

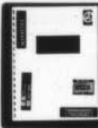
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COMMUNICATIONS SATELLITE CHARACTERISTICS MATRIX. ADDENDUM (U)  
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DEFENSE COMMUNICATIONS AGENCY

ADDENDUM TO THE COMMUNICATIONS SATELLITE CHARACTERISTICS MATRIX

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## SECTION 1 - INTRODUCTION

This Addendum to the Communications Satellite Characteristics Matrix revises and supplements the information contained in Reference 11. The purpose of the document is to provide a comprehensive overview of communications satellite program development throughout the world. The data included represents the most accurate and up-to-date information available at the time of publication.

The program parameters are presented in tabular form and relate to operational communications satellites now in orbit and future satellites to be launched in the 1976 to 1981 time frame.

## SECTION 2 - PROGRAM DATA

### 2.1 NEW INPUTS

Those communications satellite programs, not mentioned in earlier reports, include:

- DSCS II Satellites 7-18
- DSCS III
- Fltsatcom
- LES-8/9
- LES-10
- U.S. Military Comsats
- Arabsat
- Palapa
- Molniya 3
- Cosmos
- Brazilsat
- Satellite Business Systems
- Aerosat
- Japansats
- OSCAR 7
- Intelsat V
- Telsat -2
- AT&T
- Iranian Sat

### 2.2 SUMMARY

DSCS II Satellites 7-18: satellites 7 and 8 are to be launched in March 1977. Each dual launch thereafter will take place at 6-month intervals. Satellites 13-18 will have 40W TWTAs and one NB antenna will be defocused to provide AC. The DSCS will be employed in conjunction with terrestrial facilities to provide the global Defense Communications System (DCS) with a flexible and diversified transmission capability required to enhance survivability under war conditions by alternate routing. It will provide a unique and cost-effective way to meet the increasing demands for secure wideband communications.

DSCS III: intended to replace the DSCS II satellites, the DSCS III satellites will be three-axis stabilized, employ multiple beam antennas, and have a lifetime goal of 10 years. The Deputy Secretary of Defense has stated that, when the DSCS approaches full operational capability in 1979, it should be recognized as a primary transmission subsystem of the DCS. The DSCS III may be launched using the Space Shuttle, permitting a 15-foot S/C diameter versus the 10-foot present S/C diameter.

Fltsatcom: will provide worldwide high priority UHF communications between naval A/C, ships, submarines, ground stations, the Strategic Air Command and the Presidential command networks. This system will be hardened against nuclear radiation.

LES-8/9: a dual launch configuration designed to realistically test, in orbit, advanced devices and techniques developed by Lincoln Laboratories for possible use in satellite communications systems.

LES-10: a tentative design by Lincoln Laboratories for possible use in satellite communications systems.

U.S. Military Comsats: currently in the planning stage, this program will operate at an uplink frequency of 30-31 GHz and at a downlink frequency of 20.2-21.2 GHz.

Arabsat: designed to meet the telecommunications requirements of Arab League members and other Arabic-speaking states in North Africa and the Middle East. Currently in the planning stage, this system will operate at C-band (4/6 GHz).

Palapa: currently in launch preparation and development, this system will provide a low cost national Indonesian communications network to assist in a program of economic development.

Molniya 3: an updated version of Molnias 1 and 2, this Soviet system provides video and multichannel radio communications from highly elliptical orbits. These S/C form part of the Washington - Moscow Hot Line.

Cosmos: a Soviet military comsat system providing communications from elliptical orbits. One launch vehicle normally places 8 S/C in orbit.

Brazilsat: currently in the planning stage, this program will provide domestic satellite communications from geostationary orbits.

Satellite Business Systems: formed by an agreement between COMSAT General Corporation, International Business Machines, and Aetna Casualty and Surety Company. Currently in the planning stage, this program will provide domestic satellite communications with an antenna coverage pattern weighted to present greater power to the eastern CONUS.

Aerosat: designed to facilitate the introduction of improved air traffic services over the oceans, this program will have a 7-year lifetime with the first launch scheduled for late 1978.

Japansats: sponsored by NASDA, this program includes the BSE (S-band and  $K_u$  - band), the CS (C-band and  $K_a$  -band), the CCS ( $K_a$  -band), the ECS (34/31 GHz) and ETS II (X-band and K-band).

OSCAR 7: a radio comsat for amateur use. The acronym OSCAR stands for "Orbital Satellite Carrying Amateur Radio."

Intelsat V: currently in the planning stage, this program will operate at C-band and at  $K_u$  - band.

Telsat-2: the next generation of Canadian comsats, this program will operate at C-band and  $K_u$  -band.

AT&T: not to be confused with AT&T's COMSTAR system, this planned program will operate at  $K_a$ -band.

Iranian Sat: a planned communications satellite system to operate at C-band.

### 2.3 MATRICES

The Communications Satellite Characteristics Matrices, updated through September 1976, are contained in Tables 2-1 through 2-3.

Table 2-1. U.S. Government Sponsored Communications

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
DSCS II (F-3)	DOD/SAMSO; TRW	12/13/1973; Titan III C	1250	Geo-synchronous; 5 year design life; 3.2 year mean mission duration (MMD)	Spin with hydrazine jets	Solar array; 3 Ni-Cd batteries	520 W BOL; 390 W EOL; full eclipse capability	13° W + 3° E-W; 0.7°	Single conversion multi-channel cross-strapped repeaters. Each of 4 channels operate in linear, semi-linear, or hard-limiting modes.	Uplink: CH 1 from 7.975 to 8.1 GHz; CH 2 from 8.125 to 8.175 GHz; CH 3 from 8.215 to 8.4 GHz; CH 4 from 7.9 to 7.95 GHz. Downlink: CH 1 from 7.25 to 7.375 GHz; CH 2 from 7.4 to 7.45 GHz; CH 3 from 7.49 to 7.675 GHz; CH 4 from 7.7 to 7.75 GHz. TT & C at S-band.	CH 1: 125 MHz CH 2: 50 MHz CH 3: 185 MHz CH 4: 50 MHz 410 MHz usable BW
DSCS II (F-4)								175° E ± 3° E-W; 0.7°			
DSCS II (F-7/8)		3/77; Titan III C	1294					May replace F-3 and F-4; may be located at 13° W, 172° E, 135° W, or 60° E to provide 4- satellite DSCS			
DSCS II (F-9/10)		6/77; Titan III C									
DSCS II (F-11/12)		3/78; Titan III C									

Table 2-1. U.S. Government Sponsored Communications Satellites

2

nt Sponsored Communications Satellite Characteristics

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
The conventional multi-channel cross-linked repeaters. Each channel operates in linear, semi-linear, or hard limiting modes.	Uplink: CH 1 from 7.975 to 8.1 GHz; CH2 from 8.125 to 8.175 GHz; CH 3 from 8.215 to 8.4 GHz; CH 4 from 7.9 to 7.95 GHz. Downlink: CH 1 from 7.25 to 7.375 GHz; CH 2 from 7.4 to 7.45 GHz; CH 3 from 7.49 to 7.675 GHz; CH 4 from 7.7 to 7.75 GHz. TT & C at S-band.	CH 1: 125 MHz and CH 2: 50 MHz; CH 3: 185 MHz; CH 4: 50 MHz, 410 MHz usable BW	7.2501 and 7.6751 GHz	2 EC horns, 18° BW, 17 dB gain at beam edge. 2 NB parabolic steerable dishes, 2.5° BW, 33 dB gain at beam edge. 1 S-band TT&C bicone antenna, 32° toroidal beam, 3 dB peak gain. Xmit LHCP, receive RHCP.	2-20 W TWTA's. TWTA driver	28 dBW in EC mode; 43 dBW in single NB mode; 40 dBW in dual NB mode	-16.9 dB/°K in CH 1 and CH 4; -4.4 dB/°K in CH 2 and CH 3	Occasionally non-operable due to despin bearing problem	1300 duplex audio channels, or up to 100 Mbps data	CH 1 is EC-EC; CH 2 is NB-EC; CH 3 is NB-NB; CH 4 is EC-NB. See Ref. (3), (5), (6), (7), (19), (39)
								In operation		
				S/A DSCS II (F - 3/4) except that 1 NB (2.4°) antenna will be defocused to provide broadened NB pattern. This is called AC or defocused narrow coverage (DNC)		S/A DSCS II (F-3/4) except 28.5 dBW for AC at 6° BW in dual NB/AC mode	S/A DSCS II (F-3/4) except -10.7 dB/°K for AC	In manufacture		

Table 2-1. U.S. Government Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
DSCS II (F-13 through F-18)	DOD/SAMSO; TRW	At 6-month intervals following launch of F-11/12	1360	s/a F-3	s/a F-3	s/a F-3	s/a F-3	s/a F-7	s/a F-3	s/a F-3	s/a F-3
DSCS III	DOD/SAMSO; TBD (See Notes)	Engineering Development Models (EDM's) to fly in 1979; flight models operational in 1981. Titan III C or Space Transport System (STS)	Approx 2000	Geo-synchronous; 7 years with design goal of 10 yrs, MMD of 6 years with 1/2 of communications capability still operable	3-axis with hydrazine jets	Solar array; Ni-Cd batteries	800 W BOL; full eclipse capability	DSCS II locations; $\pm 0.5^\circ$ E-W and N-S station-keeping	6-channel repeater operating in linear, semi-linear or saturating modes. Redundant local oscillator	S/A DSCS II; receives from 7.9 to 8.4 GHz; transmits from 7.25 to 7.75 GHz. TT&C at X- and S-band	CH 1: 60 MHz; CH 2: 60 MHz; CH 3: 70 MHz; CH 4: 60 MHz; CH 5: 60 MHz; CH 6: 50 MHz

2

nt Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
F-3	s/a F-3	s/a F-3	s/a F-3	s/a F-7	2-40W TWTA's	Single antenna mode: 31 dBW for EC; 46 dBW for NB; 34.5 dBW for AC. Dual antenna mode: 31 dBW for EC; 40 dBW for NB; 33 dBW for AC	S/A F-7	In development	Greater than F-3	s/a F-3
Channel re- r operat- a linear, -linear or ating s. Redun- local os- tor	S/A DSCS II; reves from 7.9 to 8.4 GHz; xmits from 7.25 to 7.75 GHz. TT&C at X- and S-band	CH 1: 60 MHz; CH 2: 60 MHz; CH 3: 70 MHz; CH 4: 60 MHz; CH 5: 60 MHz; CH 6: 50 MHz	Located between CH 4 & CH 5; also carries X-band telemetry	4-EC horns; 1-61 element beam antenna (MBA); 2-19 element xmit MBA's; design goal of 1-37 element or 2-37 element xmit MBA's	6-10 W TWTA's; 3 to 4 40 W TWTA's	CH 1 and CH 2: 29 dBW in EC mode, 39 dBW in 1/2° spot mode; CH 3 and CH 4: 23 dBW in EC mode, 33 dBW in 1/2° spot mode; ... see notes	-15 dB/°K for EC; -16 dB/°K for MBA EC mode; -1 dB/°K for 1/2° spot	In technical competition		Manufacturer TBD by 2/77; HAC or G. E. technical competition. ..... EIRP (cont'd) CH 3, CH4, CH5, and CH6: 25 dBW through EC antenna ..... See Ref. (1), (2), (6)

