ADVANCED COMMUNICATIONS TECHNOLOGY

Technology Assessment of Mobile Satellite System Alternatives

- Appendices -

Prepared for:

United States Coast Guard
Systems Directorate

Prepared By:

United States Coast Guard
Research and Development Center
Advanced Communications Technology Project
LCDR Gregory W. Johnson
Mr. Jon Turban
ETCS Robert Erickson

April 1998

Appendices*

*** Appendices have been published as a separate Addendum available from the Research and Development Center upon request.**

A. Summary Information of Satellite Systems Separated into the Following Tables:

1. General Information
2. Ground Segment
3. Space Segment
4. User Segment
5. User Terminal

B. Complete Information on the Satellite Systems

APPENDIX A
TABLE A.1 GENERAL INFORMATION

SYSTEM NAME	SYSTEM TYPE	FREQUENCY BAND	FIRST LAUNCH	INITIAL OPERATIONAL CAPABILITY	FINAL OPERATIONAL CAPABILITY	ESTIMATED SYSTEM COST (million $)	COUNTRIES LICENSED	FCC LICENSED ?	URL REFERENCES	PRIME COMPANY
Aeronautical Inmarsat -C	GEO	L	1996	1996	1996	$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)
Argos	LEO	UHF	1/1/78	1975?	1976		30		http://www.argosinc.com/DOCS/sainc.htm	NOAA; CLS; Service Argos, Inc.
Astrolink	GEO	Ka	2000	2002	2002	$4,000		Filed	http://www.astrolink.com/	Lockheed Martin Corp.
Boatracs/ OmniTRACS	GEO	Ku	5/1/85	1988	1986		31	Yes	http://www.boatracs.com/	Qualcomm
Celestri	LEO	Ka	2001	2003	2004	$12,900		Yes	http://www.mot.com/GSS/SSTG/projects/celestri/	Motorola
Constellation	MEO	L		2000 ?	2001	$1,700		Yes		Raytheon E-Systems; Bell Atlantic; CTA Inc.; SpaceVest
CTA/GEMNET	LEO	UHF	Canx	Canx	Canx	$184				CTA Commercial Systems
CyberPath	GEO			2002		$1,174		Filed		Loral
CyberStar	GEO	Ka		1998 mid	1999	$1,600		Filed	http://www.cyberstar.com/	Loral
DirecPC	GEO	Ku		1997				Yes	http://www.direcpc.com/	Hughes Network Systems
E-Sat	LEO	VHF		2001 ?	2001	$49		Yes		E-Sat, Inc.
EchoStar	GEO	Ka		2002				Filed	http://www.echostar.com/	EchoStar Satellite Corp; Lockheed Martin Aerospace
Ellipso	MEO	L	2000	2001	2003	$750		Yes	http://www.ellipso.com/	Mobile Communications Holding Inc. (MCHI) Lockheed Martin Management & Data Systems
Ellipso 2G	LEO	S		2003	2004					Mobile Communications Holding Inc. (MCHI)
Expressway	LEO	V/Ku		2004		$3,925		Filed		Hughes
FAISAT	LEO	VHF	Jan-95	2000 ?	2000	$200	9	Yes	http://www.finalanalysis.com/	Final Analysis, Inc.
GE*Star	GEO	Ka		2002		$4,000		Filed		GE American Communications
GE*Star Plus	GEO			2002 +?		$3,370			http://www.ge.com/capital/americom/	GE American Communications
GESN	GEO/MEO	V		2003		$3,400		Filed		TRW, Inc.
Globalstar	LEO	L	2/14/98	1998 Fall	1999	$2,600	17	Yes	http://www.globalstar.com/	Loral Qualcomm Partership (LQP); Space Systems/Loral Ltd.; QUALCOMM, Inc.; Alcatel
Globalstar GS-40	LEO			2002 +?				Filed		Globalstar L.P.; Space Systems/Loral; Qualcomm
Horizons			2001	2002						Inmarsat
ICO	MEO	S	late 1998?	2000	2001	$2,600	90		http://www.i-co.co.uk/	ICO Global Communications (44 countries); Hughes Space and Communications; COMSAT; Inmarsat; TRW
Inmarsat -A	GEO	L	1979	1982	1982	$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)
Inmarsat -B	GEO	L	1996	1996	1996	$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)
Inmarsat -C	GEO	L	1979	1991	1992	$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)
Inmarsat -M	GEO	L	1979	1993	1994	$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)

