain			8.4	dB
Sat. Antenna Gain	40.8			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		12.7	12.7	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		68.0	59.4	dB/Hz

SUMMARY of Downlink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	40.0			GHz
Link			99.0	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			5256	minutes
Chip Rate	81.9			Mcps
User Data Rate	1.5			Mbps
Coded Data Rate	2.5			Mcbps
Satellite TWTA	50.0			W
Sat. Transmit Power	17.0			dBW
Sat. HPA Backoff	2.0			dB
# of FDM Carriers/HPA	3.0			
# CDMA/FDMA Band	6.0			
Transmitter Losses	0.5			dB
Sat Min. Ant. Gain	41.3			dBi
EIRP of D/L Beam	55.8			dBW
EIRP/ FDM carrier	51.0			
EIRP per CDMA User		43.2	43.2	dBW
MEO Slant Range	12391			km
Space Loss		206.3	206.3	dB
Atm. Gas Att.		1.0	2.9	dB
Cloud Att.		1.7	1.7	dB
Rain			6.9	dB
Ant. Pointing		0.5	0.5	dB
Peak Antenna Gain	31.5			dBi
Receiver Sys. Temp.	334.8		527.3	°K
Receiver Sys. Temp.	25.2		27.2	dBK
Station G/T		5.8	3.8	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		68.0	57.2	dB/Hz

Uplink	Clear		Rain	Units
Uplink Total C/I	10.0			dB
C/Io		89.6	89.6	dB/Hz
Available C/(No+Io)		68.0	59.4	dB/Hz
Available Eb/(No+Io)		6.2	-2.4	dB
Required Eb/No		6.0	6.0	dB
Total Uplink		0.2	-8.4	dB

Downlink	Clear		Rain	Units
Downlink Total C/I	10.0			dB
C/Io		89.7	79.6	dB/Hz
Available C/(No+Io)		68.0	57.2	dB/Hz
Available Eb/(No+Io)		6.2	-4.6	dB
Required Eb/No		6.0	6.0	dB
Total Downlink		0.2	-10.6	dB

Table A-5. MEO Mobile V-Band Link

MEO Mobile Clear Conditions

SUMMARY of Uplink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	50.0			GHz
Link			99.0	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			5256	minutes
CDMA Chip Rate	81.9			Mcps
User Data Rate	6.0			Mbps
Coded Data Rate	10.0			Mcbps
Array Power	12.0			W
Transmitter Pwr	10.8			dBW
Power Back-off	1.0		1.0	dB
# of Amplified Carriers	1.0			
Transmitter Losses	0.5			dB
Antenna	0.6			m
Min. Antenna Gain	39.2			dBi
EIRP per carrier		48.5	48.5	dBW
Point./Pol. Loss		0.5	0.5	dB
MEO Slant Range	12391			km
Space Loss		208.3	208.3	dB
Atm. Gas Att.		3.6	3.8	dB
Cloud Att.		2.6	2.6	dB
Rain			8.4	dB
Sat. Antenna Gain	40.8			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		12.7	12.7	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		74.8	66.2	dB/Hz

SUMMARY of Downlink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	40.0			GHz
Link			99.0	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			5256	minutes
Chip Rate	81.9			Mcps
User Data Rate	6.0			Mbps
Coded Data Rate	10.0			Mcbps
Satellite TWTA	50.0			W
Sat. Transmit Power	17.0			dBW
Sat. HPA Backoff	2.0			dB
# of FDM Carriers/HPA	3.0			
# CDMA/FDMA Band	5.0			
Transmitter Losses	0.5			dB
Sat Min. Ant. Gain	41.3			dBi
EIRP of D/L Beam	55.8			dBW
EIRP/ FDM carrier	51.0			
EIRP per CDMA User		44.0	44.0	dBW
MEO Slant Range	12391			km
Space Loss		206.3	206.3	dB
Atm. Gas Att.		1.0	2.9	dB
Cloud Att.		1.7	1.7	dB
Rain			6.9	dB
Ant. Pointing		0.5	0.5	dB
Peak Antenna Gain	37.5			dBi
Receiver Sys. Temp.	334.8		527.3	°K
Receiver Sys. Temp.	25.2		27.2	dBK
Station G/T		11.8	9.8	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		74.8	64.0	dB/Hz

Regenerative Payload

Uplink	Clear		Rain	Units
Uplink Total C/I	8.2			dB
C/Io		87.8	87.8	dB/Hz
Available C/(No+Io)		74.6	66.1	dB/Hz
Available Eb/(No+Io)		6.8	-1.6	dB
Required Eb/No		6.0	6.0	dB
Total Uplink		0.8	-7.6	dB

Downlink	Clear		Rain	Units
Downlink Total C/I	8.2			dB
C/Io		87.9	79.6	dB/Hz
Available C/(No+Io)		74.6	63.9	dB/Hz
Available Eb/(No+Io)		6.8	-3.9	dB
Required Eb/No		6.0	6.0	dB
Total Downlink		0.8	-9.9	dB

Table A-6. GSO Portable V-Band Link In Rain

GSO Portable Rain Conditions									
SUMMARY of Uplink					SUMMARY of Downlink				
	Clear		Rain	Units		Clear		Rain	Units
Site Elevation	35.0			deg	Site Elevation	35.0			deg
Site Altitude (ASL)				km	Site Altitude (ASL)				km
Frequency	50.0			GHz	Frequency	40.0			GHz
Link			98.4	%	Link			96.4	%
Rain Model Used			CCIR		Rain Model Used			CCIR	
CCIR Rain Region			K		CCIR Rain Region			K	
Average Outage/Yr.			8410	minutes	Average Outage/Yr.			18922	minutes
CDMA Chip Rate	81.9			Mcps	Chip Rate	81.9			Mcps
User Data Rate	0.5			Mbps	User Data Rate	0.5			Mbps
Coded Data Rate	0.9			Mcbps	Coded Data Rate	0.9			Mcbps
Array Power	10.0			W	Satellite TWTA	100.0			W
Transmitter Pwr	10.0			dBW	Sat. Transmit Power	20.0			dBW
Power Back-off	1.0		1.0	dB	Sat. HPA Backoff	2.0			dB
# of Amplified Carriers	1.0				# of FDM Carriers/HPA	3.0			
Transmitter Losses	0.5			dB	# CDMA/FDMA Band	12.0			
Antenna	0.3			m	Transmitter Losses	0.5			dB
Min. Antenna Gain	33.2			dBi	Sat Min. Ant. Gain	53.0			dBi
EIRP per carrier		41.7	41.7	dBW	EIRP of D/L Beam	70.5			dBW
					EIRP/ FDM carrier	65.7			
Point./Pol. Loss		0.5	0.5	dB	EIRP per CDMA User		54.9	54.9	dBW
GEO Slant Range	38182			km	GEO Slant Range	38182			km
Space Loss		218.1	218.1	dB	Space Loss		216.1	216.1	dB
Atm. Gas Att.		3.6	3.8	dB	Atm. Gas Att.		1.0	2.9	dB
Cloud Att.		2.6	2.6	dB	Cloud Att.		1.7	1.7	dB
Rain			6.5	dB	Rain			3.3	dB
					Ant. Pointing		0.5	0.5	dB
Sat. Antenna Gain	52.5			dBi	Peak Antenna Gain	31.5			dBi
System Noise Temp	649.2			°K	Receiver Sys. Temp.	334.8		466.8	°K
System Noise Temp	28.1			dBK	Receiver Sys. Temp.	25.2		26.7	dBK
Satellite G/T		24.4	24.4	dB/K	Station G/T		5.8	4.3	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz	Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz	Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz	Noise BW	79.5			dBHz
Available C/No		69.9	63.2	dB/Hz	Available C/No		69.9	63.3	dB/Hz
Regenerative Payload									
Uplink					Downlink				
	Clear		Rain	Units		Clear		Rain	Units
Uplink Total C/I	10.4			dB	Downlink Total C/I	10.4			dB
C/Io		89.9	89.9	dB/Hz	C/Io		90.0	79.6	dB/Hz
Available C/(No+Io)		69.9	63.2	dB/Hz	Available C/(No+Io)		69.9	63.2	dB/Hz
Available Eb/(No+Io)		12.8	6.1	dB	Available Eb/(No+Io)		12.8	6.1	dB
Required Eb/No		6.0	6.0	dB	Required Eb/No		6.0	6.0	dB
Total Uplink		6.8	0.1	dB	Total Downlink		6.8	0.1	dB