Table 2-1. U.S. Government Sponsored Communications Satellite (C)

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS			
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon
NATO IIIA	DoD/NATO; Aero-nutronic Ford	4/22/1976; Thor-Delta 2914 (AKM)	1540; 774	Geo-syn-chronous; 7 years	Spin; hydra-zine jets	Solar array; 3 Ni-Cd batteries	538 W BOL; 421 W EOL; full eclipse capability	18° W ± 0.3 E-W and ± 0.4° N-S	Single conver-sion transpon-ders. Redun-dant active units	Uplink: CH1 from 7.975 to 7.992 GHz; CH2 from 8.077 to 8.162 GHz; CH3 from 8.002 to 8.052 GHz. Downlink: CH1 from 7.25 to 7.267 GHz; CH2 from 7.352 to 7.437 GHz; CH3 from 7.277 to 7.327 GHz. Tele-metry from 2.2 to 2.3 GHz. Command from 1.76 to 1.84 GHz.	CH1: 17 MHz; CH2: 85 MHz; CH3: 50 MHz	7.34 GHz; 6.5 dBW
NATO IIIB		12/1976; Thor-Delta 2914 (AKM)						17°W to 20°W ± 0.3° E-W and ± 0.4° N-S				
NATO IIIC		1979; Thor-Delta 2914 (AKM)						15°W to 20°W ± 0.3° E-W and ± 0.4° N-S				

2

Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA			
Location System	Repeater and TT&C Frequencies	RF Channel Band- width	Beacon	Antenna	Power Ampli- fier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes	
Non- respon- sive	Uplink: CH1 from 7.975 to 7.992 GHz; CH2 from 8.077 to 8.162 GHz; CH3 from 8.002 to 8.052 GHz. Downlink: CH1 from 7.25 to 7.267 GHz; CH2 from 7.352 to 7.437 GHz; CH3 from 7.277 to 7.327 GHz. Tele- metry from 2.2 to 2.3 GHz. Command from 1.76 to 1.84 GHz.	CH1: 17 MHz; CH2: 85 MHz; CH3: 50 MHz	7.34 GHz at 6.5 dBW	2 EC horns, 15° x 12° beamwidth, 19.3dB peak xmit gain, 18.5dB peak reve gain. 1 NB horn, 7.5° beamwidth, 27.5 dB peak gain for xmit and reve. TT&C ring array. Circular polarization.	4-22W TWTA's	CH1: 35dBW; CH2: 35dBW; CH3: 29dBW	-14.1 dB/K	In oper- ation	Audio, TTY, facsimile and data on 3 simultan- eous inde- pendent channels	CH1: NB; CH2: NB; CH3: WB. See Ref. (5), (9), (19), (46)	
								In launch prepara- tion			On loan to U. S. at 135°W for one year
								In manufa- cture			

Table 2-1. U.S. Government Sponsored Communications Sa

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Fltsatcom	DoD/ SAMSO; TRW	1977-9; Atlas-Centaur (AKM)	4100; 2170	Geo-synchronous; 5 years	3 axis; hydrazine mono-propellant with redundant thrusters.	Solar array; 3 Ni-Cd batteries.	1435W BOL; 1200W EOL; full eclipse capability.		Single conversion transponders. Contains Fleet broadcast and relay channels, DoD WB channel, USAF NB channel.	Command and telemetry operates at S-band. Transponders operate at UHF and X-band.	

2

Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Application System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Conversion- Fleet and Channels, USAF Channel.	Command and telemetry operates at S-band. Transponders operate at UHF and X-band.			16 ft. UHF xmit paraboloid; 18-turn UHF receive helix; SHF horn antenna; log conical spiral TT&C antenna.	UHF transponder features low-level amps, pre-drivers and power amps; output power levels of about 26W, 38W, and 42W. 12 UHF transmitters, 1 SHF transmitter.			In manufacture	Will provide at least 30 voice and 12 TTY channels to serve small mobile users	4 satellite system; protected against hostile radiation; ground spares. See Ref. (4), (8), (37), (38)

Table 2-1. U.S. Government Sponsored Communications S

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARAC		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
LES-6	DoD: MIT	9/26/1968; Titan IIC	360 on-orbit	Geo-synchronous; 5 year design goal exceeded	Spin; cold ammonia or pulsed plasma thrusters	Solar array; Ni-Cd batteries	220W BOL; 130W EOL; no eclipse capability	40° W± 2° E-W; 3.0°	Single conversion hard-limiting UHF transponder	UHF uplink from 290 to 315 MHz; uplink center frequency is 302.7 MHz; downlink center frequency is 249.1 MHz; TT&C at 236 MHz	100 kHz switchable to 500 kHz
LES-8/9	DOD: MIT	3/14/1976; Titan III C	1000	Geo-synchronous; 3 years	3 axis; gas thrusters	Radio-isotope electric power generators		LES-8: 116.3° W; LES-9: 26.3° W; 23° inclination for both S/C	Mixer-type rcvrs	LES-8: rcves at 36.7876 and 36.8333 GHz, xmits at 37.04 GHz. LES-9: rcves at 38.0924 and 38.0474 GHz, xmits at 36.9 and 38.84 GHz.	

Government Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Single conversion hard-limiting UHF transmitter	UHF uplink from 290 to 315 MHz; uplink center frequency is 302.7 MHz; downlink center frequency is 249.1 MHz; TT&C at 236 MHz	100 kHz switchable to 500 kHz	254.14 MHz at 15.5 dBW	Omnidirectional monopole telemetry stub; electronically despun switched UHF array antenna 10 dB peak gain for receive/transmit, 34° x 47° beamwidth.	8 hybrid summed solid-state amps with 122W power output BOL	29 dBW BOL; 21 dBW 1/75	-20.8 dB/K	In orbit and active with output power reduced due to solar array degradation	300 TTY or 20 vocoded voice entries	Spin axis offset 2.2° See Ref. (8), (19)
Mixer-type receivers	LES-8: receives at 36.7876 and 36.8333 GHz, xmits at 37.04 GHz. LES-9: receives at 38.0924 and 38.0474 GHz, xmits at 36.9 and 38.84 GHz.			18 inch diameter K-band paraboloid, 42.7 dBi gain, 1.15° beam width. 2.5 inch diameter K-band horn, 25 dBi gain, 10° beam width. UHF antenna, S-band antenna.	0.5 W IMPATT diodes	22 dBW with horn; 39 dBW with paraboloid		In operation	Experiments	See Ref. (4), (8), (26), (28), (40), (41)

Table 2-1. U.S. Government Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
LES-10	DOD; MIT	TBD; Titan III C	3200 at launch	Geo-synchronous	Spin; hydrazine mono-propellant or pulsed plasma thrusters	Solar array; Ni-Cd battery	1200 W BOL; full eclipse capability	TBD	Will include signal processing equipment, anti-jam capability. UHF diplexer and RF preamp, uses FDM on uplink and TDM on downlink	SHF & UHF	TBD
Skynet IIB	U. K. / DOD; Marconi/Aeronic-Ford	11/22/1974; TAD (AKM)	960; 518	Geo-synchronous; 3 years	Spin; mono-propellant hydrazine	Solar array; 2 Ni-Cd batteries	258 W BOL; 196 W EOL; full eclipse capability	49°E ± 3° E-W; 1.4°	Hard-limiting single-conversion dual-channel repeater. S-band TT&C repeater.	Uplink: 7.97602 to 7.97802 GHz for NB; 7.98512 to 8.00512 GHz for WB. Downlink: 7.2573 to 7.2593 GHz for NB; 7.2664 to 7.2864 GHz for WB.	2 MHz for NB; 20 MHz for WB

Secure Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Station Name	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	FIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Mobile Access, Repeaters and RF Links	SHF & UHF	TBD	TBD	UHF multi-beam antenna system (MBA) with 19 narrow beams; SHF MBA with 37 narrow beams; UHF circular array of 12 crossed dipoles for EC; UHF MBA has 26.7 dB minimum gain; UHF circular array has 13 dB minimum gain; SHF MBA has 32.5 dB minimum gain.	19 UHF PA's of 20W	TBD	TBD	In proposal stage	500 kbps total data rate in TDM mode	This is a tentative design. See Ref. (27)
Station Name	Uplink: 7.97602 to 7.97802 GHz for NB; 7.98512 to 8.00512 GHz for WB. Downlink: 7.2573 to 7.2593 GHz for NB; 7.2664 to 7.2864 GHz for WB.	2 MHz for NB; 20 MHz for WB	7.2995 GHz carrier	Mechanically despun X-band horn, 19° beam width, 17 dB peak gain; 2 S-band omnidirectional antennas, 4.0 dB peak gain, RHCP.	2-16 W TWTA's	23.2 dBW for NB; 17.2 dBW for WB	-16.6 to -17.6 dB/K	In operation	Strategic and tactical communications	See Ref. (5), (9), (19), (34)

Table 2-1. U.S. Government Sponsored Communications Satel

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTER			
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	B
ATS-1	NASA; HAC	12/6/1966; Atlas-Agena D (AKM)	1550; 775	Geo-Syn-chro-nous	Spin; mono-propellant hydrazine with redundant thrusters	Solar array; 2 Ni-Cd batteries	175W BOL; partial eclipse capability	149°W + 0.2° E-W; 7.4°	SHF: 2 integrated triple mode repeaters, (a) IF translation soft-limited (b) real-time IF modulation conversion (c) on-board WB data. Any 2 modes operate simultaneously. VHF:1 single IF translation hard-limited repeater.	Uplinks at 6212.094 MHz, 6301.05 MHz, 6212.294 MHz, 6217.694 MHz, 6301.25 MHz, 6306.65 MHz, 149.22 MHz, 149.195 MHz, 149.245 MHz. Downlinks at 4119.599 MHz, 4178.591 MHz, 135.575 MHz, 135.625 MHz, 135.6 MHz. Command at 148.26 MHz. Telemetry at 136.47 MHz.	SHF: (a) 25 MHz (b) 5.45 MHz up (c) 25 MHz down (d) 25 MHz VHF: 100 kHz	41 94 M 41 17 M 41 58 M 41 58 M 13 M 41 M