APPENDIX A
TABLE A.1 GENERAL INFORMATION

SYSTEM NAME	SYSTEM TYPE	FREQUENCY BAND	FIRST LAUNCH	INITIAL OPERATIONAL CAPABILITY	FINAL OPERATIONAL CAPABILITY	ESTIMATED SYSTEM COST (million $)	COUNTRIES LICENSED	FCC LICENSED ?	URL REFERENCES	PRIME COMPANY
Inmarsat Aero H	GEO	L	1979	1990	1992	$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)
Inmarsat Aero I	GEO	L	1979	1998		$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)
Inmarsat Aero L	GEO	L	1979	1997	1998	$2,000	82	Yes	http://www.inmarsat.org/	Inmarsat Coop (82+ countries); COMSAT (US Signatory)
Iridium	LEO	L	5/5/97	1991	1999	$5,000	35	Yes	http://www.iridium.com/welcome.html	Iridium LLC (international partnership); Motorola (prime); Sprint
KaStar	GEO	Ka		2002	2006	$645		Filed	http://www.kastarcom.com/	KaStar Satellite; Lockheed Martin
Leo One	LEO	VHF		2001 ?	2002	$500		Yes	http://www.leoone.com/	LEO One USA
M-Star	LEO	V		2002 ?	2004 ?					Motorola
Millennium	GEO	Ka	1998	SEE CELESTRI	SEE CELESTRI	$2,300		CELESTRI		Comm Inc. (Motorola)
Morning Star	GEO	Ka		2002		$936		Filed		
NetSat 28	GEO	Ka		2002		$250		Filed		
Odyssey	MEO	L		CANCELLED	CANCELLED	$3,000		Yes	http://www.trw.com/seg/sats/ODY.html	TRW Space & Electronics Group; Teleglobe
ORBCOMM	LEO	VHF	4/3/95	1996	1999	$350	97	Yes	http://www.orbcomm.net/	Orbital Communications Comrp.; Teleglobe Inc.
OrbLink	MEO			2002		$900		Filed	http://www.orbital.com/OSC/Press_releases/pr92.html	Orbital Sciences Corp.
Orion Network Systems	GEO	Ka		2002		$500		Filed		
Panamsat PAS 10 and PAS 11	GEO	Ka		2002		$409		Filed	http://www.panamsat.com/	PanAmSat Corp.; Hughes Communications
Pentriad	MEO		2001 +?	2002 +?		$1,890		Filed		Denali Telecom
Q/V-Band	GEO			2004 +?		$4,750		Filed		Lockheed Martin
SkyBridge	LEO	Ku	2001	2001	2002	$3,500				SkyBridge Limited Partnership Alcatel Loral
SkyCell	GEO	L	Apr-95	1996	1996	$500	1	Yes	http://www.skycell.com/	AMSC-US (Hughes, AT&T, Singapore Telecom); TMI-Canada
SpaceCast	GEO			2004 +?		$2,000		Filed		Hughes
Spaceway	GEO	Ka		2001	2002	$3,200		Filed	http://www.spaceway.com/SPACEWAY/SPACEWAY.html	Hughes Communications
Spectrum Astro Aster	GEO			2002		$2,357		Filed	http://www.spectrumastro.com/	Spectrum Astro, Inc.
Starlynx	MEO/GEO			2004 +?		$2,871		Filed		Hughes
Starsys	LEO	VHF		Cancelled	Cancelled	$150		Yes		GE Americom
Teledesic	LEO	Ka	2001	2002	2004	$9,000		Yes	http://www.teledesic.com/	Craig McCaw; Bill Gates; Boeing
Turbosat	GEO	Ku		1998				Yes	http://www.ge.com/capital/spacenet/about-sn/brief3.htm	GE Capital Spacenet Services
V-Stream	GEO	V		2005 ?	2006	$3,500				PanAmSat Corp.
VisionStar	GEO	Ka	2000	2002		$208		Filed		VisionStar Inc.
VITA	LEO	VHF	9/23/97	1998	1998	$3		Yes	http://www.vita.org/	Volunteers in Technical Assistance
VoiceSpan	GEO	Ka		Cancelled	Cancelled			Withdrawn		AT&T

APPENDIX A
TABLE A.2 GROUND SEGMENT

SYSTEM NAME	GES DOWNLINK FREQUENCY	GES UPLINK FREQUENCY	NO. OF GES	GES LOCATION	NCC LOCATION
Aeronautical Inmarsat -C			2	Southbury, CT	Inmarsat HQ, London, UK
Argos			1	Wallaps Island, VA	Largo, MD
Astrolink			100	Worldwide	
Boatracs/ OmniTRACS			2	San Diego, CA; Las Vegas, NV	San Diego, CA
Celestri					
Constellation	5.160 C-Band	6.555 C-Band			
CTA/GEMNET	459-460 MHz	455-456 MHz	3		colocated with US gateway
CyberPath					
CyberStar					Silcon Valley, CA
DirecPC					
E-Sat					
EchoStar					
Ellipso	C-Band	C-Band			
Ellipso 2G	6775-7075 MHz	15400-15700 MHz			
Expressway					
FAISAT			2	Logan, UT; Lanham, MD; Andoya, Norway	Greenbelt, MD
GE*Star			2	GE American	
GE*Star Plus			2	GE American	
GESN					
Globalstar	6875-7055 MHz	5091-5250 MHz	1	Clifton, TX	San Jose, CA
Globalstar GS-40					
Horizons					
ICO	6925-7075 MHz	5100-5250 MHz	1	Brewster, WA	Uxbridge, UK
Inmarsat -A	3600-3623 MHz	6425-6443 MHz	2	Southbury, CT; Santa Paula, CA	Inmarsat HQ, London, UK
Inmarsat -B	3600-3623 MHz	6425-6443 MHz	2	Southbury, CT; Santa Paula, CA	Inmarsat HQ, London, UK
Inmarsat -C	3600-3623 MHz	6425-6443 MHz	2	Southbury, CT; Santa Paula, CA	Inmarsat HQ, London, UK
Inmarsat -M	3600-3623 MHz	6425-6443 MHz	2	Southbury, CT; Santa Paula, CA	Inmarsat HQ, London, UK
Inmarsat Aero H	3600-3623 MHz	6425-6443 MHz	2	Southbury, CT; Santa Paula, CA	Inmarsat HQ, London, UK
Inmarsat Aero I	3600-3623 MHz	6425-6443 MHz	2	Southbury, CT; Santa Paula, CA	Inmarsat HQ, London, UK