Table A-7. GSO Mobile V-Band Link In Rain

GSO Mobile Rain Conditions

SUMMARY of Uplink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	50.0			GHz
Link			98.7	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			6833	minutes
CDMA Chip Rate	81.9			Mcps
User Data Rate	2.0			Mbps
Coded Data Rate	3.4			Mcbps
Array Power	12.0			W
Transmitter Pwr	10.8			dBW
Power Back-off	1.0		1.0	dB
# of Amplified Carriers	1.0			
Transmitter Losses	0.5			dB
Antenna	0.6			m
Min. Antenna Gain	39.2			dBi
EIRP per carrier		48.5	48.5	dBW
Point./Pol. Loss		0.5	0.5	dB
GEO Slant Range	38182			km
Space Loss		218.1	218.1	dB
Atm. Gas Att.		3.6	3.8	dB
Cloud Att.		2.6	2.6	dB
Rain			7.3	dB
Sat. Antenna Gain	52.5			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		24.4	24.4	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		76.7	69.2	dB/Hz

SUMMARY of Downlink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	40.0			GHz
Link			98.5	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			7884	minutes
Chip Rate	81.9			Mcps
User Data Rate	2.0			Mbps
Coded Data Rate	3.4			Mcbps
Satellite TWTA	100.0			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2.0			dB
# of FDM Carriers/HPA	3.0			
# CDMA/FDMA Band	6.0			
Transmitter Losses	0.5			dB
Sat Min. Ant. Gain	53.0			dBi
EIRP of D/L Beam	70.5			dBW
EIRP/ FDM carrier	65.7			
EIRP per CDMA User		57.9	57.9	dBW
GEO Slant Range	38182			km
Space Loss		216.1	216.1	dB
Atm. Gas Att.		1.0	2.9	dB
Cloud Att.		1.7	1.7	dB
Rain			5.5	dB
Ant. Pointing		0.5	0.5	dB
Peak Antenna Gain	37.5			dBi
Receiver Sys. Temp.	334.8		509.5	°K
Receiver Sys. Temp.	25.2		27.1	dBK
Station G/T		11.8	9.9	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		78.9	69.7	dB/Hz

Uplink

	Clear		Rain	Units
Uplink Total C/I	9.7			dB
C/Io		89.3	89.3	dB/Hz
Available C/(No+Io)		76.5	69.2	dB/Hz
Available Eb/(No+Io)		13.4	6.1	dB
Required Eb/No		6.0	6.0	dB
Total Uplink		7.4	0.1	dB

Downlink

	Clear		Rain	Units
Downlink Total C/I	9.7			dB
C/Io		89.4	79.6	dB/Hz
Available C/(No+Io)		78.6	69.3	dB/Hz
Available Eb/(No+Io)		15.5	6.2	dB
Required Eb/No		6.0	6.0	dB
Total Downlink		9.5	0.2	dB

Table A-8. MEO Portable V-Band Link In Rain

MEO Portable Rain Conditions

SUMMARY of Uplink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	50.0			GHz
Link			98.2	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			9461	minutes
CDMA Chip Rate	81.9			Mcps
User Data Rate	0.4			Mbps
Coded Data Rate	0.6			Mcbps
Array Power	10.0			W
Transmitter Pwr	10.0			dBW
Power Back-off	1.0		1.0	dB
# of Amplified Carriers	1.0			
Transmitter Losses	0.5			dB
Antenna	0.3			m
Min. Antenna Gain	33.2			dBi
EIRP per carrier		41.7	41.7	dBW
Point./Pol. Loss		0.5	0.5	dB
MEO Slant Range	12391			km
Space Loss		208.3	208.3	dB
Atm. Gas Att.		3.6	3.8	dB
Cloud Att.		2.6	2.6	dB
Rain			6.0	dB
Sat. Antenna Gain	40.8			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		12.7	12.7	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		68.0	61.7	dB/Hz

SUMMARY of Downlink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	40.0			GHz
Link			95.4	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			24178	minutes
Chip Rate	81.9			Mcps
User Data Rate	0.4			Mbps
Coded Data Rate	0.6			Mcbps
Satellite TWTA	50.0			W
Sat. Transmit Power	17.0			dBW
Sat. HPA Backoff	2.0			dB
# of FDM Carriers/HPA	3.0			
# CDMA/FDMA Band	6.0			
Transmitter Losses	0.5			dB
Sat Min. Ant. Gain	41.3			dBi
EIRP of D/L Beam	55.8			dBW
EIRP/ FDM carrier	51.0			
EIRP per CDMA User		43.2	43.2	dBW
MEO Slant Range	12391			km
Space Loss		206.3	206.3	dB
Atm. Gas Att.		1.0	2.9	dB
Cloud Att.		1.7	1.7	dB
Rain			2.9	dB
Ant. Pointing		0.5	0.5	dB
Peak Antenna Gain	31.5			dBi
Receiver Sys. Temp.	334.8		455.0	°K
Receiver Sys. Temp.	25.2		26.6	dBK
Station G/T		5.8	4.4	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		68.0	61.9	dB/Hz

Regenerative Payload

Uplink	Clear		Rain	Units
Uplink Total C/I	10.8			dB
C/Io		90.4	90.4	dB/Hz
Available C/(No+Io)		68.0	61.7	dB/Hz
Available Eb/(No+Io)		12.3	6.0	dB
Required Eb/No		6.0	6.0	dB
Total Uplink		6.3	0.0	dB

Downlink	Clear		Rain	Units
Downlink Total C/I	10.8			dB
C/Io		90.5	79.6	dB/Hz
Available C/(No+Io)		68.0	61.8	dB/Hz
Available Eb/(No+Io)		12.2	6.1	dB
Required Eb/No		6.0	6.0	dB
Total Downlink		6.2	0.1	dB

Table A-9. MEO Mobile V-Band Link In Rain

MEO Mobile Rain Conditions

SUMMARY of Uplink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	50.0			GHz
Link			98.5	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			7884	minutes
CDMA Chip Rate	81.9			Mcps
User Data Rate	1.5			Mbps
Coded Data Rate	2.5			Mcbps
Array Power	12.0			W
Transmitter Pwr	10.8			dBW
Power Back-off	1.0		1.0	dB
# of Amplified Carriers	1.0			
Transmitter Losses	0.5			dB
Antenna	0.6			m
Min. Antenna Gain	39.2			dBi
EIRP per carrier		48.5	48.5	dBW
Point./Pol. Loss		0.5	0.5	dB
MEO Slant Range	12391			km
Space Loss		208.3	208.3	dB
Atm. Gas Att.		3.6	3.8	dB
Cloud Att.		2.6	2.6	dB
Rain			6.7	dB
Sat. Antenna Gain	40.8			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		12.7	12.7	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		74.8	67.9	dB/Hz