2

Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
<p>Integrable modes. (a) Translation limited (b) Time IF station con-on (c) on-WB data. Modes to simul-usly. 1 single translation limited ster.</p>	<p>Uplinks at 6212.094 MHz, 6301.05 MHz, 6212.294 MHz, 6217.694 MHz, 6301.25 MHz, 6306.65 MHz, 149.22 MHz, 149.195 MHz, 149.245 MHz. Downlinks at 4119.599 MHz, 4178.591 MHz, 135.575 MHz, 135.625 MHz, 135.6 MHz. Command at 148.26 MHz. Telemetry at 136.47 MHz.</p>	<p>SHF: (a) 25 MHz (b) 5.45 MHz up 25 MHz down (c) 25 MHz VHF: 100 kHz</p>	<p>4135.946 MHz, 4195.172 MHz, 4119.599 MHz, 4178.591 MHz, 137.37 MHz, 412.05 MHz</p>	<p>SHF xmit has 1-16 element electronically despun phased array with 14dB peak gain and 21° beamwidth. SHF rcve has 1 collinear array with 7.8 dB peak gain. VHF has 1-8 element elec-tronically de-spun phased array with 9 dB xmit peak gain and 8dB rcve peak gain and 60° beamwidth. VHF TT&amp;C has 1 8-whip turnstile, omnidirec-tional.</p>	<p>SHF has 2-4W TWTA'S. VHF has 8-5W solid state devices</p>	<p>SHF: 22dBW with both TWTA's. VHF: 23dBW for 1 carrier.</p>	<p>-23.0 dB/°K for SHF; -20.6 dB/°K for VHF</p>	<p>S/C active; limited station-keeping capability left; solar array out-put degrad-ed. Trans-mits on command only.</p>	<p>Applications experiments</p>	<p>See Ref. (19), (52)</p>

Table 2-1. U.S. Government Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
ATS-3	NASA; HAC	11 / 5 / 1967; Atlas-Agena D (AKM)	1550; 805	Geo-Syn-chro-uous	Spin; hydra-zine mono-propel-lant or nitro-gen jets	s/a ATS-1	175 BOL; partial eclipse capabi-lity	70°W + 0 2° E-W; 5 7°	s/a ATS-1	s/a ATS-1	s/a ATS-1

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nt Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
ATS-1	s/a ATS-1	s/a ATS-1	s/a ATS-1	1 SHF mechanically despun cylindrical parabolic collimator illuminated by collinear xmit and reve line feeds, peak xmit gain 16dB, peak reve gain 17.5dB, 20° beam width. 1 VHF 8-element electronically despun phased array, peak xmit gain 10dB, peak reve gain 8dB, 60° beam width. 1 VHF TT&C 8-whip turnstile, omnidirectional	2-4W TWTA'S and 2-12W TWTA'S in SHF; 1-12W TWTA failed. 8-6,3W solid-state devices in VHF.	SHF: 24.5 dBW with 2 TWTA 's, or 26.5 dBW with 2 TWTA 's. VHF: 25.8 dBW for 1 carrier	-13.3 dB/°K for SHF; -29.1 dB/°K for VHF	S/C active Solar array output de-graded. Xmits on command only. 1-12W TWTA has failed	Applications experiments	See Ref. (19), (52)

Table 2-1. U.S. Government Sponsored Communications

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
ATS-5	NASA; HAC	8/12/1969; Atlas Centaur (AKM)	1630; 954	Geo-synchronous	Gravity gradient with nitrogen jets	Solar array; 2 Ni-Cd batteries	175 W BOL; partial eclipse capability	105° W; 3.1°	Multiple SHF modes: (a) NB soft-limited, (b) WB soft-limited, (c) modulation conversion for multiple access, (d) WB data, (e) C-L and L-C band cross-strap. VHF uses IF translation hard-limiting.	MMW: 31.65 GHz up, 15.3 GHz down. L-Band: 1.65 GHz up, 1.55 GHz down. SHF: 6.212 and 6.301 GHz up, 4.119 and 4.178 GHz down. Telemetry at 136 MHz. Command at 148 MHz.	SHF: (a) 2 MHz, (b) 2 MHz, (c) 10 kHz, (d) 25 MHz down, (e) 2 MHz for C 100kHz up for L-C, 25 MHz down for L VHF: 100kHz

ent Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Multiple SHF links: (a) NB limited, (b) WB soft-limited, (c) modulation conversion for multiple access, (d) WB data, (e) L and L-C and cross-cap. VHF S IF transition hard-limiting.	MMW: 31.65 GHz up, 15.3 GHz down. L-Band: 1.65 GHz up, 1.55 GHz down. SHF: 6.212 and 6.301 GHz up, 4.119 and 4.178 GHz down. Telemetry at 136 MHz. Command at 148 MHz.	SHF: (a) 2.5 MHz, (b) 25 MHz, (c) 100 kHz up, 25 MHz down. (d) 25 MHz, (e) 25 MHz for C-L 100kHz up for L-C, 25 MHz down for L-C. VHF: 100kHz.	15.3 GHz carrier	1-12 helix L-band planar array for xmit and receive, xmit peak gain 14dB, receive peak gain 15dB, 24° beamwidth. 1 mmw conical horn for xmit and receive, 19dB peak gain for receive and xmit, 20° beamwidth. 1 SHF planar array for xmit and receive, 16.5 dB peak gain for xmit and receive, 23° beam width. 1-8 whip TT&C turnstile, omnidirectional.	2-12 W TWTA's	SHF: 25.4 dBW with 2 TWTA's. VHF: 24 dBW with 2 TWTA's	-16.6 dB/°K for SHF; -13.6 dB/°K for VHF	S/C active but spinning around longitudinal axis. Xmits on command only.	Applications experiments	See Ref. (19), (52)

Table 2-1. U.S. Government Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS			
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	
ATS-6	NASA; Fairchild	5/30/1974; Titan III C	3094; 2991	Geo-synchronous; 2 years	3 axis; hydrazine jets	Solar array; Ni-Cd batteries	600 W BOL; 470 W EOL; partial eclipse capability	35° E + 0.1° E-W and N-S; 0.3°	See insert	See insert	See Insert	
Communications	Parabolic antenna	9.1-meter (30-foot) diameter 100 MHz to 10 GHz f/d = 0.44 Stowed dimensions, annulus with 2.0 meter OD x 1.5 meter ID x 0.2 meter (6.6 feet OD x 4.8 feet ID x 0.8 feet) high										
	Communication frequency Power amplifiers Repeater operation Transponder bandwidths Experiment interface Baseband IF Peak antenna gain Peak ERP	VHF, UHF, L-, S-, C-, Ku, and Ka-Bands <u>Solid state transmitters</u> UHF--105 watts (SITE/TRUST) L-Band--40 watts (PLACE) S-Band--20 watts (TDRE) S-Band--15 watts (HET) <u>Traveling Wave Tubes</u> C-Band--12/24 watts Full duplex, coherent linear translation and/or modulation conversion (DM) of up to 3 independent RF channels simultaneously Selectable RF bandwidths 12 and 40 MHz VCO (5 MHz) Discriminator (6 MHz) Bandwidth 40 MHz 49 dB 54.5 dBW										
Telemetry	Telemetry transmission (ERP) Telemetry transmitter	15 dBW (high gain link)--4 dBW (omni-link) 2 watt FM/PM										
Assumes the following nominal antenna gains: C-band horn - 17 dB      L-band fan - 32 dB C-band dish - 50 dB      L-band pencil - 38 dB S-band array - 39 dB      VHF dish - 18 dB												
		Mode	User	Nominal Frequency (MHz)	Bandwidth (MHz)	Polarization	Altitude Field of View (Degrees)	Peak Antenna Gain (dB)	Max G/T Over FOV (dB/K)	Receiver		
		9-meter (30-foot) C-Band Receive	MMW Monopulse	63.50 61.50	40 12	Linear	0.4	49.0	10.5			
		9-meter (30-foot) C-Band Transmit	MMW	3750 3950	40	Linear	0.6	46.0	-			
		Horn C-Band Receive	T&RE SITE PLACE MMW ATS-R	6350 6150 5950	40 12	Linear	20	16.5	-20			
		Horn C-Band Transmit	T&RE Beacon PLACE	3950 3750 4150	40	Linear	10	16.6	-			
		9-meter (30-foot) C-Band Receive	RFI	3900 6150	500	Linear	10	14.7	-			
		9-meter (30-foot) S-Band Receive Scan	T&RE	2750	40	RCP	8	40.5	-			
		9-meter (30-foot) S-Band Transmit on Axis	T&RE	2075	12	RCP	-	39.5	-			
		9-meter (30-foot) S-Band Transmit Scan	T&RE	2075	12	RCP	8	39.0	-			
		9-meter (30-foot) S-Band Receive on Axis	T&RE	2250	12	RCP	-	40.5	-			
		9-meter (30-foot) L-Band Pencil Beam Receive	PLACE	1650	12	RCP	1.5	38.5	2.5			
		9-meter (30-foot) L-Band Pencil Beam Transmit	PLACE	1350	12	RCP	1.5	38.5	-			
		9-meter (30-foot) L-Band Fan Beam Receive	PLACE	1650	12	RCP	1 x 7.5	31.5	5.0			
		9-meter (30-foot) L-Band Fan Beam Transmit	PLACE	1550	12	RCP	1 x 7.5	31.5	-			
		9-meter (30-foot) UHF Transmit	SITE TRUST	860	40	RCP	2.8	33.0	-			
		9-meter (30-foot) VHF Receive	Monopulse	150	6	RCP	15	17	-20			
		9-meter (30-foot) VHF Receive	Command	148.26 154.2	3	RCP	15	17	-20			
		9-meter (30-foot) VHF Transmit	Telemetry I&M	136.23 137.11	2	RCP	15	17	-			
		9-meter (30-foot) S-Band Transmit	ETV	2569.2 2670.0	40 40	LCP	0.9(3)	43.2	-			