APPENDIX A
TABLE A.2 GROUND SEGMENT

SYSTEM NAME	GES DOWNLINK FREQUENCY	GES UPLINK FREQUENCY	NO. OF GES	GES LOCATION	NCC LOCATION
Inmarsat Aero L	3600-3623 MHz	6425-6443 MHz	2	Southbury, CT; Santa Paula, CA	Inmarsat HQ, London, UK
Iridium	19.4-19.6 GHz	29.1-29.25 GHz	1	Tempe, AZ	Leesburg, VA
KaStar					
Leo One			2	SW; SE; Alaska	
M-Star					
Millennium	28.35-28.6 GHz	28.35-28.6 GHz			
Morning Star					
NetSat 28					
Odyssey	19.70-20.20 GHz	29.50-30.00 GHz	11		
ORBCOMM	137.0-138.0 MHz, 400.1 MHz	148.0-150.05 MHz	4	GA; NY; AZ; WA	Dulles, VA
OrbLink					
Orion Network Systems					
Panamsat PAS 10 and PAS 11					
Pentriad			3		
Q/V-Band					
SkyBridge					
SkyCell	10.75-10.95 GHz	13.0-13.15, 13.2-13.25 GHz	1	Reston, VA	Reston, VA
SpaceCast					
Spaceway					
Spectrum Astro Aster					
Starlynx					
Starsys					
Teledesic					
Turbosat					
V-Stream					
VisionStar					
VITA					Arlington, VA; Logan, UT
VoiceSpan					

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	ORBIT TYPE	ORBITAL SLOTS	NO. OF PLANES	INCLINATION (degrees)	SATELLITES PER PLANE	IN ORBIT SPARES
Aeronautical Inmarsat -C	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	
Argos	Polar; Circular			98		0
Astrolink	Geostationary	97 W; 21.5 W; 38 E; 130 E; 175.25 E				
Boatracs/ OmniTRACS	Geostationary					
Celestri	Circular GEO/LEO Hybrid		7/4	48	9/1	7
Constellation	Circular; Equatorial					
CTA/GEMNET	Circular; Polar Circular			50		
CyberPath	Geostationary					
CyberStar	Geostationary	115 W; 28 E; 105.5 E				
DirecPC	Geostationary					
E-Sat	Circular			100.7		
EchoStar	Geostationary					
Ellipso	Elliptical; Equatorial			116.5		
Ellipso 2G	Elliptical; Equatorial		4/1		5/6	
Expressway						
FAISAT	Circular			66; 83		
GE*Star	Geostationary	17 W; 56 E; 114.5 E				
GE*Star Plus	GEO					
GESN	Geostationary; MEO; Circular	GEOs at 113 W; 83 W; 15 E; 112 E	3/4		5/1	
Globalstar	Circular			52		8
Globalstar GS-40	Circular		10	52	8	
Horizons						
ICO	Circular			45		2
Inmarsat -A	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	
Inmarsat -B	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	
Inmarsat -C	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	TOTAL SATELLITES	CIRCUITS/ SATELLITE	BEAMS/ SATELLITE	SATELLITE APOGEE (Km)	SATELLITE PERIGEE	ORBITAL PERIOD (minutes)	AVERAGE VISIBILITY (minutes)
Aeronautical Inmarsat -C	4		6	35786	35786		
Argos	2	4	1	850	850	102	10
Astrolink	9		96 UP/64	35786	35786		
Boatracs/ OmniTRACS	2		16	36000	36000		
Celestri	63			1400	1400	114	
Constellation	46		32	2000	2000	105.3	
CTA/GEMNET	38			1000	1000		
CyberPath	10			35786	35786		
CyberStar	3			35786	35786		
DirecPC	2			35786	35786		
E-Sat	6			1261	1261		102
EchoStar	2		48	35786	35786		
Ellipso	20	3000	61	7846/8063	520/8063	180, 288	41.77
Ellipso 2G	26						
Expressway	14		204V/8Ku	35786	35786		
FAISAT	26-30	28		1000	1000		13/10
GE*Star	9		44	35786	35786		
GE*Star Plus	11		20V/9Ku	35786	35786		
GESN	19			35786/10355	35786/10355		
Globalstar	56	2000-3000	16	1414	1414	113	8.21
Globalstar GS-40	80		30	1440	1440		
Horizons	4		100-200	35786	35786		
ICO	12	4500	163	10355	10355		
Inmarsat -A	4		6	35786	35786		
Inmarsat -B	4		6	35786	35786		
Inmarsat -C	4		6	35786	35786		

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	SATELLITE FOOTPRINT (km)	INTERSAT LINK	INTERSAT FREQUENCY	ONBOARD PROCESSING ?	SATELLITE LIFETIME (Years)	SATELLITE MASS (kg)
Aeronautical Inmarsat -C		No		Yes	13	1300
Argos	5000	No		No		
Astrolink		Yes	54.25-58.2 GHz			
Boatracs/ OmniTRACS	CONUS plus 200 mi	No		No	10	715
Celestri		Yes			36017	3100
Constellation					5	500
CTA/GEMNET		No		Yes	35922	45
CyberPath		Yes	59.0-64.0 GHz	Yes		
CyberStar						
DirecPC						
E-Sat						
EchoStar		Yes	59 GHz E-W			
Ellipso	11960	No		No	5	650
Ellipso 2G						
Expressway		Yes	Optical Laser			
FAISAT	5000	Unknown		Yes	7/10	150
GE*Star						
GE*Star Plus		Yes	Optical Laser			
GESN						
Globalstar	5850	No		No	7.5	450
Globalstar GS-40		No		No		
Horizons						
ICO		No		Yes	12	2000
Inmarsat -A		No		Yes	13	1300
Inmarsat -B		No		Yes	13	1300
Inmarsat -C		No		Yes	13	1300