SUMMARY of Downlink	Clear		Rain	Units
Site Elevation	35.0			deg
Site Altitude (ASL)				km
Frequency	40.0			GHz
Link			96.4	%
Rain Model Used			CCIR	
CCIR Rain Region			K	
Average Outage/Yr.			18922	minutes
Chip Rate	81.9			Mcps
User Data Rate	1.5			Mbps
Coded Data Rate	2.5			Mcbps
Satellite TWTA	50.0			W
Sat. Transmit Power	17.0			dBW
Sat. HPA Backoff	2.0			dB
# of FDM Carriers/HPA	3.0			
# CDMA/FDMA Band	5.0			
Transmitter Losses	0.5			dB
Sat Min. Ant. Gain	41.3			dBi
EIRP of D/L Beam	55.8			dBW
EIRP/ FDM carrier	51.0			
EIRP per CDMA User		44.0	44.0	dBW
MEO Slant Range	12391			km
Space Loss		206.3	206.3	dB
Atm. Gas Att.		1.0	2.9	dB
Cloud Att.		1.7	1.7	dB
Rain			3.3	dB
Ant. Pointing		0.5	0.5	dB
Peak Antenna Gain	37.5			dBi
Receiver Sys. Temp.	334.8		466.8	°K
Receiver Sys. Temp.	25.2		26.7	dBK
Station G/T		11.8	10.3	dB/K
Boltzmann's		-228.6	-228.6	dBW/K-Hz
Detection Bandwidth	90.1			MHz
Noise BW	79.5			dBHz
Available C/No		74.8	68.1	dB/Hz

Regenerative Payload

Uplink	Clear		Rain	Units
Uplink Total C/I	10.2			dB
C/Io		89.8	89.8	dB/Hz
Available C/(No+Io)		74.7	67.8	dB/Hz
Available Eb/(No+Io)		12.9	6.1	dB
Required Eb/No		6.0	6.0	dB
Total Uplink		6.9	0.1	dB

Downlink	Clear		Rain	Units
Downlink Total C/I	10.2			dB
C/Io		89.9	79.6	dB/Hz
Available C/(No+Io)		74.7	67.8	dB/Hz
Available Eb/(No+Io)		12.9	6.1	dB
Required Eb/No		6.0	6.0	dB
Total Downlink		6.9	0.1	dB

Table A-10. GSO C-Band Command Links - On - Station Planar Array

Contribution	Value	Note/Link Parameter
Command Uplink Frequency, GHz	6.523	Wavelength, m=0.046
Max Ground Station EIRP ,dBW	79.0	11 m antenna
Space Loss, dB-m^2	-200.3	40° elevation
Max Slant Range, Km		**37,781**
Clear sky loss, dB	-0.1	
Pointing error, dB	-0.1	
Spacecraft Reflector Gain, dB	25.0	Scaled from USDBS
Polarization Loss, dB	-0.1	
Path Loss to CR, dB	-16.3	
Power at TCR input, dBW	-112.9	
CR command threshold,dBW	-135.0	
Command margin,dB	22.1	
Command margin with rain fade,dB	20.6	99.95% availability

Table A-11. GSO C-Band Command Links - On - Station Pipe Antenna

Contribution	Value	Note/Link Parameter
Command Uplink Frequency, GHz	6.524	Wavelength, m=0.046
Max Ground Station EIRP ,dBW	79.0	11 m antenna
Space Loss, dB-m^2	-200.3	40° elevation
Max Slant Range, Km		**37,781**
Clear Sky Loss, dB	-0.1	
Pointing Error, dB	-0.1	
Pipe Antenna Gain, dB	2.0	On-axis C-band
Polarization Loss, dB	-0.1	
Path Loss to CR, dB	-6.3	
Power at TCR Input, dBW	-125.9	
CR command Threshold,dBW	-135.0	
Command Margin,dB	9.1	
Command Margin with Rain Fade,dB	7.6	99.95% availability

Table A-12. GSO C-Band Telemetry Links

Parameter	Spot Antenna	Omni Pipe	Comments
Telemetry Downlink Frequency, GHz	3.699	3.698	Wavelength, m=0.081
Minimum EIRP, dBW	8.0	0.0	Estimate
Space Loss, dB/m^{-2}	-195.3	-195.3	40° elevation; Max Slant Range, Km=37,781
Atmospheric Absorption, dB	-0.1	-0.1	Estimate; Clear Sky
Ground Station G/T, dB/K	33.2	33.2	11 m Antenna
Polarization Mismatch, dB	0.0	0.0	Assume Ground Station Receives Linear Polarization
Boltzmann's Constant, dBW/°K-Hz	-228.6	-228.6	
Downlink C/No. @ TM Receiver, dB-Hz	74.4	66.4	
Minimum C/No @ TM Receiver, dB-Hz	53.0	53.0	For 4 Kbps Stream
Clear Weather C/No Margin, dB	21.4	13.4	0.7 dB Fade 99.95% Availability
S/No Computation for Ranging:			
Receiver Baseband S/No, dB-Hz	69.1	61.1	
Carrier Recovery:			
TM Receiver Loop Bandwidth, dB-Hz	40.0	40.0	10 KHz PM demod PLL BW
Margin, dB	25.2	17.2	
Subcarrier Recovery:			
TM Receiver IF Bandwidth, dB-Hz	57.0	57.0	500 KHz BW
Margin, dB	27.1	19.1	
BER Computation:			
Demodulation Loss ($2J1^2(0.85)$), dB	-5.2	-5.2	
PM Demodulator Loss, dB	-1.0	-1.0	
Bit Sync Loss, dB	-1.5	-1.5	
Received Baseband S/No, dB-Hz	66.6	58.6	
Eb/No, dB-Hz	30.6	22.6	For 4 Kbps Stream
Minimum Eb/No for 10^6 BER, dB-Hz	10.5	10.5	Coherent PSK
Margin, dB	20.1	12.1	

Table A-13. MEO C-Band Command Links - On - Station Planar Array

Contribution	Value	Note/Link Parameter
Command Uplink Frequency, GHz	6.426	Wavelength, m=0.047
Max Ground Station EIRP ,dBW	77.0	9 m antenna
Space Loss, dB-m^2	-190.6	30° elevation
Max Slant Range, Km		12,601
Clear Sky Loss, dB	-0.1	
Pointing Error, dB	-0.1	
Pipe Antenna Gain, dB	25.0	
Polarization Loss, dB	-0.1	
Path Loss to CR, dB	-16.3	
Power at TCR Input, dBW	-105.2	
CR command Threshold,dBW	-135.0	
Command Margin,dB	29.8	
Command Margin with Rain Fade,dB	28.3	99.95% Availability

Table A-14. MEO C-Band Command Links - On - Station Pipe Antenna

Contribution	Value	Note/Link Parameter
Command Uplink Frequency, GHz	6.427	Wavelength, m=0.047
Max Ground Station EIRP ,dBW	77.0	9 m antenna
Space Loss, dB-m^2	-190.6	30° elevation
		Max Slant Range, Km=12,601
Clear Sky Loss, dB	-0.1	
Pointing Error, dB	-0.1	
Pipe Antenna Gain, dB	2.0	
Polarization Loss, dB	-0.1	
Path Loss to CR, dB	-6.3	
Power at TCR Input, dBW	-118.2	
CR command Threshold,dBW	-135.0	
Command Margin,dB	16.8	
Command Margin with Rain Fade,dB	15.3	99.95% Availability