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at Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS										OPERATIONAL DATA	
Communication System	Repeater and TT&C Frequencies		RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Insert	See insert		See Insert	See Insert	See Insert	See Insert	See Insert	See insert	Active	Applications experiments	Located at 94° W for first year; located at 35° E second year; located at 94° E until EOL. Return trip from 8/76 to 10/76. See Ref. (19), (21), (34), (52)
Band (MHz)	Bandwidth (MHz)	Polarization	Antenna Field of View (degrees)	Receiver			Transmitter			ERP (Peak) (dB/W)	
				Peak Antenna Gain (dB)	Min G/T Over FOV (dB/K)	G/T (Peak) (dB/K)	Transmitter Output Power (watts)	Min ERP Over FOV (dB/W)	ERP (Peak) (dB/W)		
30-30	40-12	Linear	0.4	49.0	10.5	13.5	-	-	-	-	
30-30	40	Linear	0.4	48.0	-	-	21.0	51.5(1) 47.2(2)	54.8(1) 50.2(2)	-	
30-30	40-12	Linear	20	16.5	-20	-17	-	-	-	-	
30-30	40	Linear	10	16.8	-	-	21.0	28.9(1) 20.7(2)	28.9(1) 23.7(2)	-	
30-30	500	Linear	10	16.7	-	-	30.0	-	-	-	
30-30	500	Horizontal Vertical RCP	0.4	48.5	NA	NA	NA	NA	NA	NA	
30-30	40	RCP	9	40.5	-	-	-	-	-	-	
30-30	12	RCP	-	39.5	-	-	20.0	-	50.8	-	
30-30	12	RCP	9	39.0	-	-	20.0	48	-	-	
30-30	12-40	RCP	-	40.5	-	9.5	-	-	-	-	
30-30	12	RCP	1.5	38.5	2.5	5.5	-	-	-	-	
30-30	40-12	RCP	1.5	38.5	-	-	40.0	49.0	51	-	
30-30	40-12	RCP	1 x 7.5	31.5	5.0	-2	-	-	-	-	
30-30	40-12	RCP	1 x 7.5	31.5	-	-	40.0	42.0	45	-	
30-30	40	RCP	2.6	33.0	-	-	105	48.0	51	-	
30-30	6	RCP	15	17	-20	-18	-	-	-	-	
30-30	3	RCP	15	17	-20	-18	-	-	-	-	
30-30	2	RCP	15	17	-	-	2.0	17	20	-	
30-30	40	LCP	0.9(3)	43.2	-	-	12	44.5(3)	53	-	
30-30	40						12			-	

Transmitters		Type	Frequencies (Synthesized)	Power Output
		C-Band	3950, 4150 and 3750 MHz	11 watts
		Designed for HET experiment	2569 and 2670 MHz	15 watts
		S-Band	2075 MHz	21 watts
		L-Band	1550 MHz	40 watts
		UHF	860 MHz	105 watts
Receivers		Type	Frequencies (Synthesized)	
		C-Band*	5950, 6150, and 6350 MHz	
		S-Band*	2250 MHz	
		L-Band	1650 MHz	
		VHF	150 MHz	
Special Features		Monopulse operation		
		Coherent phase-lock operation		
		Receipt/transmission of up to 3 frequencies simultaneously		
		17 frequencies, ** with direct synthesis of 14 from a single frequency standard		

Table 2-2. Foreign Government Sponsored Communicati

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARAC		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Molniya 1 (F-18)	USSR	7/28/1971; A Ile	2205 on-orbit	Elliptical; 12-hour orbit	Gyro, orbital correction engine, gas jets or liquid fuel jets	Solar array; battery	500 W to 700 W BOL	39491 x 861 km; 65.4°	Nonlinear frequency translating repeaters, 1 operating and 2 spares. Front end rcvr is a Si diode mixer.	Xmits in 800 MHz band; rcves in 1 GHz band; video xmit from 3.4 to 4.1 GHz.	
Molniya 1 (F-19)		12/19/1971; A Ile						39604 x 731 km; 65.0°			
Molniya 1 (F-21)		10/14/1972; A Ile						39963 x 383 km; 65.1°			
Molniya 1 (F-23)		2/3/1973; A Ile						39534 x 824 km; 65.1°			
Molniya 1 (F-24)		8/30/1973; A Ile						38941 x 1415 km; 65.5°			
Molniya 1 (F-25)		11/14/1973; A Ile						39577 x 775 km; 65.4°			
Molniya 1 (F-26)		11/30/1973; A Ile						39646 x 709 km; 63.0°			
Molniya 1 (F-27)		4/20/1974; A Ile						39827 x 522 km; 64.1°			
Molniya 1 (F-28)		10/24/1974; A Ile						39515 x 840 km; 63.1°			

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Government Sponsored Communications Satellite Characteristics

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
near frequency transmitters, repeaters, and receiving antennas. Front end is a double mixer.	Xmits in 800 MHz band; reves in 1 GHz band; video xmit from 3.4 to 4.1 GHz.			2-3 ft. steerable EC dishes (1 reserve) 16 to 18 dB gain, 22° beamwidth. Circular polarization.	1-2-stage TWTA per repeater. 40 W for video or 14W per duplex multi-channel telephony. 4th TWTA held in reserve.	30 dBW	Est. -15.6 to -18.6 dB/°K	In operation	1 video channel and multi-channel audio. Some telephone channels can be multiplexed for VHF telegraphy, photo-facsimile, audio.	See Ref. (9), (19), (34), (60), (61), (63)

Table 2-2. Foreign Government Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Molniya 1 (F-29)	USSR	4/29/1975; A lle	s/a F-18	s/a F-18	s/a F-18	s/a F-18	s/a F-18	39582 x 770 km; 63.0°	s/a F-18	s/a F-18	
Molniya 1 (F-30)		6/5/1975; A lle						39601 x 744 km; 62.9°			
Molniya 1 (F-31)		9/2/1975; A lle						35794 x 611 km; 63.0°			
Molniya 1 (F-32)		1/22/1976; A lle						39848 x 506 km; 62.9°			
Molniya 1 (F-33)		3/12/1976; A lle						40683 x 518 km; 62.5°			
Molniya 1 (F-34)		3/19/1976; A lle						38984 x 494 km; 63.0°			
Molniya 1 (F-35)		7/23/1976; A lle						39059 x 499 km; 62.9°			

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nt Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
s/a F-18	s/a F-18			s/a F-18	s/a F-18	s/a F-18	s/a F-18	In operation	s/a F-18	

Table 2-2. Foreign Government Sponsored Communication

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	Channel Bandwidth
Molniya 2 (F-1)	USSR	11/24/1971 A lle	2756	s/a Molniya 1 (est)	s/a Molniya 1 (est)	s/a Molniya 1 (est)	s/a Molniya 1 (est)	39976 x 182 km; 65.2°	32-NB channels, 14 MHz apart; 1 WB channel	5.7 to 6.4 GHz up, 3.4 to 4.2 GHz down	NB 10 WE 40
Molniya 2 (F-2)		5/19/1972; A lle						39094 x 474 km; 65.0°			
Molniya 2 (F-3)		9/30/1972; A lle						39228 x 1125 km; 65.5°			
Molniya 2 (F-5)		4/5/1973; A lle						38927 x 1412 km; 65.5°			
Molniya 2 (F-6)		7/11/1973; A lle						39777 x 576 km; 65.6°			
Molniya 2 (F-7)		10/19/1973; A lle						40588 x 497 km; 64.3°			
Molniya 2 (F-8)		12/25/1973; A lle						39680 x 673 km; 63.0°			
Molniya 2 (F-9)		4/26/1974; A lle						39469 x 878 km; 63.5°			
Molniya 2 (F-10)		7/23/1974; A lle						39127 x 1227 km; 63.0°			
Molniya 2 (F-11)		12/21/1974; A lle						39777 x 575 km; 63.7°			
Molniya 2 (F-12)		2/6/1975; A lle						39624 x 726 km; 63.1°			
Molniya 2 (F-13)		7/8/1975; A lle						39612 x 695 km; 63.1°			

Sponsored Communications Satellite Characteristics (Cont'd)

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PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
annels, part; nnel	5.7 to 6.4 GHz up, 3.4 to 4.2 GHz down	NB: 10 MHz; WB: 40 MHz		s/a Molniya 1 (est)		NB: 26dBW (est); WB: 35dBW (est).	-10dB/0 K(est.)	In operation	s/a Molniya 1 (est)	See Ref. (9), (19), (34), (61)

Table 2-2. Foreign Government Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Molniya 2 (F-14)	USSR	9/9/1975; A lle	s/a F-1	s/a F-1	s/a F-1	s/a F-1	s/a F-1	39717 x 639 km; 63.0°	s/a F-1	s/a F-1	s/a F-1
Molniya 2 (F-15)		12/17/1975; A lle						39870 x 486 km; 62.8°			
Molniya 3 (F-1)		11/21/1974		Elliptical orbit; 12-hour period	Orbit correction system			39559 x 793 km; 63.0°			
Molniya 3 (F-2)		4/14/1975						39768 x 586 km; 63.6°			
Molniya 3 (F-3)		11/14/1975						39755 x 605 km; 63.0°			
Molniya 3 (F-4)		12/28/1975						39846 x 507 km; 62.9°			
Molniya 3 (F-5)		5/12/1976						40660 x 405 km; 62.8°			

ent Sponsored Communications Satellite Characteristics (Cont'd)

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PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
s/a F-1	s/a F-1	s/a F-1		s/a F-1		s/a F-1	s/a F-1	In operation	s/a F-1	
									Video and multi-channel radio communication	Upgraded version of Molniya 1 & 2. See Ref. (34)

Table 2-2. Foreign Government Sponsored Communications S

SATELLITE	SPACECRAFT DATA							PAYLOAD CHARACTERISTICS			
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Cosmos 637	USSR	3/26/1974		Geo-syn-chronous				75°-85° E; 1.1°			
Cosmos 665		6/29/1974		39160 x 1239 km				Elliptical; 64.3°; 718.6 minute period			
Cosmos 667-668		9/19/1974		1467 x 1468 km (ave.)				Circular; 74.0°; 115 minute period (ave.)			
Cosmos 711-718		2/28/1975		1500 x 1480 km (ave.)				Circular; 73.9°; 115.5 minute period (ave.)			
Cosmos 775		10/8/1975		Geo-syn-chronous				No data ; 0.1°			
Molniya 1-S		7/23/1974				Solar array; batteries		90° E	s/a Molniya 2 except NB channel center frequency shifted 7 MHz	5.7 to 6.4 GHz up, 3.4 to 4.2 GHz down	10 MHz for NB channel 40 MHz for WB channel
Statsionar 1		12/22/1975			3 axis with orbital correction system			99° E ± 1° E-W		6.2 GHz ± 12 MHz up, 714 ± 12 MHz down	
Statsionar 2		1976						35° E		5.75 to 6.2 GHz up, 3.42 to 3.87 GHz down	

Government Sponsored Communications Satellite Characteristics (Cont'd)

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PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
								In operation		Military communications. See Ref. (61), (63)
s/a Molniya 2 except NB channel center frequency shifted 7 MHz	5.7 to 6.4 GHz up, 3.4 to 4.2 GHz down	10 MHz for NB channels, 40 MHz for WB channels							Audio and video broadcast capabilities	
	6.2 GHz $\pm$ 12 MHz up, 714 $\pm$ 12 MHz down								Video, telephone and telegraph capabilities	See Ref. (61)
	5.75 to 6.2 GHz up, 3.42 to 3.87 GHz down			Peak gain 23 dB				In flight preparation		