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	SATELLITE POWER (Watts)	SPACECRAFT TYPE	SATELLITE COST (million $)	LAUNCH VEHICLES
Aeronautical Inmarsat -C	1200	Lockheed Martin GE Series 4000		Atlas Centaur; Proton; Ariane
Argos				
Astrolink		A2100 series bus		
Boatracs/ OmniTRACS	1900			Ariane
Celestri	4.6Kw	Matra Marconi		
Constellation				Khrunichev Proton; Lockheed Martin Atlas 2AS; McDonnell Douglas Delta 2; Ariane
CTA/GEMNET		gravity gradient stabilized		Lockheed LLV1-Orbital Sciences Taurus
CyberPath				
CyberStar				
DirecPC				
E-Sat				Lockheed LLV1
EchoStar				
Ellipso		3-axis stabilized		Ariane; Yuzhnoye
Ellipso 2G				
Expressway				
FAISAT	75			Cosmos; Lockheed LLV1; Pegasus
GE*Star				
GE*Star Plus				
GESN				
Globalstar	2000 peak	Loral 3-axis stabilized		McDonnell Douglas Delta 2; NPO Yuzhnoye Zenit-2; Starsem Soyuz
Globalstar GS-40				
Horizons				
ICO		Hughes HS 601	$108	Lockheed Martin Atlas 2AS; McDonnell Douglas Delta 3; Khrunichev Proton; NPO Yuzhnoye Zenit-2
Inmarsat -A	1200	Lockheed Martin GE Series 4000		Atlas Centaur; Proton; Ariane
Inmarsat -B	1200	Lockheed Martin GE Series 4000		Atlas Centaur; Proton; Ariane
Inmarsat -C	1200	Lockheed Martin GE Series 4000		Atlas Centaur; Proton; Ariane

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	ORBIT TYPE	ORBITAL SLOTS	NO. OF PLANES	INCLINATION (degrees)	SATELLITES PER PLANE	IN ORBIT SPARES
Inmarsat -M	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	
Inmarsat Aero H	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	
Inmarsat Aero I	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	
Inmarsat Aero L	Geostationary	15.5 W; 34.0 W; 55.5 W; 64.5 E; 179.5 W	4		1	
Iridium	Near Polar			86.4		6
KaStar	Geostationary					
Leo One	Circular		8	50	6	
M-Star	Circular		12	47	6	
Millennium	Geostationary	SEE CELESTRI				
Morning Star	Geostationary	62 W; 30 E; 107.5 E				
NetSat 28	Geostationary					
Odyssey	Circular			55		
ORBCOMM	Circular; Inclined, Near Polar		2	4/45	4/32	0
OrbLink	Equatorial		1		7	1
Orion Network Systems	Geostationary	78 E; 89 W; 81 W; 47 W; 126.5 E				
Panamsat PAS 10 and PAS 11	Geostationary	58 W				
Pentriad	Highly Elliptical		3	63	3	3
Q/V-Band						
SkyBridge	Circular		2		32	
SkyCell	Geostationary	101 W	1		1	0
SpaceCast	GEO					
Spaceway	Geostationary	101 W; 99 W; 49 W; 25 E; 54 E; 101 E; 111 E 164; 36 E; 40 E; 124.5 E; 173 E				
Spectrum Astro Aster	Geostationary					
Starlynx	Circular; Geostationary		1/4		20/1	
Starsys						
Teledesic	Polar Circular		12		24	
Turbosat	Geostationary					
V-Stream	Geostationary					

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	TOTAL SATELLITES	CIRCUITS/ SATELLITE	BEAMS/ SATELLITE	SATELLITE APOGEE (Km)	SATELLITE PERIGEE	ORBITAL PERIOD (minutes)	AVERAGE VISIBILITY (minutes)
Inmarsat -M	4		6	35786	35786		
Inmarsat Aero H	4		6	35786	35786		
Inmarsat Aero I	4		6	35786	35786		
Inmarsat Aero L	4		6	35786	35786		
Iridium	72	1100	48	950	950	100.13	5.54
KaStar	4		48	35786	35786		
Leo One	48	4		950	950	104	7
M-Star	72			1350	1350		
Millennium	4			35786	35786		
Morning Star	4			35786	35786		
NetSat 28	1		1000				
Odyssey	12	3000	37	10354	10354	360	47.27
ORBCOMM	36			825/825	825/825		10
OrbLink	7		100	9000	9000		
Orion Network Systems	3		27	35786	35786		
Panamsat PAS 10 and PAS 11	3			35786	35786		
Pentriad	9						
Q/V-Band	9						
SkyBridge	64		45	1457	1457		
SkyCell	1	5000	6	35786	35786		
SpaceCast	6		204 V/16Ku	35786	35786		
Spaceway	21	230400		35786	35786		
Spectrum Astro Aster	25		58				
Starlynx	24			35786	35786		
Starsys	24						
Teledesic	288	100000		720	720		
Turbosat				35786	35786		
V-Stream	12		163	35786	35786		