Table A-15. MEO C-Band Telemetry Links

Parameter	Spot Antenna	Omni Pipe	Comments
Telemetry Downlink Frequency, GHz	3.601	3.602	Wavelength, m=0.083
Minimum EIRP, dBW	8.0	0.0	
Space Loss, dB/m^{-2}	-185.6	-185.6	30° elevation; Max Slant Range, Km=12,601
Atmospheric Absorption, dB	-0.1	-0.1	Clear Sky
Ground Station G/T, dB/°K	31.0	31.0	9 m Antenna
Polarization Mismatch, dB	0.0	0.0	Assume Ground Station Receives Linear Polarization
Boltzmann's Constant, dBW/°K-Hz	-228.6	-228.6	
Downlink C/No. @ TM Receiver, dB-Hz	81.8	73.8	
Minimum C/No @ TM Receiver, dB-Hz	53.0	53.0	For 4 Kb/s Stream
Clear Weather C/No Margin, dB	28.8	20.8	0.7 dB Fade 99.95% Availability
S/No Computation for Ranging:			
Receiver Baseband S/No, dB-Hz	76.6	68.6	
Carrier Recovery:			
TLM Receiver Loop Bandwidth, dB-Hz	40.0	40.0	10 KHz PM demod PLL BW
Margin, dB	32.7	24.7	
Subcarrier Recovery:			
TLM Receiver IF Bandwidth, dB-Hz	57.0	57.0	500 KHz BW
Margin, dB	34.6	26.6	
BER Computation:			
Demodulation Loss ($2J1^2(0.85)$), dB	-5.2	-5.2	
PM Demodulator Loss, dB	-1.0	-1.0	
Bit Sync Loss, dB	-1.5	-1.5	
Received Baseband S/No, dB-Hz	74.1	66.1	
Eb/No, dB-Hz	38.1	30.1	For 4 Kbps Telemetry Data
Minimum Eb/No for 10^6 BER, dB-Hz	10.5	10.5	Coherent PSK
Margin, dB	27.6	19.6	

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Appendix B
Interference Analysis

APPENDIX B: INTERFERENCE ANALYSIS

Sharing criteria and results of interference analyses between StarLynx™ and other systems are presented in this section. The four subsections show (1) system parameters, (2) C/I results, (3) satellite diversity analyses, and (4) intra-service sharing, respectively.

For the following cases: (1) GSO into NGSO uplink, (2) GSO into NGSO downlink, (3) NGSO into GSO uplink, and (4) NGSO into GSO downlink, the worst-case interference is due to the transmission from a GSO-system uplink to an NGSO system. Figure B-1 provides an illustration of these four cases.

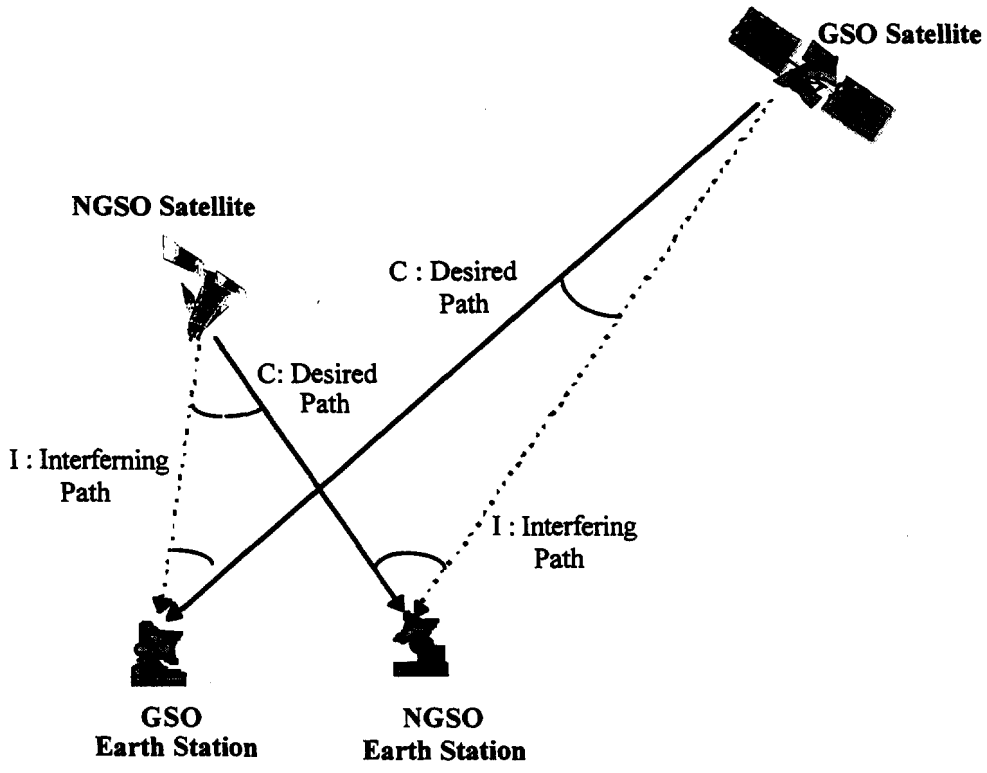


Figure B-1. Example of Interference Between a GSO and an NGSO System

B.1. System Parameters Used in Simulation

Table B-1. StarLynx™ GSO and Expressway™ Link Parameters

SYSTEM PARAMETER TABLE			StarLynx™ GSO vs Expressway™		
	UPLINK		DOWNLINK		
LINK PARAMETER	Expressway™	StarLynx™ GSO	Expressway™	StarLynx™ GSO	UNITS
Spacial Separation	2		2		deg.
Signal frequency	46	46	38	38	GHz
Tx Power (Earth/Satellite)	30	10	100	100	W
Tx HPA Backoff	3	1	2	2	dB
Tx Losses	0.5	0.5	1	0.5	dB
Number of Carriers	1	1	10	36	
Slant Range	37,000	37,000	37,000	37,000	km
Earth-Station Tx Antenna Size	2.5	0.3			m
Earth-Station Rx Antenna Size			2.5	0.3	m
Earth-Station Tx Ant. Peak Gain	59.4	33.2			dBi
Earth-Station Rx Ant. Peak Gain			57.7	31.5	dBi
Satellite Tx Ant. Peak Gain			52	56	dBi
Satellite Rx Ant. Peak Gain	52	56			dBi
Band Width of Signal	285	90	285	90	MHz
Rx Noise Temperature	650	650	450	335	K

Table B-2. StarLynx™ MEO and Expressway™ Link Parameters

SYSTEM PARAMETER TABLE			StarLynx™ MEO vs Expressway™		
	UPLINK		DOWNLINK		
LINK PARAMETER	Expressway™	StarLynx™ MEO	Expressway™	StarLynx™ MEO	UNITS
Spacial Separation	2		2		deg.
Signal frequency	46	46	38	38	GHz
Tx Power (Earth/Satellite)	30	10	100	50	W
Tx HPA Backoff	3	1	2	2	dB
Tx Losses	0.5	0.5	1	0.5	dB
Number of Carriers	1	1	10	18	
Slant Range	37,000	10,500	37,000	10,500	km
Earth-Station Tx Antenna Size	2.5	0.3			m
Earth-Station Rx Antenna Size			2.5	0.3	m
Earth-Station Tx Ant. Peak Gain	59.4	33.2			dBi
Earth-Station Rx Ant. Peak Gain			57.7	31.5	dBi
Satellite Tx Ant. Peak Gain			52	44.3	dBi
Satellite Rx Ant. Peak Gain	52	44.3			dBi
Band Width of Signal	285	90	285	90	MHz
Rx Noise Temperature	650	650	450	335	K

Table B-3. StarLynx™ GSO and StarLynx™ MEO Link Parameters

SYSTEM PARAMETER TABLE			StarLynx™ GSO vs StarLynx™ MEO		
	UPLINK		DOWNLINK		
LINK PARAMETER	StarLynx™ MEO	StarLynx™ GSO	StarLynx™ MEO	StarLynx™ GSO	UNITS
Spacial Separation	2		2		deg.
Signal frequency	46	46	38	38	GHz
Tx Power (Earth/Satellite)	10	10	50	100	W
Tx HPA Backoff	1	1	2	2	dB
Tx Losses	0.5	0.5	0.5	0.5	dB
Number of Carriers	1	1	18	36	
Slant Range	10,500	37,000	10,500	37,000	km
Earth-Station Tx Antenna Size	0.3	0.3			m
Earth-Station Rx Antenna Size			0.3	0.3	m
Earth-Station Tx Ant. Peak Gain	33.2	33.2			dBi
Earth-Station Rx Ant. Peak Gain			31.5	31.5	dBi
Satellite Tx Ant. Peak Gain			44.3	56	dBi
Satellite Rx Ant. Peak Gain	44.3	56			dBi
Band Width of Signal	90	90	90	90	MHz
Rx Noise Temperature	650	650	335	335	K