Table 2-2. Foreign Government Sponsored Communications S

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS			
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	
Stasionar 3	USSR	1976		Geo-syn-chronous	3 axis with orbital correction system	Solar array		85° E		5.75 to 6.2 GHz up, 3.42 to 3.87 GHz down.		
Stasionar 4		1978-1979						14° W				6.0 to 6.25 GHz up, 3.5 to 3.9 GHz down
Stasionar 5								58° E				6.0 to 6.25 GHz up, 3.67 to 3.9 GHz down
Stasionar 6		1979-1980						85° E				
Stasionar 7								140° E				
Stasionar 8		1980						25° W				5.75 to 6.0 GHz up, 3.42 to 3.67 GHz down
Stasionar 9								45° E				
Stasionar 10								170° W				

ent Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
	5.75 to 6.2 GHz up, 3.42 to 3.87 GHz down.			Peak gain 23 dB				In flight preparation	Telephone, telegraph, photo-telegraph, audio and video capabilities	
	6.0 to 6.25 GHz up, 3.5 to 3.9 GHz down							In proposal stage		
	6.0 to 6.25 GHz up, 3.67 to 3.9 GHz down									
				Two antennas						
	5.75 to 6.0 GHz up, 3.42 to 3.67 GHz down									

Table 2-2. Foreign Government Sponsored Communications

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Communications Technology Satellite (CTS)	Canada and NASA; SPAP, RCA, SED, Bristol Aerospace	1/17/1976; Thor-Delta 2914 (AKM)	1489; 764	Geo-synchronous; 2 years	3 axis with momentum wheel and hydrazine jets.	Solar array; Ni-Cd batteries.	1260 W BOL (1040 W for experiment); 220 W for house-keeping; 1000 W EOL; Limited eclipse capability.	116° W ± 0.2° E-W; 0.6°	Single conversion linear repeaters. High-power TWTA has efficiency greater than 50%.	Receives from 14.01 to 14.29 GHz. Transmits from 11.843 to 12.123 GHz. Tracking uplink is 2097.198 MHz, downlink is 2277.5 MHz.	Four 85 MHz channels; 10 MHz telemetry; 1.5 MHz command.
Engineering Test Satellite, Type II (ETS II)	Japan/NASDA; Mitsubishi Electric/Aeroford	1977; N-launch vehicle (AKM)	559; 302	Geo-synchronous; 1 year	Spin; monopropellant hydrazine	Solar array; 2 Ni-Cd batteries	107 W BOL; 92 W EOL; partial eclipse capability	130° E ± 0.5° E-W and ± 1.0° N-S; 0.5° ± 0.5°	6-channel vibration data xmt; S, X, and K-band propagation experiments. S-band transponder provides ranging and communications. VHF telemetry and command transponder.	S-band: 2.1 GHz up, 1.7 GHz down. VHF: 136 MHz down, 148 MHz up. Coherent signals transmitted at 11 GHz and at 34 GHz.	8.2 MHz for S-band

Table 2-2. Foreign Government Sponsored Communications Sate

Government Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Single conversion linear repeaters. High-power TWTAs has efficiency greater than 60%.	Receives from 14.01 to 14.29 GHz. Transmits from 11.843 to 12.123 GHz. Tracking uplink is 2097.198 MHz, downlink is 2277.5 MHz.	Four 85 MHz channels, 10 MHz telemetry. 1.5 MHz command.	11.7 GHz carrier	Two SHF gimbaled parabolic reflectors with 2.5° beamwidth, 36.2 dB maximum gain, 71.1 cm. in diameter, steerable within 14.5° cone, using orthogonal polarization. T, T&C uses 1 conical beam antenna circular polarization, 16° x 16° beamwidth. 1 SHF beacon antenna.	2-20 W TWTAs in communications transponder. 1-200 W TWTAs for experiments. 2 W solid-state telemetry transmitter.	59 dBW	+2.6 dB/K	In operation	Experiments: video broadcast to 8 ft. diameter earth terminals, audio broadcast, digital data transmission, TDMA distribution of WB information.	Antenna coverage depends upon experiment being performed. Control ET is in Ottawa. See Ref. (19), (20), (34), (42), (43)
Multi-channel vibration data transmitter; S, X, and K-band propagation experiments. S-band transponder provides ranging and communications. VHF telemetry and command transponder.	S-band: 2.1 GHz up, 1.7 GHz down. VHF: 136 MHz down, 148 MHz up. Coherent signals transmitted at 11 GHz and at 34 GHz.	8.2 MHz for S-band	1.7 GHz carrier	1 S-band dish, 1 X-band dish, 1 K-band dish, all mechanically despun and fed by rotary joint. All have RHCP. VHF 4-whip antenna has omni-directional composite LHCP/RHCP in xmit and rcv modes. K-band antenna coverage pattern illuminates main island.	Solid state devices.	Xmtr power 2W or 8W for VHF.		In manufacture	Propagation experiments	See Ref. (45)

Table 2-2. Foreign Government Sponsored Communications

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Aerosat	Comsat General acting for F. A. A. ESRO, Canada	1978; TBD	TBD	Geo-synchronous; 7 years	TBD	TBD	TBD	TBD	5 ET-to-S/C channels, 15 S/C-to-ET channels, 3 A/C-to-S/C channels, 2 S/C-to-ET experimental channels, 2 ET-to-S/C experimental channels.	1.5435 to 1.5585 GHz for S/C-to-AC. 1.645 to 1.66 GHz for A/C-to-S/C. 5.0 to 5.125 GHz for ET-to-S/C. 5.125 to 5.25 GHz for S/C-to-ET.	80 kHz ET-to-S/C. 40 S/C-to-ET. 400 kHz and 1 MHz experimental channels
Oscar 7	AMSAT	11/15/1974; piggy-back aboard Thor-Delta	65;65	Sun synchronous; 3 years	None	Solar array; Ni-Cd batteries		1461 x 1442 km; 101.6°	2 linear repeaters	2/10 rcves from 145.85 to 145.95 MHz, xmits from 29.4 to 29.5 MHz. 70/2 rcves from 432.125 to 432.175 MHz, xmits from 145.975 to 145.925 MHz.	2/10; 100 kHz; 70/2; 50 MHz

Table 2-3. Commercially Sponsored Communication

Government Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS							OPERATIONAL DATA			
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
ET-to-S/C channels, 15 C-to-ET channels, 3 C-to-S/C channels, 2 C-to-ET experimental channels, 2 T-to-S/C experimental channels.	1.5435 to 1.5585 GHz for S/C-to-AC. 1.645 to 1.66 GHz for A/C-to-S/C. 5.0 to 5.125 GHz for ET-to-S/C. 5.125 to 5.25 GHz for S/C-to-ET.	80 kHz ET-to-S/C. 40 S/C-to-ET. 400 kHz and 10 MHz experimental channels	TBD	TBD	TBD	23 dBW for A/C, 55 dBW for forward channel, 70 dBW for experimental channel	TBD	Proposed	TBD	3 S/C system. See Ref. (47)
Linear repeaters	2/10 reves from 145.85 to 145.95 MHz, xmits from 29.4 to 29.5 MHz. 70/2 reves from 432.125 to 432.175 MHz, xmits from 145.975 to 145.925 MHz.	2/10: 100 kHz 70/2: 50 MHz	2.304 GHz, LHCP canted turnstile, 435.1 MHz, 2/10 xmit is linearly polarized dipole. 70/2 reves and xmit is RHCP canted turnstile. 435.1 MHz beacon is LHCP dipole; 2.304 GHz beacon is RHCP dipole.	2/10 reve is LHCP canted turnstile, 2/10 xmit is linearly polarized dipole. 70/2 reves and xmit is RHCP canted turnstile. 435.1 MHz beacon is LHCP dipole; 2.304 GHz beacon is RHCP dipole.	2/10 is 2 W solid state; 70/2 is 8 W solid state; 435.1 MHz beacon is 0.3 W solid state; 2.304 GHz beacon is 40 mW solid state			In operation	Morse code telemetry, teletype telemetry	Radio amateur

Table 2-2. Foreign Government Sponsored Communications S

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARAC		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
ANIK I	Telesat Canada; HAC	11/9/1972; Thor-Delta 1914 (AKM)	1250; 654	Geo-synchronous; 7 years	Spin; hydrazine jets	Solar array; 2 Ni-Cd batteries	300W BOL; 220 W EOL; partial eclipse capability	113° W ± 0.1° E-W and N-S; 0.0°	Nonlinear, single conversion transponders. 1 WB revr drives 12 NB xmtrs.	Reve center frequencies from 5.945 to 6.345 GHz in 40 MHz steps. Xmit center frequencies from 3.72 to 4.16 GHz in 40 MHz steps. Telemetry at 4.198 and at 4.199 GHz. Command at 6.42 GHz.	36 MHz for each xmtr.
ANIK II		4/20/1973; Thor-Delta 1914 (AKM)						109° W ± 0.1° E-W and N-S; 0.0°			
ANIK III		5/7/1975; Thor-Delta 1914 (AKM)	1500; 904					104° W ± 0.1° E-W and N-S; 0.0°			

Table 2-3. Commercially Sponsored Communications S

Government Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Nonlinear, single conversion transponders. 1 WB receiver drives 12 WB xmitters.	Reve center frequencies from 5.945 to 6.345 GHz in 40 MHz steps. Xmit center frequencies from 3.72 to 4.16 GHz in 40 MHz steps. Telemetry at 4.198 and at 4.199 GHz. Command at 6.42 GHz.	36 MHz for each xmitr.	4.5 GHz carrier	Dual-mode 5 ft. diameter dish, receives vertically, xmits horizontally, 27 dB peak gain, 3° x 8° beam width, illuminates Canada. Bicone telemetry antenna. Cloverleaf command antenna.	12-5W TWTA's	33 dBW per channel	-7.4 dB/K for CONUS; -18 dB/K for Hawaii	In operation	5000 duplex audio or 12 video channels	10 R F channels during eclipse. See Ref. (10), (19), (44)
										Greater fuel allotment of 250 lbs for station keeping

Table 2-2. Foreign Government Sponsored Communication

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	Channel Bandwidth
Orbital Test Satellite (OTS)	ESRO; Hawker Siddeley Dynamics	6/77; Thor-Delta 3914 (AKM)	1980; 1000	Geosynchronous; 3 years	3 axis	Solar array; Ni-Cd batteries	600 W BOL; 520 W EOL; limited eclipse capacity	10°E ±0.1°N-S and E-W	Double conversion. Module A (MA) has two WB and two NB channels. Module B (MB) has two very NB chains.	MA: TC up is 14125 MHz, NB up is 14152.5 to 14192.5 MHz, WB up is 14242.5 to 14362.5 MHz. TC down is 11575 MHz, NB down is 11490 to 11530 MHz, WB down is 11580 to 11700 MHz. MB: Down is 11792.5 to 11797.5 MHz, up is 14455 to 14460 MHz.	MA is 4 MHz MB is 1 MHz ME is 1 MHz

Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Station Name	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Over- the- air to NB Mo- B) has NB	MA: TC up is 14125 MHz, NB up is 14152.5 to 14192.5 MHz, WB up is 14242.5 to 14362.5 MHz. TC down is 11575 MHz, NB down is 11490 to 11530 MHz, WB down is 11580 to 11700 MHz. MB: Down is 11792.5 to 11797.5 MHz, up is 14455 to 14460 MHz.	MA: NB is 40 MHz, WB is 120 MHz. MB: 5 MHz	11.786 GHz carrier	Six circular reflectors: 3 Eurobeam A(EBA), 2 Eurobeam B (ERB), 1 spot beam (SB). Peak gains of EBA, EBB and SB are, respectively, 26.5 dB, 29.1 dB and 35.5 dB. EBA uses orthogonal polarization. EBB uses circular polarization. SB uses orthogonal polarization. EBA is elliptical E-W, EBB is elliptical WNW-ESE, both cover N. Africa, Scandinavia, Middle East. SB is circular and centered on Switzerland. EBA: 7.5° x 4.25°. EBB: 5° x 3.5°. SB: 2.5°.	4 - 20W TWTA's	TBD	-3.6 <sub>0</sub> dB/K	In manufacture	Mission is to confirm soundness of general design	Forerunner of European communications satellite (ECS) to commence in 1980. See Ref. (32)

Table 2-2. Foreign Government Sponsored Communications Satel

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Symphonie A	Fr/FRG; CIFAS consortium	12/18/1974; Thor-Delta 2914 (AKM)	884; 506	Geo-syn-chronous; 5 years	3-axis with N-jets	Solar array; 2 Ni-Cd batteries	300 W BOL; 180W BOL; partial eclipse capability	11.5°W ± 0.5°E-W and N-S; 0.1°	2 repeaters using double conversion	Uplink from 5.94 to 5.03 GHz and from 6.195 to 6.285 GHz. Downlink from 3.715 to 3.80 GHz and from 3.97 to 4.06 GHz. Telemetry from 136 to 138 MHz. Command from 148 to 150 MHz.	90 MHz for each repeater
Symphonie B		8/26/1975; Thor-Delta 2914 (AKM)						11.5°W ± 0.5°E-W and N-S; 0.0°		Uplink from 6.32 to 6.41 GHz and from 6.065 to 6.155 GHz. Downlink from 4.095 to 4.185 GHz and from 3.855 to 3.93 GHz. TC s/a "A"	
Symphonie C		TBD						TBD		s/a "A"	

Table 2-3. Commercially Sponsored Communications S

Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Satellite Double Mission	Uplink from 5.94 to 6.03 GHz and from 6.195 to 6.285 GHz. Downlink from 3.715 to 3.80 GHz and from 3.97 to 4.06 GHz. Telemetry from 136 to 138 MHz. Command from 148 to 150 MHz.	90 MHz for each repeater		2-parabolic transmit antennas each with $13^{\circ} \times 8^{\circ}$ BW, one centered on $11^{\circ} E-11^{\circ} N$ with main axis U.K. - Madagascar, the other centered on $43^{\circ} W-3^{\circ} N$ with main axis Montreal Buenos Aires. 1-horn receive antenna, $17.2^{\circ}$ BW, 16 dB peak gain.	2-3W TWTA's	29 dBW at beam edge	-15 dB/K	In operation	1 video with 3 audio and 1 order-wire circuit per repeater, or 192 duplex audio circuits per repeater	See Ref. (10), (62)
	Uplink from 6.32 to 6.41 GHz and from 6.065 to 6.155 GHz. Downlink from 4.095 to 4.185 GHz and from 3.855 to 3.93 GHz. TC s/a "A"									
	s/a "A"							Ground spare		May be placed over India

Table 2-2. Foreign Government Sponsored Communication

SATELLITE	SPACECRAFT DATA								PAYLOAD CHAR		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	Bandwidth
Communications Satellite (CS); a/k/a Medium Capacity Communications Satellite for Experimental Purposes	Japan/NASDA; Mitsubishi Electric Aeronutronic Ford	11/77; Thor-Delta 2914 (AKM)	1485 at launch	Geo-synchronous; 3 years	Spin; hydrazine monopropellant with redundant thrusters	Solar array; 1 Ni-Cd battery	529W BOL; 475W EOL; full eclipse capability	135° E ± 0.1° E-W and N-S; 0° ± 0.1°	6 double-conversion K-band and 2 single conversion C-band transponders. TDA preamps for K-band; no preamps for C-band	K-band uplink from 27.5 to 31 GHz, downlink from 17.7 to 21.2 GHz. C-band uplink from 5.925 to 6.425 GHz, downlink from 3.7 to 4.2 GHz. TT&C operates at S-band and at C-band, xmits at 2.2868 GHz, revs at 2.1108 and at 6.175 GHz.	6-20 MHz char for 1 band 2-20 MHz char for 1 band S-band 1dB band width 4MHz
Maritime Orbital Test Satellite (MAROTS or OTS 2)	ESRO; Hawker Siddeley Dynamics	10/77; Thor-Delta 3914 (AKM)	1015 on-orbit	Geo-synchronous; 3 years.	3 axis	s/a OTS	360 W EOL; limited eclipse capability	40° E ± 0.1° E-W and N-S	Solid-State L-band repeater	S/C to ship: 1540 to 1542.5 MHz. Ship to S/C: 1641.5 to 1644.5 MHz. Shore to S/C: 14490 to 15500 MHz. S/C to shore: 11690 to 11700 MHz.	2.5 in sh to-s direction, MHz ship shor dire tion

Table 2-3. Commercially Sponsored Communications Sa

ent Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
able-con- on K-band single - ersion C- transpon- TDA amps for K- h, no pre- s for C-	K -band uplink from 27.5 to 31 GHz, downlink from 17.7 to 21.2 GHz. C-band uplink from 5.925 to 5.425 GHz, downlink from 2.7 to 4.2 GHz. TT&C operates at S-band and at C-band, xmits at 2.2865 GHz, reveas at 2.1108 and at 6.175 GHz.	6-200 MHz channels for K-band; 2-200 MHz channels for C-band. S-band 1dB bandwidth is 4MHz.	3.95 GHz carrier	1 despun horn reflector used for C- and K-band. K-band pattern covers main island group with 33 dBi gain at beam edge. C-band pattern covers Japanese territory with 25dBi gain at beam edge. Reflector has CP. S-band antenna is ring array with near-isotropic coverage. S-band antenna has RHCP for transmit and receive.	6-5W TWTA's for K-band; 2-5W TWTA's for C-band; TT&C use 1W device.	Output power is 34 dBm for K-band, 34.5 dBm for C-band, 31.5 dBm for S-band.	-4.6 dB/°K for K-band; -5.6 dB/°K for C-band; -7 dB/°K for S-band	In manu- facture	Video, data and audio capabilities. Mission includes emergency communication, S/C control and system operation. experiments at K-band.	Original contract let for 2 S/C. See Ref. (55)
id-State band eater	S/C to ship: 1540 to 1542.5 MHz. Ship to S/C: 1641.5 to 1644.5 MHz. Shore to S/C: 14490 to 15500 MHz. S/C to shore: 11690 to 11700 MHz.	2.5 MHz in shore-to-ship direction, 3.0 MHz in ship-to-shore direction		L-band shaped reflector (2 meters in diameter) with edge gain of 17.6 dB. Two X-band horns. This will provide earth coverage extending from mid-Atlantic to Singapore to Northern Antarctica to Scandinavia.	Linearized transistor PA for L-band. TWTA for X-band.	34 to 37 dBW	-14 dB/°K	In manu- facture	To be used in collaboration with two Marisat satellites. Audio, high speed data, teleprinter and telex capabilities.	Adaptation of OTS. Communications capacity influenced by ship terminals. See Ref. (33)

Table 2-2. Foreign Government Sponsored Communications :

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Palapa I	Indonesia; HAC	7/8/1976; Thor-Delta 2914 (AKM)	654 on-orbit	Geosynchronous; 7 years	Spin; hydrazine monopropellant	Solar array; Ni-Cd batteries	300 W BOL; 220 W EOL; partial eclipse capability	77° E ± 0.1° E-W	Single-conversion C-band transponders; 1 WB revr driving 12 NB xmtrs; redundant revr.	Revs from 5.925 to 6.425 GHz; xmits from 3.7 to 4.2 GHz; telemetry at 4.19825, 4.19875, 4.19925 GHz; tracking at 5.767 GHz.	36 MHz for each xmtr
Palapa II		Fall 1977; Thor-Delta 2914 (AKM)					83° E ± 0.1° E-W				
Sirio	Italian National Research Council; CIA S.p.A.	6/77; Thor-Delta 2313 (AKM)	875; 401	Geosynchronous; 2 years	Spin; hydrazine jets	Solar array; 2 Ni-Cd batteries	118 W BOL; 93 W EOL; no eclipse capability	15° W + 1° E-W and +0.3° N-S; 0° ± 0.3°	Propagation experiments: (1) absolute attenuation at 12 and 18GHz, (2) differential attenuation at 12 and 18 GHz, (3) phase distortion at 12GHz. NB communications experiment: 12 multiple access telephone carriers. WB communications exp (cont'd "Notes")	SHF: 11.15 to 12.05 GHz down, 16.95 to 17.85 GHz up. Command at 136.62, 136.14 and 148.26 MHz. Telemetry at 11.476, 2.2445, 2.2415 and 2.2505 GHz.	NB: 1.5MHz WB: 35 MHz

Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Con- ver- sion and sion s; ver 12 NB redun- dant.	Reves from 5.925 to 6.425 GHz; xmits from 3.7 to 4.2 GHz; telemetry at 4.19825, 4.19875, 4.19925 GHz; tracking at 5.767 GHz.	36 MHz for each xmtr	5.767 GHz carrier	5 ft. diameter parabolic reflector with offset feed horn configuration; coverage pattern includes Samatra, Java, West Irian, Kalimantan Islands. Uplink polarization parallel to spin axis; downlink polarization perpendicular to spin axis.	12-5 W TWTA's	30 dBW	$-7 \text{ dB/}^{\circ}\text{K}$	In operation	7000 duplex voice or 12 color video channels per satellite. 50 Mbps data rate per transponder.	Almost identical to Westar 1. See Ref. (59)
								In manufacture		
tion ents: lute on at 8GHz. rental on at 8 GHz, e dist- t 12GHz. nica- peri- ? mult- ss tel- arri- ? comm- ns exp- Notes")	SHF: 11.15 to 12.05 GHz down, 16.95 to 17.85 GHz up. Command at 136.62, 136.14 and 148.26 MHz. Telemetry at 11.476, 2.2445, 2.2415 and 2.2505 GHz.	NB: 1.5MHz; WB: 35 MHz		0.35m SHF paraboloid, 22.5 dB gain at 12 GHz, 23.5 dB gain at 18 GHz. VHF whip antenna. SHF coverage: (1) Italy, (2) Central Europe, (3) Europe plus North American East Coast. SHF xmit LHCP, SHF rcve RHCP.	2-9W TWTA's	31.5 dBW at beam center			Experiments	(cont'd) eriment: digital or FM video.