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	SATELLITE FOOTPRINT (km)	INTERSAT LINK	INTERSAT FREQUENCY	ONBOARD PROCESSING ?	SATELLITE LIFETIME (Years)	SATELLITE MASS (kg)
Inmarsat -M		No		Yes	13	1300
Inmarsat Aero H		No		Yes		
Inmarsat Aero I		No		Yes		
Inmarsat Aero L		No		Yes		
Iridium	4700	Yes	23.18-23.38 GHz	Yes	5-8	689
KaStar			Microwave			
Leo One	3944	No		Yes	5-8	154
M-Star						
Millennium		Yes	59.5-60.5 GHz			
Morning Star						
NetSat 28						
Odyssey	10540	No		No	10	1917
ORBCOMM	4800	No		No	4	38.5
OrbLink		Yes	65.0-71.0 GHz			
Orion Network Systems				Yes		
Panamsat PAS 10 and PAS 11						
Pentriad		No		No		
Q/V-Band		Yes	54.25-58.2 GHz	Yes		
SkyBridge	3000				8	800
SkyCell		No		No	12	
SpaceCast		Yes	Optical Laser			
Spaceway		Yes			15	
Spectrum Astro Aster		Yes	Optical Laser	No		
Starlynx						
Starsys						
Teledesic	100	Yes	59.5-60.5 GHz	Yes		
Turbosat						
V-Stream						

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	SATELLITE POWER (Watts)	SPACECRAFT TYPE	SATELLITE COST (million $)	LAUNCH VEHICLES
Inmarsat -M	1200	Lockheed Martin GE Series 4000		Atlas Centaur; Proton; Ariane
Inmarsat Aero H				
Inmarsat Aero I				
Inmarsat Aero L				
Iridium		Lockheed Martin body stabilized	$500	McDonnell Douglas Delta 2; Khrunichev Proton; China Great Wall Long March 2
KaStar				
Leo One				McDonnell Douglas Delta 2; Pegasus; China Great Wall Long March 2; Lockheed LLV1; Cosmos
M-Star				
Millennium				
Morning Star				
NetSat 28				
Odyssey	3126	TRW AB940		Ariane 4- Atlas 2
ORBCOMM	160	Orbital	$1	Pegasus XL; Taurus
OrbLink				
Orion Network Systems	32*60W			
Panamsat PAS 10 and PAS 11				
Pentriad				
Q/V-Band				
SkyBridge	2500	Alcatel 1633 SX		McDonnell Douglas Delta 2; Ariane; Lockheed Martin Atlas 2AS; Khrunichev Proton; Starsem Soyuz
SkyCell	56.6 dBW	Hughes HS601		
SpaceCast				
Spaceway		HS702		
Spectrum Astro Aster				
Starlynx				
Starsys				
Teledesic				
Turbosat				
V-Stream				

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	ORBIT TYPE	ORBITAL SLOTS	NO. OF PLANES	INCLINATION (degrees)	SATELLITES PER PLANE	IN ORBIT SPARES
VisionStar	Geostationary					
VITA	Near Polar		1	83		
VoiceSpan	Geostationary	55 W; 2 E; 42 E; 97 E; 116.5 E				

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	TOTAL SATELLITES	CIRCUITS/ SATELLITE	BEAMS/ SATELLITE	SATELLITE APOGEE (Km)	SATELLITE PERIGEE	ORBITAL PERIOD (minutes)	AVERAGE VISIBILITY (minutes)
VisionStar	1			35786	35786		
VITA	2			1000	1000	105	10
VoiceSpan	12			35786	35786		

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	SATELLITE FOOTPRINT (km)	INTERSAT LINK	INTERSAT FREQUENCY	ONBOARD PROCESSING ?	SATELLITE LIFETIME (Years)	SATELLITE MASS (kg)
VisionStar						
VITA	4800	No			5	
VoiceSpan						

APPENDIX A
TABLE A.3 SPACE SEGMENT

SYSTEM NAME	SATELLITE POWER (Watts)	SPACECRAFT TYPE	SATELLITE COST (million $)	LAUNCH VEHICLES
VisionStar				
VITA				Polyot; Cosmos
VoiceSpan				

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	MASK ANGLE	MAXIMUM PROPAGATION DELAY (ms)	MINIMUM PROPAGATION DELAY (ms)	MOBILE DOWNLINK FREQUENCY	MOBILE UPLINK FREQUENCY	MULTIPLEXING SCHEME	MONTHY COST ($)	PER MINUTE COSTS ($)	BILLING INCREMENT
Aeronautical Inmarsat -C	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz			.25/32 bytes	
Argos	10	16	3		401.65 MHz				
Astrolink	10	287	120	19.7-20.2 GHz	28.35-28.6; 29.5-30 GHz				
Boatracs/ OmniTRACS	10	691	120	11.7-12.7 GHz	14-14.5 GHz	CDMA	$40	.002	character plus .05/ message
Celestri	10	27	5	18.8-19.3, 19.7-20.2 GHz	28.6-29-1, 29.5-30.0 GHz				
Constellation	10	39	7	2483.5-2500.0 MHz	1616.0-1626.5 MHz	CDMA			
CTA/GEMNET	10	19	3	459-460 MHz	455-456 MHz				
CyberPath	10	687	120	40.5-41.5 GHz	49.2-50.2 GHz	TDM/FDM/CDMA			
CyberStar	10	687	120	18.35-18.6 and 19.7-20.2 GHz	28.35-28.6 and 29.5-30 GHz	FDM/TDMA Uplink TDN			
DirecPC	10	687	120	11.7-12.2 GHz	N/A		$10-$130	$3.95/$4.95	Hour
E-Sat	10	24	4						
EchoStar	10	687	120	19.7-20.2 GHz	29.5-30.0 GHz				
Ellipso	10	151	2	2483.5-2500 MHz	1610-1626.5 MHz	CDMA	$35	.50	min
Ellipso 2G	10	0		2.165 GHz	2.200 GHz	CDMA			
Expressway	10	687	120	39.5-42.5 GHz	47.2-50.2 GHz				
FAISAT	10	20	2	137-138 MHz	148-150.5 MHz, 450-460 MHz	GMSK			
GE*Star	10	687	120	18.55-18.8;19.45-20.2 GHz	28.35-28.6;29.25-30 GHz				
GE*Star Plus	10	687	120	39.5-42.5; 10.5-12.75 GHz	47.2-50.2; 12.75-14.5 GHz	FDM			
GESN	30	69	34		37.5-50.2 GHz				
Globalstar	10	27	5	2483.5-2500.0 MHz	1610-1621.35 MHz	CDMA/FDMA		.35-.53	minute
Globalstar GS-40	10	28	4.8	37.5-38.5 GHz	48.2-49.2 GHz	TDMA			
Horizons	10	687	120						
ICO	10	199	35	2.170-2.200 GHz	1.980-2.010 GHz	TDMA		2.00	
Inmarsat -A	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz	FDMA		$3.00-8.00	minute
Inmarsat -B	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz	FDMA		3.50-5.50	minute
Inmarsat -C	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz	FDMA		.25/32 bytes	
Inmarsat -M	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz	FDMA		$2-$6.00	
Inmarsat Aero H	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz	FDMA			