Table B-4. StarLynx™ GSO and StarLynx™ GSO Link Parameters

SYSTEM PARAMETER TABLE			StarLynx™ GSO vs StarLynx™ GSO		
	UPLINK		DOWNLINK		
LINK PARAMETER	StarLynx™ GSO	StarLynx™ GSO	StarLynx™ GSO	StarLynx™ GSO	UNITS
Spacial Separation	2		2		deg.
Signal frequency	46	46	38	38	GHz
Tx Power (Earth/Satellite)	10	10	100	100	W
Tx HPA Backoff	1	1	2	2	dB
Tx Losses	0.5	0.5	0.5	0.5	dB
Number of Carriers	1	1	36	36	
Slant Range	37,000	37,000	37,000	37,000	km
Earth-Station Tx Antenna Size	0.3	0.3			m
Earth-Station Rx Antenna Size			0.3	0.3	m
Earth-Station Tx Ant. Peak Gain	33.2	33.2			dBi
Earth-Station Rx Ant. Peak Gain			31.5	31.5	dBi
Satellite Tx Ant. Peak Gain			56	56	dBi
Satellite Rx Ant. Peak Gain	56	56			dBi
Band Width of Signal	90	90	90	90	MHz
Rx Noise Temperature	650	650	335	335	K

B.2. Results of C/I Calculations

Table B-5. C/I results of StarLynx™ GSO and Expressway™

INTERFERENCE ANALYSIS TABLE					StarLynx™ GSO vs Expressway™				
	UPLINK		DOWNLINK		UPLINK		DOWNLINK		
PARAMETER	Desired	Interfer.	Desired	Interfer.	Interfer.	Desired	Interfer.	Desired	UNITS
	Expressway™	StarLynx™ GSO	Expressway™	StarLynx™ GSO	Expressway™	StarLynx™ GSO	Expressway™	StarLynx™ GSO	
Signal frequency	46	46	38	38	46	46	38	38	GHz
+ TX Power	14.8	10.0	20.0	20.0	14.8	10.0	20.0	20.0	dBW
- TX Loss	0.5	0.5	1	0.5	0.5	0.5	1	0.5	dB
- HPA Backoff	3	1	2	2	3	1	2	2	dB
+ TX Ant. Gain	59.4	13.2	49.0	56.0	21.5	33.2	52.0	53.0	dBi
- Per Carrier Loss	0.0	0.0	10.0	15.6	0.0	0.0	10.0	15.6	dB
= Tx EIRP	70.7	21.7	56.0	57.9	32.7	41.7	59.0	54.9	dBW
- Space Loss	217.1	217.1	215.4	215.4	217.1	217.1	215.4	215.4	dB
- Atmospheric Loss	6.2	6.2	2.7	2.7	6.2	6.2	2.7	2.7	dB
+ Rx Ant. Gain	49.0	52.0	57.7	21.5	56.0	53.0	11.5	31.5	dBi
= Carrier Power (C)	-103.6		-104.4			-128.6		-131.7	dBW
= Interfer. Power (I)		-149.6		-138.7	-134.5		-147.6		dBW
- Rx Noise Temp.	28.1	28.1	26.5	26.5	28.1	28.1	25.3	25.3	dBK
- Boltzmann's Const.	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	dBW/K-Hz
- Signal Bandwidth	84.5	79.5	84.5	79.5	84.5	79.5	84.5	79.5	dB-Hz
Co/No or Io/No	12.3	-28.6	13.2	-16.2	-18.6	-7.6	-28.8	-7.9	dB/Hz
Co/Io up or Co/Io down	41.0 (up)		29.3 (down)		11.0 (up)		20.9 (down)		dB
Co/Io total		29.0 (total)				10.5 (total)			dB

Table B-6. C/I results of StarLynx™ MEO and Expressway™

INTERFERENCE ANALYSIS TABLE					StarLynx™ MEO vs Expressway™				
	UPLINK		DOWNLINK		UPLINK		DOWNLINK		
PARAMETER	Desired	Interfer.	Desired	Interfer.	Interfer.	Desired	Interfer.	Desired	UNITS
	Expressway™	StarLynx™ MEO	Expressway™	StarLynx™ MEO	Expressway™	StarLynx™ MEO	Expressway™	StarLynx™ MEO	
Signal frequency	46	46	38	38	46	46	38	38	GHz
+ TX Power	14.8	10.0	20.0	17.0	14.8	10.0	20.0	17.0	dBW
- TX Loss	0.5	0.5	1	0.5	0.5	0.5	1	0.5	dB
- HPA Backoff	3	1	2	2	3	1	2	2	dB
+ TX Ant. Gain	59.4	13.2	49.0	44.3	21.5	33.2	52.0	41.3	dBi
- Per Carrier Loss	0.0	0.0	10.0	12.6	0.0	0.0	10.0	12.6	dB
= Tx EIRP	70.7	21.7	56.0	46.2	32.7	41.7	59.0	43.2	dBW
- Space Loss	217.1	217.1	215.4	204.5	206.1	206.1	215.4	204.5	dB
- Atmospheric Loss	6.2	6.2	2.7	2.7	6.2	6.2	2.7	2.7	dB
+ Rx Ant. Gain	49.0	52.0	57.7	21.5	44.3	41.3	11.5	31.5	dBi
= Carrier Power (C)	-103.6		-104.4			-129.3		-132.4	dBW
= Interfer. Power (I)		-149.6		-139.5	-135.3		-147.6		dBW
- Rx Noise Temp.	28.1	28.1	26.5	26.5	28.1	28.1	25.3	25.3	dBK
- Boltzmann's Const.	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	dBW/K-Hz
- Signal Bandwidth	84.5	79.5	84.5	79.5	84.5	79.5	84.5	79.5	dB-Hz
Co/No or Io/No	12.3	-28.6	13.1	-16.9	-19.4	-8.4	-28.8	-8.6	dB/Hz
Co/Io up or Co/Io down	41.0 (up)		30.0 (down)		11.0 (up)		20.2 (down)		dB
Co/Io total		29.7 (total)				10.5 (total)			dB