Table 2-2. Foreign Government Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Medium Scale Broadcasting Satellite for Experimental Purpose (BSE)	Japan / NASDA; Toshiba Electric General Electric	Late 1977; Thor-Delta 2914 (AKM)	1473 at launch	Geo-synchronous; 3 years	3-axis; hydrazine mono-propellant with redundant thrusters	Solar array; 3 Ni-Cd batteries	1000W BOL; 780W EOL; partial eclipse capability	110° E ± 0.1° E-W and N-S; 0°	2 single - conversion channels with redundant receiver and transmitter. Both channels use TDA preamps.	TT&C: 14 to 14.025 GHz up, 11.7 to 11.725 GHz down. Channel A: 14.25 to 14.3 GHz up, 11.95 to 12 GHz down. Channel B: 14.35 to 14.43 GHz up, 12.05 to 12.13 GHz down. Telemetry and ranging downlink is 2.2 GHz; command and ranging is 2.1 GHz.	50 MHz and 80 MHz video channel groups; 430 MHz effective total BW
Acme	India	No immediate plans for implementation	858; 458	Geo-synchronous	Spin with hydrazine jets	Solar array; Ag-Cd batteries	360 W BOL; limited eclipse capability	82° E	RF-to-RF transponder with direct frequency translation. WB frequency modulation.	6.055 to 6.4 GHz uplink; 3.855 to 4.2 GHz downlink	345 MHz

Government Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS							OPERATIONAL DATA			
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
single - conversion channels with redundant receiver and transmitter. Both channels use TDA preamps.	TT&C: 14 to 14.025 GHz up, 11.7 to 11.725 GHz down. Channel A: 14.25 to 14.3 GHz up, 11.95 to 12 GHz down. Channel B: 14.35 to 14.43 GHz up, 12.05 to 12.13 GHz down. Telemetry and ranging downlink is 2.2 GHz; command and ranging is 2.1 GHz.	50 MHz and 80 MHz video channel groups. 430 MHz effective total BW		S-band turnstile antenna for TT&C; K-band antenna is elliptical dish reflector with multibeam pattern to provide main-island coverage (MIC) and out-island coverage (OIC). MIC has 37dB xmit gain at beam edge, 41.5 dB receive gain. OIC has 28dB xmit gain at beam edge. K-band antenna uses 3-horn feed.	2-100W TWTA'S	TBD	TBD	In manufacture	Mission includes experiments to evaluate performance of ground systems, experiments of operational techniques for broadcasting satellite systems, experiments of S/C control techniques, experimental video and voice signal transmission	2 S/C being built. See Ref. (53), (54)
RF-to-RF transponder with direct frequency translation. WB frequency modulation.	6.055 to 6.4 GHz uplink; 3.855 to 4.2 GHz downlink	345 MHz	140 MHz signal on command	3.12 ft. parabolic antenna, mechanically despun with 5.1° BW.	TWTA	48 dBW		Proposed	Video, audio, data and facsimile. Multiple access to earth terminals. 1560 duplex telephone and 1 video capacity, or 1800 full duplex telephone capacity.	

Table 2-3. Commercially Sponsored Communication

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Westar I	Western Union; HAC	4/13/1974; Thor-Delta 2914 (AKM)	1270; 549	Geo-synchronous; 7 years	Spin; hydrazine jets	Solar array; Ni-Cd batteries	300W BOL; 220 W EOL. Limited eclipse capability	99° W ± 0.1° E-W and N-S; 0.0°.	Single conversion redundant receiver. WB receiver drives transmitters.	Receive center frequencies from 5945 to 6385 MHz in 40 MHz steps. Transmit center frequencies from 3720 to 4160 MHz in 40 MHz steps. Telemetry at 4198.25, 4198.75, 4199.25 MHz.	12-3 MHz channel
Westar II		10/10/1974 Thor-Delta 2914 (AKM)						123.5° W ± 0.1° E-W and N-S 0.0°.			
Westar III		TBD						TBD			

ally Sponsored Communications Satellite Characteristics

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PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
<p>redundant WB drives mitters.</p>	<p>Receive center frequencies from 5945 to 6385 MHz in 40 MHz steps. Transmit center frequencies from 3720 to 4160 MHz in 40 MHz steps. Telemetry at 4198.25, 4198.75, 4199.25 MHz.</p>	<p>12-36 MHz channels</p>	<p>5767 MHz</p>	<p>60 inch parabolic reflector with 4 dual-polarized feed horns. 27 dB gain at beam edge. Coverage to CONUS has beamwidth of 6.8 x 3.5°. 8.0° spot beam to Hawaii and Alaska. Receive polarization parallel to spin axis. Transmit polarization perpendicular to spin axis.</p>	<p>12-5W TWTAs</p>	<p>33 dBW for CONUS 26 dBW for Alaska and Hawaii</p>	<p>-6 dB/°K</p>	<p>In operation</p>	<p>System capacity (2 satellites) is 24 video or 28000 FDM simplex audio channels, or 1.44 Gbps simplex. Each transponder has 1 video or 50 Mbps data rate in SCPC mode. 7000 duplex audio circuits per satellite.</p>	<p>See Ref. (19), (48), (49)</p>
								<p>Ground spare.</p>		<p>Permanent location 91° W.</p>

Table 2-3. Commercially Sponsored Communications S

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Comstar A	Comsat General HAC	5/14/1976; Atlas Centaur (AKM)	3285; 1741	Geosynchronous; 7 years.	Spin; hydrazine jets.	Solar array, Batteries.	760 W BOL, 610 E EOL. Limited eclipse capability	128° W ± 0.1° E-W and N-S	Single conversion. 2 WB working receivers with one-for-one protection, each driving 12 xmit channels.	Vertical transmit center frequencies from 3720 to 4160 MHz in 40 MHz steps. Vertical receive center frequencies from 5945 to 6385 MHz in 40 MHz steps. Horizontal transmit center frequencies from 3740 to 4180 MHz in 40 MHz steps. Horizontal receive center frequencies from 5965 to 6405 MHz steps. Telemetry at 3700.5 and 4198 MHz. Command from 5925 to 5928 MHz.	24-36 MHz transponders
Comstar B		8/22/1976; Atlas Centaur (AKM)						119° W ± 0.1 E-W and N-S			
Comstar C		Fall 1976; Atlas Centaur (AKM)						128° W ± 0.1 E-W and N-S			
Comstar D		TBD						TBD			

Publicly Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
The converter system consists of two wideband receiving repeaters with frequency conversion, driving transmitters.	Vertical transmit center frequencies from 3720 to 4160 MHz in 40 MHz steps. Vertical receive center frequencies from 5945 to 6385 MHz in 40 MHz steps. Horizontal transmit center frequencies from 3740 to 4180 MHz in 40 MHz steps. Horizontal receive center frequencies from 5965 to 6405 MHz steps. Telemetry at 3700.5 and 4198 MHz. Command from 5925 to 5928 MHz.	24-36 MHz transponders	19 GHz, 28.6 GHz	2 gridded reflectors, one vertically polarized, one horizontally polarized. Vertically polarized reflector fed by 5-horn array, horizontally polarized reflector fed by 6-horn array. Telemetry and command bicone antennas. 6 millimeter wave experimental horns. CONUS broad beam coverage, Alaska, Hawaii and Puerto Rico spot beam coverage.	24-5W TWTAs. 2-1.5W TWT drivers.	33 dBW to CONUS Hawaii, Puerto Rico or Alaska only. 31 dBW to CONUS and Alaska combined.	$-8.8 \frac{\text{dB}}{\text{K}}$	In operation	Approximately 14400 duplex audio circuits	19 GHz and 28.6 GHz experimental transmitters carried on-board. See Ref. (19), (56), (57), (58)
								In launch preparation		
								Spare		

Table 2-3. Commercially Sponsored Communications Satellites

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Satcom A	RCA Globcom; RCA AED	12/12/1975; Thor-Delta 3914 (AKM)	2000; 1020	Geo-synchronous; 8 years	3 axis; hydrazine jets	Solar array; 3 Ni-Cd batteries	770 W BOL; 550 W EOL; full eclipse capability	119° W ± 0.1° E-W and N-S; 0.0°	24 single - conversion repeaters. Redundant rcvr/driver configuration.	Downlink: horizontal center frequencies from 3.74 to 4.18 GHz in 40 MHz steps, vertical center frequencies from 3.72 to 4.16 GHz in 40 MHz steps. Uplink: horizontal center frequencies from 5.945 to 6.385 GHz in 40 MHz steps, vertical center frequencies from 5.965 to 6.405 in 40 MHz steps. Telemetry at 4.1995 and at 3.7005 GHz. Command at 6.4235 GHz	24-36 MHz channel with frequency spectrum re-use. Command has 3 MHz BW

Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
<p>le - con- repea- ndant river ration.</p>	<p>Downlink: horizontal center frequencies from 3.74 to 4.18 GHz in 40 MHz steps, vertical center frequencies from 3.72 to 4.16 GHz in 40 MHz steps. Uplink: horizontal center frequencies from 5.945 to 6.385 GHz in 40 MHz steps, vertical center frequencies from 5.965 to 6.405 in 40 MHz steps. Telemetry at 4.1995 and at 3.7005 GHz. Command at 6.4235 GHz</p>	<p>24-36 MHz channels with frequency re-use. Command has 3 MHz BW</p>	<p>Ranging tones at 35.1 Hz, 283.4 Hz, 3.9681 MHz, 27.777 kHz</p>	<p>2 horizontally polarized and 2 vertically polarized reflectors. Horn has six feeds. Beams 1 and 3 cover CONUS and Alaska with beam size 8.4° x 3.2°, gain of 29.9 dB at beam center and 26.5 dB at beam edge, both horizontally polarized. Beams 2 &amp; 4 cover CONUS and Alaska with beam size 8.4° x 3.2°, gain of 30 dB at beam center and 26.5 dB at beam edge, both vertically polarized. Beam 5 covers Hawaii with beam size 2.6° x 1°, gain of 31 dB at beam center and 30 dB at beam edge, horizontally polarized. Beam 6 covers Hawaii with beam size</p>	<p>24 - 5W TWTA's</p>	<p>32 dBW to CONUS; 26 dBW to Hawaii</p>	<p>-7 dB/K for CONUS; -10 dB/K for Hawaii</p>	<p>In operation</p>	<p>1 video with audio or 900 half-duplex audio or 64 Mbps data per channel</p>	<p>See Ref. (19), (35)</p>