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	POSITIONING	NO. TERMINAL MAKERS	TERMINAL MAKERS	TERMINAL COST ($)	TERMINAL WEIGHT (gm)	TERMINAL XMT POWER (watts)	TERMINAL BATTERY LIFE	TERMINAL ANTENNA TYPE
Aeronautical Inmarsat -C	yes (GPS)	4	Thrane & Thrane; 25 manufacturers; 10 marine	$ 4,000.00				Tracking or ro
Argos	Doppler, GPS also available	2			30-300	.25-.9	low	whip, flat
Astrolink								
Boatracs/ OmniTRACS	2 satellite triangulation, optional GPS	2	Qualcomm	$ 4,000.00	3175	1	60	azimuth tracking, fixed elevation
Celestri								
Constellation								
CTA/GEMNET				$ 500.00				
CyberPath								
CyberStar			Adaptec					.9 m dish
DirecPC	No			$ 300.00				21in elliptical dish VSAT
E-Sat			Seimac, Ltd.					
EchoStar								
Ellipso	Yes			$ 1,000.00				
Ellipso 2G	yes							
Expressway								2.5 m
FAISAT		2						
GE*Star								
GE*Star Plus								2.5 m
GESN								2 m
Globalstar	Yes (self plus GPS). 10Km spec.	0	QUALCOMM; Ericsson OMC Ltd.; TELITAL S.r.l.	$ 750.00	350	.5	8/1	Omni whip 1-1.5 dB gain
Globalstar GS-40								
Horizons				$ 1,000.00				A4 Flat Plate
ICO		0		$ 1,000.00	300-3000	.625	1	10 cm whip
Inmarsat -A	no	4	Numerous	$ 25,000.00	heavy	40	n/a	Parabolic Tracking (1m)
Inmarsat -B	no	4	7 of land mobile; 3 of marine	$ 30,000.00	heavy		n/a	Parabolic Tracking (1m)
Inmarsat -C	yes (GPS)	4	Thrane & Thrane; 25 manufacturers; 10 marine	$ 4,000.00				Tracking or rod
Inmarsat -M	no	4	Thrane & Thrane; 25 manufacturers; 10 marine	$5000-$15000	3000	14 dbW		Tracking or rod
Inmarsat Aero H				$ 250,000.00				

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	TERMINAL MODULATION TYPE	VOICE CODING	VOICE RATE (kb/s)	DATA RATE (kb/s)
Aeronautical Inmarsat -C				.6
Argos				1.2
Astrolink				2000-15500 UP/DN
Boatracs/ OmniTRACS	DSSS			.6
Celestri				
Constellation			4.8	2.4
CTA/GEMNET				4.8 UP 4800 DN
CyberPath				3.088-6 UP/DN
CyberStar				384-30,000 UP 92000 DN
DirecPC				.4
E-Sat				
EchoStar				1544 UP/DN
Ellipso	OQPSK	IMBE	4.8	9.6
Ellipso 2G				64 UP 64,000 DN
Expressway				T1-OC3 UP/DN
FAISAT				19.2 UP 128 DN
GE*Star				40000 UP/DN
GE*Star Plus				155000 UP/DN
GESN				1500-3000
Globalstar	QPSK	PN/QPSK	2.4	9.6
Globalstar GS-40				2.048-51.84 UP/DN
Horizons				144 UP/DN
ICO		QPSK	4800	38.4
Inmarsat -A	FM	N/A		9.6 UP/DN
Inmarsat -B		APC	16	9.6 UP/DN
Inmarsat -C				.6 UP/DN
Inmarsat -M		IMBE	6.4	2.4 UP/DN
Inmarsat Aero H				10.5