Table B-7. C/I results of StarLynx™ GSO and StarLynx™ MEO

INTERFERENCE ANALYSIS TABLE					StarLynx™ GSO vs StarLynx™ MEO				
	UPLINK		DOWNLINK		UPLINK		DOWNLINK		
PARAMETER	Desired	Interfer.	Desired	Interfer.	Interfer.	Desired	Interfer.	Desired	UNITS
	StarLynx™ MEO	StarLynx™ GSO	StarLynx™ MEO	StarLynx™ GSO	StarLynx™ MEO	StarLynx™ GSO	StarLynx™ MEO	StarLynx™ GSO	
Signal frequency	46	46	38	38	46	46	38	38	GHz
+ TX Power	10.0	10.0	17.0	20.0	10.0	10.0	17.0	20.0	dBW
- TX Loss	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	dB
- HPA Backoff	1	1	2	2	1	1	2	2	dB
+ TX Ant. Gain	33.2	13.2	41.3	56.0	13.2	33.2	44.3	53.0	dBi
- Per Carrier Loss	0.0	0.0	12.6	15.6	0.0	0.0	12.6	15.6	dB
= Tx EIRP	41.7	21.7	43.2	57.9	21.7	41.7	46.2	54.9	dBW
- Space Loss	206.1	206.1	204.5	215.4	217.1	217.1	204.5	215.4	dB
- Atmospheric Loss	6.2	6.2	2.7	2.7	6.2	6.2	2.7	2.7	dB
+ Rx Ant. Gain	41.3	44.3	31.5	11.5	56.0	53.0	11.5	31.5	dBi
= Carrier Power (C)	-129.3		-132.4			-128.6		-131.7	dBW
= Interfer. Power (I)		-146.3		-148.7	-145.6		-149.4		dBW
- Rx Noise Temp.	28.1	28.1	25.3	25.3	28.1	28.1	25.3	25.3	dBK
- Boltzmann's Const.	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	dBW/K-Hz
- Signal Bandwidth	79.5	79.5	79.5	79.5	79.5	79.5	79.5	79.5	dB-Hz
Co/No or Io/No	-8.4	-25.4	-8.6	-24.9	-24.6	-7.6	-25.6	-7.9	dB/Hz
Co/Io $_{up}$ or Co/Io $_{down}$	17.0	(up)	16.2	(down)	17.0	(up)	17.8	(down)	dB
Co/Io total		13.6	(total)			14.4	(total)		dB

Table B-8. C/I results of StarLynx™ GSO and StarLynx™ GSO

INTERFERENCE ANALYSIS TABLE					StarLynx™ GSO vs StarLynx™ GSO				
	UPLINK		DOWNLINK		UPLINK		DOWNLINK		
PARAMETER	Desired	Interfer.	Desired	Interfer.	Interfer.	Desired	Interfer.	Desired	UNITS
	GSO	GSO	GSO	GSO	GSO	GSO	GSO	GSO	
Signal frequency	46	46	38	38	46	46	38	38	GHz
+ TX Power	10.0	10.0	20.0	20.0	10.0	10.0	20.0	20.0	dBW
- TX Loss	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	dB
- HPA Backoff	1	1	2	2	1	1	2	2	dB
+ TX Ant. Gain	33.2	13.2	53.0	56.0	13.2	33.2	56.0	53.0	dBi
- Per Carrier Loss	0.0	0.0	15.6	15.6	0.0	0.0	15.6	15.6	dB
= Tx EIRP	41.7	21.7	54.9	57.9	21.7	41.7	57.9	54.9	dBW
- Space Loss	217.1	217.1	215.4	215.4	217.1	217.1	215.4	215.4	dB
- Atmospheric Loss	6.2	6.2	2.7	2.7	6.2	6.2	2.7	2.7	dB
+ Rx Ant. Gain	53.0	56.0	31.5	11.5	56.0	53.0	11.5	31.5	dBi
= Carrier Power (C)	-128.6		-131.7			-128.6		-131.7	dBW
= Interfer. Power (I)		-145.6		-148.7	-145.6		-148.7		dBW
- Rx Noise Temp.	28.1	28.1	25.3	25.3	28.1	28.1	25.3	25.3	dBK
- Boltzmann's Const.	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	-228.6	dBW/K-Hz
- Signal Bandwidth	79.5	79.5	79.5	79.5	79.5	79.5	79.5	79.5	dB-Hz
Co/No or Io/No	-7.6	-24.6	-7.9	-24.9	-24.6	-7.6	-24.9	-7.9	dB/Hz
Co/Io $_{up}$ or Co/Io $_{down}$	17.0	(up)	17.0	(down)	17.0	(up)	17.0	(down)	dB
Co/Io total		14.0	(total)			14.0	(total)		dB

B.3. SATELLITE DIVERSITY ANALYSES

Interference is measured by the level of interference-to-noise-ratio (Io/No) in dB where Io is the interference level from the interfering satellite link and N_o is the noise level at the receiver (satellite for the uplink and Earth station for the downlink). Orbital parameters for both GSO and MEO components of StarLynx™ are listed in Table B-9. For a user terminal located at 0° latitude, Figure B-2 shows the Io/No results between StarLynx™ GSO (S-GSO) and StarLynx™ MEO (S-MEO)

in three cases: (1) the user terminal tracks the satellite with the highest elevation angle, (2) the user terminal tracks a satellite until it drops below 30° elevation angle, and (3) the user terminal tracks the satellite with the least interference (satellite diversity implementation). In-line situation would cause harmful interference in cases (1) and (2) (no interference mitigation). In case 3 (with interference mitigation), the worst case (highest Io/No) is reduced by a significant amount. In conclusion, the use of satellite diversity reduces Io/No by a significant level depending on user terminal locations.

Table B-9. StarLynx™ GSO and MEO Orbital Parameters

	StarLynx™ GSO	StarLynx™ MEO
Number of Planes	1	4
Number of Satellites Per Plane	8	5
Altitude	35787 km	10352 km
Inclination	0°	55°
Plane Phasing	0°	0°
Orbit Period	24 hr	6 hr

Detailed interference analyses for user terminals at other latitudes were also performed. The most severe interference cases (highest Io/No values) from 0° to 70° latitude are shown in Figure B-3. The analytical results again demonstrate that the constellation design of StarLynx™ MEO with satellite diversity reduces Io/No by a significant level. Based on this analysis, sharing of the same spectrum between GSO and NGSO satellites should be facilitated.