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	MASK ANGLE	MAXIMUM PROPAGATION DELAY (ms)	MINIMUM PROPAGATION DELAY (ms)	MOBILE DOWNLINK FREQUENCY	MOBILE UPLINK FREQUENCY	MULTIPLEXING SCHEME	MONTHY COST ($)	PER MINUTE COSTS ($)	BILLING INCREMENT
Inmarsat Aero I	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz	FDMA			
Inmarsat Aero L	10	687	120	1525.0-1559.0 MHz	1626.5-1660.5 MHz	FDMA			
Iridium	10	15	3	1621.35-1626.5 MHz	1621.35-1626.5 MHz	TDMA/FDMA		3.00	
KaStar	10	687	120	19.2-19.7 GHz	29.0-29.5 GHz				
Leo One	10	18	3	137-138 MHz, 400.15-401 MHz	148.905-150.05 MHz				
M-Star	10	26	5	37.5-40.5 GHz	47.2-50.2 GHz				
Millennium	10	687	120	18.55-18.8 GHz	29.5-30 GHz	FDM/TDMA			
Morning Star	10	687	120						
NetSat 28	10			18.55-18.8; 19.7-20.2 GHz	28.35-28.6; 29.25-30 GHz				
Odyssey	22	92	35	2.4835-2.4985 GHz	1.610.0-1.62135.5 GHz	CDMA-FDMA	$24	.75	minute
ORBCOMM	10	15	3	137-138 MHz	148-150.5 MHz				
OrbLink	10	173	30	47.7-48.7 GHz	37.5-38.5 GHz				
Orion Network Systems	10	687	120	19.7–20.2 GHz	28.35–28.6 ; 29.25–30.0 GHz	FDMA uplink TDM downlink			
Panamsat PAS 10 and PAS 11	10	687	120	18.55-18.8; 19.45-20.2 GHz	28.35-28.6; 29.25-30.0 GHz				
Pentriad	10			37.5-38.5; 40.5-41.5 GHz	47.2-50.2 GHz				
Q/V-Band	10	687	120	39.5-42.5; 37.5-39.5 GHz	47.2-50.2 GHz	TDMA/FDMA; TDM down			
SkyBridge	10	28	5	12-15 GHz	12-15 GHz				
SkyCell	10	687	120	1530.0-1559.0 MHz	1631.5-1660.5 MHz		25-45	1.50-1.99	6 sec?
SpaceCast	10	687	120	39.5-42.5 GHz	47.2-50.2 GHz	FDM			
Spaceway	10	687	120	17.7-20.2 GHz	27.5-30.0 GHz				
Spectrum Astro Aster	10					TDMA			
Starlynx	10	687	120	37.5-38.5 GHz	45.5-46.7 GHz	CDMA/FDMA			
Starsys	10								
Teledesic	40	4	2.4	18.8-19.3 GHz	28.6-29.1 GHz				
Turbosat	10	687	120						
V-Stream	10	687	120	39.5-42.5 GHz	47.2-50.2 GHz				
VisionStar	10	687	120	19.7-20.2 GHz	28.35-28.6; 29.25-30.0 GHz				

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	POSITIONING	NO. TERMINAL MAKERS	TERMINAL MAKERS	TERMINAL COST ($)	TERMINAL WEIGHT (gm)	TERMINAL XMT POWER (watts)	TERMINAL BATTERY LIFE	TERMINAL ANTENNA TYPE
Inmarsat Aero I				$ 50,000.00				
Inmarsat Aero L								
Iridium	Yes	44	Kyocera; Scientific Atlanta	$ 3,000.00		.45		Whip
KaStar								
Leo One				$100-$500		7		
M-Star								
Millennium								
Morning Star								
NetSat 28								1 m
Odyssey		0	Nortel	$ 300.00		.8		quadrifilsr helix omnidirectional
ORBCOMM	inherent, doppler plus enhanced using GPS	10	Panasonic; Scientific Atlanta; Magellan; Torrey Science; Elisra	$250-$1500	300	5		50cm whip
OrbLink								
Orion Network Systems								0.7 m –1.2 m, 6m
Panamsat PAS 10 and PAS 11								
Pentriad								
Q/V-Band								.45 m
SkyBridge						2		18Ó tracking for residential
SkyCell		1	Westinghouse Electric (land, marine); Mitsubishi Electric (land, marine); Trimble Navigation (mobile data terminals); KVH TracPhone (marine); CALS (aeronautical)	2500-15000	2000			Mast (omni) or dome (tracking)
SpaceCast								.45-1.2 m RO
Spaceway				$ 1,000.00				.66m dish
Spectrum Astro Aster								1.2-5 m in regional beams
Starlynx	GPS OPTIONAL							.3m square, flat panel
Starsys								
Teledesic								.3m dish antennas
Turbosat								.47 M-64 kbps
V-Stream								
VisionStar								

TABLE A.4 USER SEGMENT

SYSTEM NAME	TERMINAL MODULATION TYPE	VOICE CODING	VOICE RATE (kb/s)	DATA RATE (kb/s)
Inmarsat Aero I			2400	4.8
Inmarsat Aero L				1.2
Iridium	DQPSK	DQPSK	2.4	2.4
KaStar				
Leo One				24 UP 2.4-9.6 DN
M-Star				
Millennium				
Morning Star	QPSK			64 UP 3000 DN
NetSat 28				1544 UP/DN
Odyssey	QPSK	QPSK	4800	9.6
ORBCOMM	Symmetric DPSK			2.4 UP 4.8 DN
OrbLink				1500-1,500,000 UP/DN
Orion Network Systems				1,544 UP 90,000 DN
Panamsat PAS 10 and PAS 11				56-45000 UP/DN
Pentriad				10000-3875 UP/DN
Q/V-Band				384-9200 UP 9600 DN
SkyBridge				2,000 UP 20,000 DN
SkyCell		IMBE	2400	4.8
SpaceCast	PCM/DQPSK			155,000 UP/DN
Spaceway		QPSK	16000	16 UP 6000 DN
Spectrum Astro Aster				2000-622,000
Starlynx	QPSK			4-8,000 UP/DN
Starsys				
Teledesic			16000	2,000 UP 64,000 DN
Turbosat	CDMA			2000-20000 UP 17000 DN
V-Stream				1.344-155 UP/DN
VisionStar				

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	MASK ANGLE	MAXIMUM PROPAGATION DELAY (ms)	MINIMUM PROPAGATION DELAY (ms)	MOBILE DOWNLINK FREQUENCY	MOBILE UPLINK FREQUENCY	MULTIPLEXING SCHEME	MONTHY COST ($)	PER MINUTE COSTS ($)	BILLING INCREMENT
VITA	10	20	3.3	400.505-400.595 MHz	149.81-149.9 MHz		$50		
VoiceSpan	10	687	120						

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	POSITIONING	NO. TERMINAL MAKERS	TERMINAL MAKERS	TERMINAL COST ($)	TERMINAL WEIGHT (gm)	TERMINAL XMT POWER (watts)	TERMINAL BATTERY LIFE	TERMINAL ANTENNA TYPE
VITA				$ 300.00				RHCP
VoiceSpan								

APPENDIX A
TABLE A.4 USER SEGMENT

SYSTEM NAME	TERMINAL MODULATION TYPE	VOICE CODING	VOICE RATE (kb/s)	DATA RATE (kb/s)
VITA				9.6
VoiceSpan				1544

APPENDIX A
TABLE A.5 MARKETS AND SERVICES

SYSTEM NAME	SERVICE TYPE	SERVICES	TARGET MARKETS	SERVICE DISTRIBUTION
Aeronautical Inmarsat -C	Data only	Data; Fax; Fax		
Argos	Data only			
Astrolink	Broadband	Digital Voice; Data; Multimedia; High Speed Data	Multi-national Corporations	
Boatracs/ OmniTRACS	Data only	Data; Positioning	Commercial Vehicles; Government; tracking; messaging	Direct
Celestri	Broadband	High Speed Data		
Constellation	Voice/Data	Digital Voice; Data; Fax		Authorized Service Providers
CTA/GEMNET	Data only	Paging; Data	tracking; monitoring; messaging	Non-common carrier
CyberPath	Broadband			
CyberStar	Broadband			
DirecPC	Broadband			
E-Sat	Data only		monitoring; messaging	Non-common Carrier
EchoStar	Broadband			
Ellipso	Voice/Data	Digital Voice; Fax; Paging; Messaging Services; Data; Advanced Calling Services	International Travelers; Rural Telephone; Commercial Vehicles; Government	
Ellipso 2G	Voice/Data	Data		
Expressway	Broadband			
FAISAT	Data only	Data	monitoring; tracking; messaging; data acquisition	Non-common Carrier
GE*Star	Broadband			
GE*Star Plus	Broadband			
GESN	Broadband			
Globalstar	Voice/Data	Digital Voice; Data; Messaging Services; Fax; Positioning; Paging	Cellular Fill-in; Rural Telephone; Commercial Vehicles; General Aviation; Maritime; International Travelers	In-country Service Providers
Globalstar GS-40	Broadband			
Horizons	Broadband			

APPENDIX A
TABLE A.5 MARKETS AND SERVICES

SYSTEM NAME	SERVICE TYPE	SERVICES	TARGET MARKETS	SERVICE DISTRIBUTION
ICO	Voice/Data	Digital Voice; Data; Fax; Messaging Services; Advanced Calling Services	Cellular Fill-in; International Travelers; Government; Commercial Vehicles; Rural Telephone; Rural Telephone; Maritime	Authorized Service Providers
Inmarsat -A	Voice/Data	Analog Voice; Data; Fax; High Speed Data		
Inmarsat -B	Voice/Data	Digital Voice; Data; Fax; High Speed Data		
Inmarsat -C	Data only	Data; Fax; Fax		
Inmarsat -M	Voice/Data	Digital Voice; Data; Fax		
Inmarsat Aero H	Voice/Data	Digital Voice; Data		
Inmarsat Aero I	Voice/Data	Digital Voice; Data; Fax		
Inmarsat Aero L	Data only	Data; Data		
Iridium	Voice/Data	Digital Voice; Data; Fax; Paging; Advanced Calling Features	International Travelers; General Aviation; Rural Telephone; Government; Corporate/industrial	In-country Service Providers
KaStar	Broadband			
Leo One	Data only	Data/Paging	monitoring; messaging; tracking; e-mail; Maritime; Commercial Vehicles	Non-common Carrier
M-Star	Broadband			
Millennium	Broadband			
Morning Star	Broadband			
NetSat 28	Broadband			
Odyssey	Voice/Data	Digital Voice; Data; Fax; Paging		
ORBCOMM	Data only	Data; Paging; Messaging Services; Positioning	tracking; messaging; monitoring	Local resellers
OrbLink	Broadband			
Orion Network Systems	Broadband			
Panamsat PAS 10 and PAS 11	Broadband			
Pentriad	Broadband			
Q/V-Band	Broadband			
SkyBridge	Broadband	Digital Voice; High Speed Data; Fax; VTC; Multimedia; Internet Access	Broadband Local Loop; Infrastructure links; telemed/teletraining	Local resellers

APPENDIX A
TABLE A.5 MARKETS AND SERVICES

SYSTEM NAME	SERVICE TYPE	SERVICES	TARGET MARKETS	SERVICE DISTRIBUTION
SkyCell	Voice/Data	Digital Voice; Data; Fax; Messaging Services; Voice Dispatch Groups		Authorized Service Providers
SpaceCast	Broadband			
Spaceway	Broadband	High Speed Data/Digital Voice		
Spectrum Astro Aster	Broadband			
Starlynx	Broadband			
Starsys	Voice/Data			
Teledesic	Broadband	High Speed Data		Authorized Service Providers
Turbosat	Broadband			
V-Stream	Broadband			
VisionStar	Broadband			
VITA	Data only	Data; Messaging Services	Nonprofit; International Humanitarian Services	Direct
VoiceSpan	Broadband			