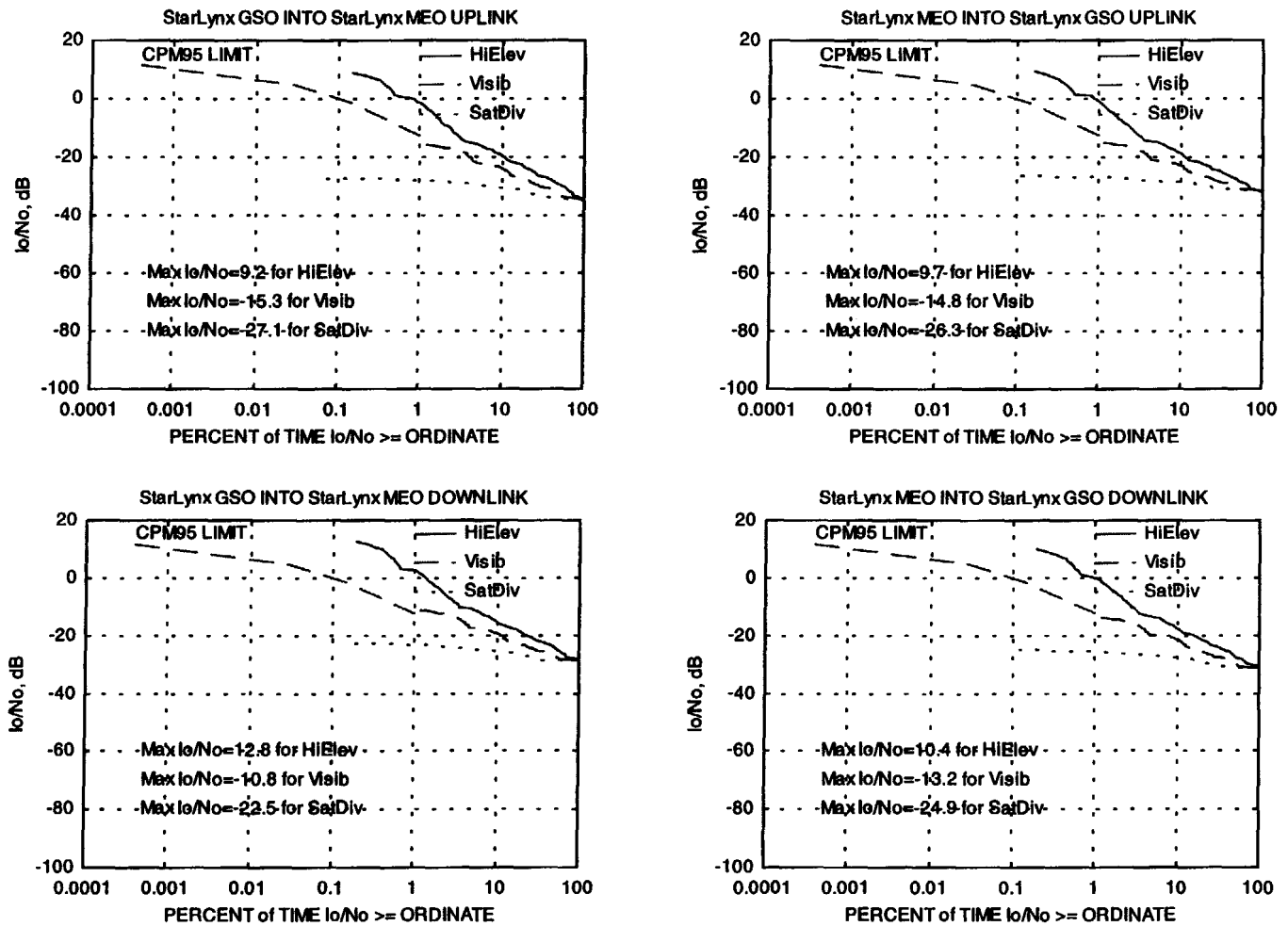
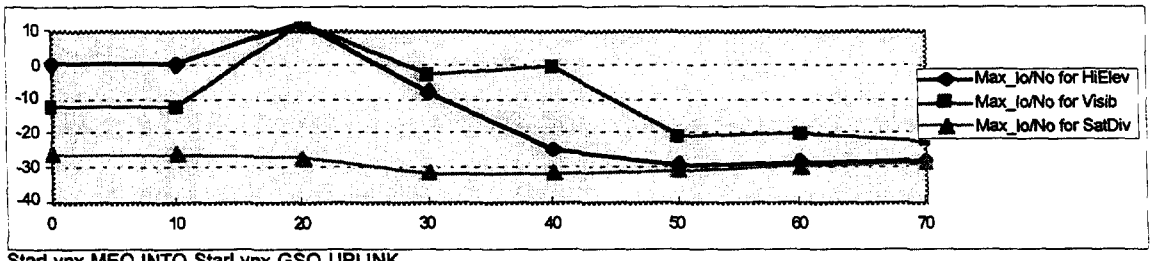


Figure B-2. Interference Simulation Results between StarLynx™ GSO and StarLynx™ MEO Using Satellite Diversity (User Terminal Location at 10° Latitude)

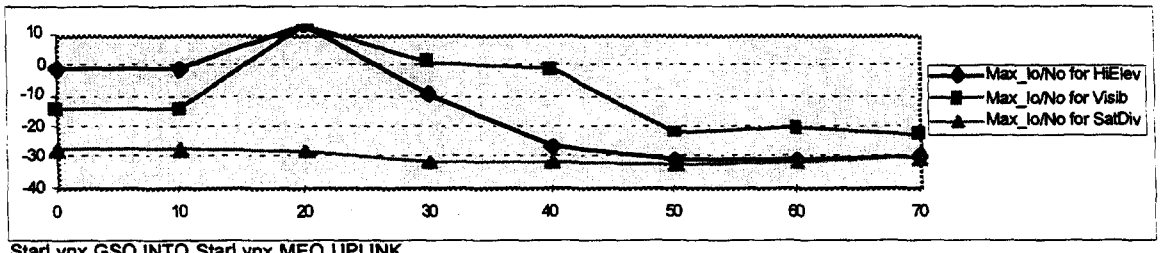
StarLynx MEO INTO StarLynx GSO DOWNLINK

Latitude	0	10	20	30	40	50	60	70
Max_Io/No for HiElev	0.4	0.4	13.1	-7.8	-24.5	-28.8	-28.3	-27.4
Max_Io/No for Visib	-12.1	-12.1	13.1	-2.6	0	-20.8	-19.7	-21.6
Max_Io/No for SatDiv	-25.6	-25.6	-27.1	-31.1	-31.1	-30.6	-29.4	-28.3



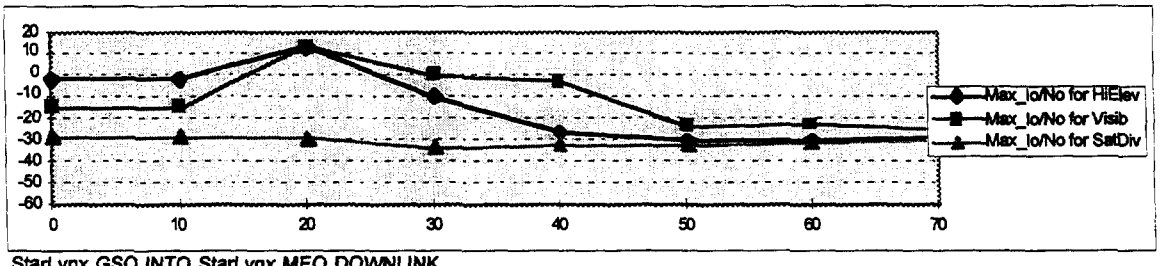
StarLynx MEO INTO StarLynx GSO UPLINK

Latitude	0	10	20	30	40	50	60	70
Max_Io/No for HiElev	-1.1	-1.1	13.7	-9.1	-26.3	-30.7	-30.2	-29.1
Max_Io/No for Visib	-13.7	-13.7	13.7	1.3	-1	-21.7	-20.4	-22.5
Max_Io/No for SatDiv	-26.7	-26.7	-28	-31.2	-31.4	-31.6	-31.3	-29.8



StarLynx GSO INTO StarLynx MEO UPLINK

Latitude	0	10	20	30	40	50	60	70
Max_Io/No for HiElev	-1.5	-1.5	12.9	-10.1	-26.4	-30.4	-30	-29.4
Max_Io/No for Visib	-14.2	-14.2	12.9	0.1	-2.8	-23.5	-22.6	-24.3
Max_Io/No for SatDiv	-28	-28	-29.8	-33.1	-32.8	-32.1	-31	-30.1



StarLynx GSO INTO StarLynx MEO DOWNLINK

Latitude	0	10	20	30	40	50	60	70
Max_Io/No for HiElev	2.8	2.8	15.5	-5.4	-22.1	-26.4	-25.9	-25
Max_Io/No for Visib	-9.7	-9.7	15.5	5	2.4	-18.4	-17.3	-19.2
Max_Io/No for SatDiv	-23.2	-23.1	-24.7	-28.7	-28.7	-28.2	-27	-25.9

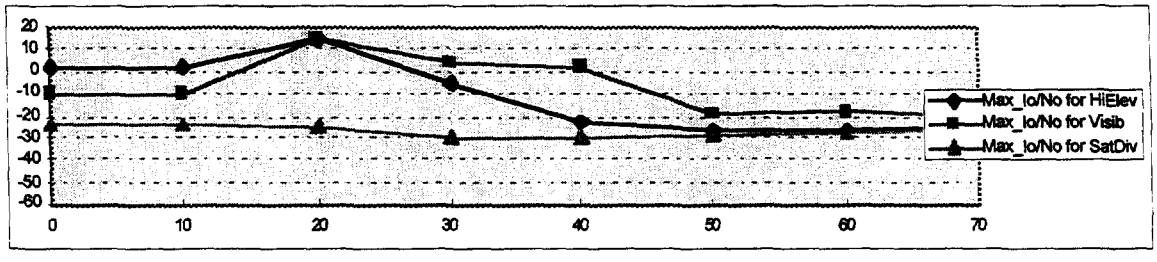


Figure B-3. Worst-Case Interference (Io/No) as a Function of Latitudes

B.4 INTRA SERVICE SHARING

B.4.1 Mobile-Satellite and Fixed-Satellite Services

B.4.1.1 StarLynx™ GSO with Other GSO FSS/MSS Analysis

Between two GSO systems, interference mitigation is achieved with orbital separation. Earth station antenna discrimination is a primary factor in interference mitigation between two GSO systems. The StarLynx™ user terminal will use array beam formation technique to achieve 20 dB or higher antenna discrimination from a GSO satellite spaced 2° away from a StarLynx™ GSO satellite. Analysis shows that StarLynx™ GSO can achieve sufficient interference protection from a hypothetical GSO system.

B.4.1.2 StarLynx™ MEO with other GSO FSS/MSS Analysis

Simulation results in Section B.3 show that satellite diversity provides an interference mitigation technique that facilitates spectrum sharing between StarLynx™ MEO and GSO systems. Table B-10 lists interference mitigation techniques to be used by StarLynx™ MEO to avoid excessive interference with GSO systems. This list shows techniques which have special applicability to NGSO systems. Sharing between GSO and NGSO systems depends on appropriate implementation of some or all of these techniques by the NGSO systems.

Table B-10. NGSO Interference Mitigation Techniques

TECHNIQUE for INTERFERENCE MITIGATION	APPLIED in StarLynx™
Satellite Diversity	Applied
Restricted Operational Elevation Angles	Applied
High Gain Antenna	Applied
Adaptive Power Control	Applied
Network Traffic Management	Applied
Hybrid System	Applied
Repeatable Ground Tracks for NGSO	Applied
Code Division	Applied

B.4.1.3 StarLynx™ GSO with NGSO FSS/MSS Analysis

The potential for harmful interference from the GSO uplink to NGSO uplink for co-located Earth stations is minimized if various interference mitigation techniques described in Table B-10 are applied.

B.4.1.4. StarLynx™ MEO with Other NGSO FSS/MSS Analysis

To achieve the most efficient spectrum usage, NGSO systems should cooperatively implement interference mitigation techniques. Multiple NGSO systems operating in a co-directional, co-frequency manner can be accomplished using various techniques listed in Table B-8. This section examines the use of satellite diversity to reduce interference and facilitate sharing between two NGSO systems.

Satellite diversity relies on a high percentage of multiple satellites visible to an Earth terminal, and the Earth terminal being able to perform high speed switching between visible satellites. However, switching is a basic requirement in NGSO satellite hand-over. Thus, additional resources are not imposed upon the Earth terminal to apply satellite diversity, except for the addition of a dynamic interference source location estimation package.

Figure B-4 shows results from a simulation that dynamically locates satellites in their orbits and allows each Earth terminal to track its respective aiming points while taking into account the Earth's rotation. The simulation sampled over a period of seven days at a relatively fine sampling resolution (2 sec). Assuming the adaptive power control technique is applied to both systems, the dynamic interference-to-noise level, Io/No, for both uplink and downlink at both systems are determined.

Table B-11 shows the orbital parameters for StarLynx™ MEO and a proposed NGSO system using the same frequency band. The results in Figure B-4 show that by applying satellite diversity, the Io/No between StarLynx™ MEO and the other NGSO system can be reduced by a significant level. Based on this analysis, sharing of the same spectrum between NGSO satellites should be facilitated.

Table B-11. StarLynx™ MEO and a Proposed NGSO System Orbital Parameters

	StarLynx™ MEO	Proposed NGSO
Number of Planes	4	12
Number of Satellites Per Plane	5	6
Altitude	10352 km	1350 km
Inclination	55°	47°
Plane Phasing	0°	25°

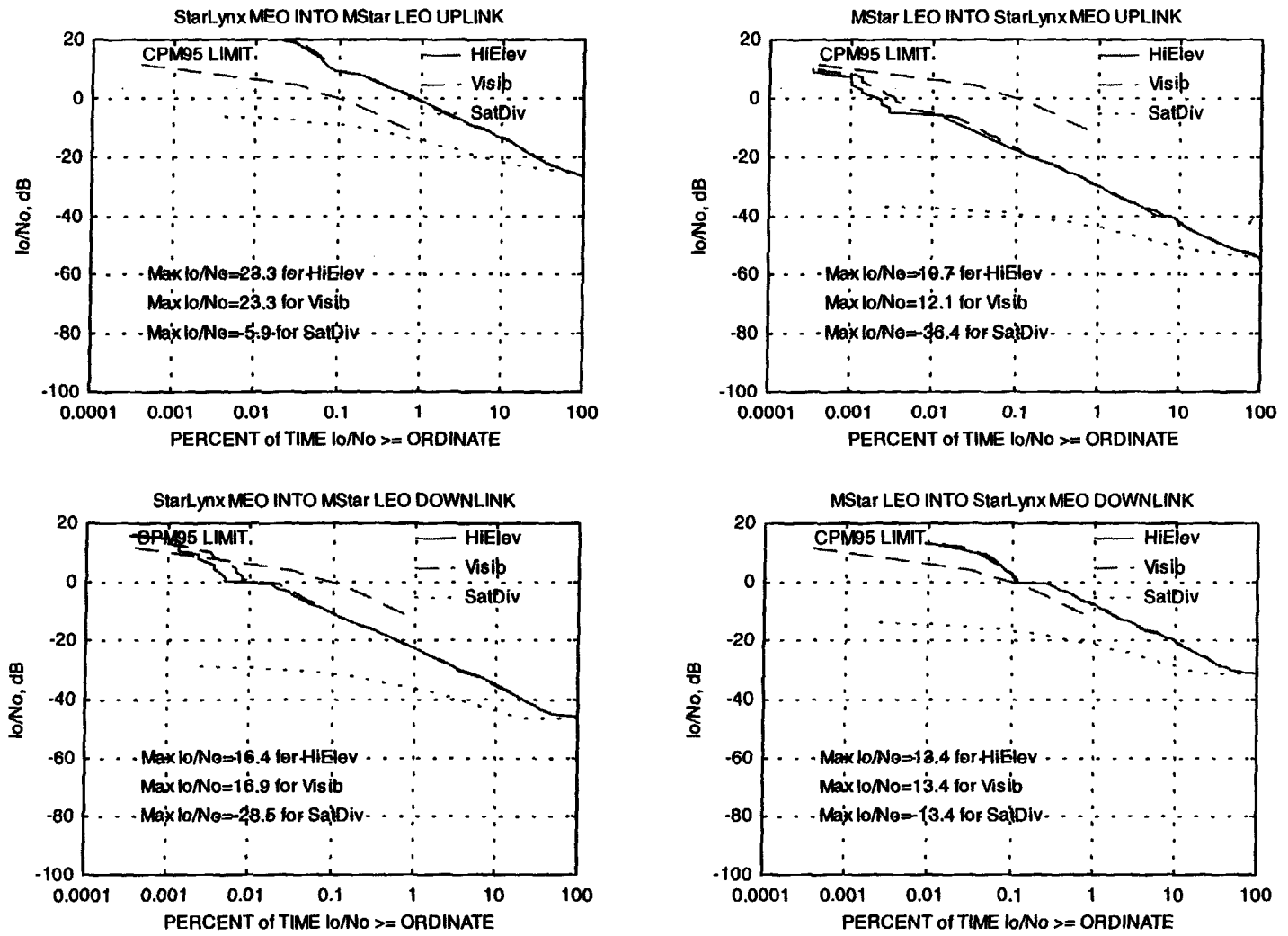


Figure B-4. Interference Simulation Results between StarLynx™ MEO and a Proposed NGSO System Using Satellite Diversity (User Terminal Location at 40° Latitude)