Table 2-3. Commercially Sponsored Communications Sa

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Satcom A (cont'd)	RCA Globcom; RCA AED		s/a "A"	s/a "A"	s/a "A"	s/a "A"	s/a "A"		s/a "A"	s/a "A"	s/a "A"
Satcom B		3/26/1976; Thor-Delta 3914 (AKM)						128° W ± 0.1° E-W and N-S			
Satcom C		10/1976; Thor-Delta 3914 (AKM)						99° W ± 0.1° E-W and N-S			

ally Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
s/a "A"	s/a "A"	s/a "A"	s/a "A"	2.6° x 1°, gain of 29.4 dB at beam center and 28.9 dB at beam edge, vertically polarized	s/a "A"	s/a "A"	s/a "A"	In operation	s/a "A"	
								In manufacture		

Table 2-3. Commercially Sponsored Communications Sa

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Marisat A	Comsat General HAC	2/19/1976; Thor Delta 2914 (AKM)	1445; 730	Geo-synchronous; 5 years	Spin; hydrazine jets	Solar array; Ni-Cd batteries	330 W BOL; 300 W EOL; full eclipse capability	15° W; 2.4°	1-WB and 2-NB UHF channels for maritime communications (currently leased by U.S.N.). C-band repeater for S/C-to-ET civil communications. L-band repeater for S/C-to-S/C links.	C-band uplink from 6.42 to 6.424 GHz. L-band uplink from 1.6385 to 1.6425 GHz. UHF uplink at 300 MHz. Command and ranging from 6.1725 to 6.1765 GHz.	WB UHF: 480 kHz; NB UHF: 24 kHz; 4 MHz for L/C and C/L

Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	FIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
and 2-NB channels maritime communications (N.). C-repeater C-to-ET communications. L-band repeater for to-S/C	C-band uplink from 6.42 to 6.424 GHz. L-band uplink from 1.6385 to 1.6425 GHz. UHF uplink at 300 MHz. Command and ranging from 6.1725 to 6.1765 GHz.	WB UHF: 480 kHz; NB UHF: 24 kHz; 4 MHz for L/C and C/L	Tracking at 1.5415 GHz; telemetry at 3.9455 and 3.9545 GHz	UHF helical array, 14dB gain at beam center, RHCP; 12.6 dB gain at earth edge. L-band helical array, RHCP, 17.8 dB gain at beam center, 14.2 dB gain at beam edge. C-band circular xmit horn, LHCP; C-band circular receive horn, RHCP; both have 19.1 dB gain at beam center, 15.7 dB gain at beam edge. Omnidirectional command cloverleaf, -1.5 dB gain. Linearly polarized telemetry bicone, 0 dB gain. Antenna coverage from Indian Ocean to Arctic Sea to Gulf of Mexico to Antarctic Ocean.	5W L-band TWTA. 3-level L-band TWTA with power outputs of 7 W, 30 W, 60 W	L-band: all UHF is for L/C; WB UHF only is 26 dBW. C-band: all UHF is 18.8 dBW; no UHF is 18.8 dBW. Total for all UHF is 30.1 dBW, for WB UHF is 28 dBW. These are representative operating modes	-17 dB / °K for L/C; -25.4 dB/°K for C/L	In operation	Telephony, real-time telegraphy, facsimile, data, broadcasting.	See Ref. (50), (51)

Table 2-3. Commercially Sponsored Communications S

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARAC			
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	
Marisat B	Comsat General HAC	6/9/1976; Thor-Delta 2914 (AKM)	s/a "A"	s/a "A"	s/a "A"	s/a "A"	s/a "A"	176.5 <sup>0</sup> W; 26 <sup>0</sup>	s/a "A"	s/a "A"	s/a "A"	
Marisat C		12/1976; Thor-Delta 2914 (AKM)						TBD				
Intelsat III (F-2)	Intelsat TRW	12/18/1968; TAD (AKM)	647; 334	Geo-synchronous; 5 years	Spin; hydrazine jets	Solar array; Ni-Cd battery	160 W BOL	30 <sup>0</sup> W; 5.7 <sup>0</sup>	2 independent linear single-conversion repeaters	Uplink from 5.93 to 6.155 GHz and from 6.195 to 6.42 GHz. Downlink from 3.705 to 3.93 GHz and from 3.97 to 4.195 GHz. Telemetry from 3.933 to 3.967 GHz. Command at 6.175 GHz.	225 MHz for each repeater	
Intelsat III (F-3)		2/5/1969; TAD (AKM)						57.6 <sup>0</sup> E; 3.8 <sup>0</sup>				
Intelsat III (F-4)		5/22/1969; TAD (AKM)						188.5 <sup>0</sup> E; 5.3 <sup>0</sup>				s/a F-3 except redundant rcvr
Intelsat III (F-6)		1/15/1970; TAD (AKM)						183.4 <sup>0</sup> E; 4.3 <sup>0</sup>				

ially Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
s/a "A"	s/a "A"	s/a "A"	s/a "A"	Antennas s/a Marisat A. Coverage from Arctic Ocean to Indian Ocean to Pacific Ocean to Antarctic Ocean.	s/a "A"	s/a "A"	s/a "A"	In operation	s/a "A"	
								In manufacture		Ground spare
7 independent linear single-conversion repeaters	Uplink from 5.93 to 6.155 GHz and from 6.195 to 6.42 GHz. Downlink from 3.705 to 3.93 GHz and from 3.97 to 4.195 GHz. Telemetry from 3.933 to 3.967 GHz. Command at 6.175 GHz.	225 MHz for each repeater	3.95 GHz at 30 dBm	1 mechanically despun conical horn with flat plate reflector, 24°/14.5° beamwidth at 4/6 GHz, gain of 16dB/21dB at 4/6 GHz. Xmit RHCP, reve LHCP.	2-12 W TWTA's	22 dBW per repeater at beam edge	-7 <sup>0</sup> / <sub>0</sub> K	In reserve	1500 circuits plus 4 video channels or combinations thereof.	6 dB of repeater gain lost. See Ref (5), (10), (19), (30)
s/a F-3 except redundant revr										

Table 2-3. Commercially Sponsored Communications S

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Intelsat IV (F-1)	Intelsat; HAC	5/22/1975; Atlas Centaur (AKM)	3120; 1610	Geo-synchronous; 7 years	Spin; hydrazine jets	Solar array; 2 Ni-Cd batteries	569 W BOL; 460 W EOL; partial eclipse capability	62.9° E ± 0.12° E-W and ± 0.25° N-S; 0.0°	12 linear or limiting (command selectable) single conversion repeaters. Redundant rcvr.	Uplink center frequencies from 5.95 to 6.4 GHz in 40 MHz steps. Downlink center frequencies from 3.725 to 4.175 GHz in 40 MHz steps. Command from 6.168 to 6.182 GHz. Telemetry at 3.9475 and at 3.9525 GHz.	36 MHz per repeater
Intelsat IV (F-8)		12/15/1974; Atlas Centaur (AKM)						174° E ± 0.12° E-W and ± 0.25° N-S; 0.6°			
Intelsat IV (F-2)		1/25/1971; Atlas Centaur (AKM)						1° W ± 0.12° E-W and ± 0.25° N-S; 0.1°			

cially Sponsored Communications Satellite Characteristics (Cont'd)

2

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
Linear or multiplexing (com- and selectable) single conversion repeaters. Redundant revr.	Uplink center frequencies from 5.95 to 6.4 GHz in 40 MHz steps. Downlink center frequencies from 3.725 to 4.175 GHz in 40 MHz steps. Command from 6.168 to 6.182 GHz. Telemetry at 3.9475 and at 3.9525 GHz.	36 MHz per repeater	3.95 GHz at 30 dBm	2-EC receive and 2-EC transmit conical horns with flat plate reflectors, 2-50 inch non-steerable parabolic SB reflectors for both receive and transmit. Transmit beam width 17°/4.5° for EC/SB mode. Transmit gain 20.5 dB/31.7dB for EC/SB mode. Transmit RHCP, receive LHCP. 1 omnidirectional command receive antenna, 1 omnidirectional telemetry transmit antenna.	12-6 W TWTA's. Receiver has 2-1.5 W TWTA drivers	22.5 dBW/34.2 dBW per repeater in EC/SB mode.	-18.6 dB/K	In operation	Average of 3750 circuits plus 2 video channels	See Ref. (5), (10), (19), (29), (30)
								In reserve		

Table 2-3. Commercially Sponsored Communications Sat

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Intelsat IV (F-3)	Intelsat; HAC	12/19/1971; Atlas Centaur (AKM)	s/a F-1	s/a F-1	s/a F-1	s/a F-1	s/a F-1	34.5° W ± 0.12° E-W and ± 0.25° N-S; 0.1°	s/a F-1	s/a F-1	s/a F-1
Intelsat IV (F-4)		1/22/1972; Atlas Centaur (AKM)						179° E ± 0.12° E-W and ± 0.25° N-S; 0.1°			
Intelsat IV (F-5)		6/13/1972; Atlas Centaur (AKM)						60° E ± 0.12° E-W and ± 0.25° N-S; 0.0°			
Intelsat IV (F-7)		8/23/1973; Atlas Centaur (AKM)						19.5° W ± 0.12° E-W and ± 0.25° N-S; 0.1°			

U.S. Navy Sponsored Communications Satellite Characteristics (Cont'd)

PAYLOAD CHARACTERISTICS								OPERATIONAL DATA		
Communication System	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure Of Merit (G/T)	Satellite Status	Operational Capability	Notes
s/a F-1	s/a F-1	s/a F-1	s/a F-1	s/a F-1	s/a F-1	s/a F-1	s/a F-1	In reserve	s/a F-1	

Table 2-3. Commercially Sponsored Communications Satellites

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARACTERISTICS		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Intelsat IVA (F-1)	Intelsat; HAC	9/25/1975; Atlas Centaur (AKM)	3240; 1820	Geo-synchronous; 7 years	Dual spin; hydrazine jets	Solar array; 2 Ni-Cd batteries	708 W BOL; 600 W EOL; partial eclipse capability	24.5° W ± 0.1° E-W and N-S; 0.2°	20 repeaters; 4 in EC mode, 16 in AC and SB mode	Uplink from 5.932 to 6.418 GHz. Downlink from 3.707 to 4.193 GHz. Command from 6.168 to 6.182 GHz. Telemetry at 3.9475 and at 3.9525 GHz.	36 MHz per repeater in single carrier mode; 32.4 MHz per repeater in multiple carrier mode
Intelsat IVA (F-2)		1/29/1976; Atlas Centaur (AKM)						29.5° N ± 0.1° E-W and N-S; 0.1°			
Intelsat IVA (F-3)		12/1976; Atlas Centaur (AKM)						TBD			
Intelsat V	Intelsat; Aeronutronic-Ford or HAC	1978 and beyond; Atlas Centaur (AKM)	TBD	Geo-synchronous; 7 years	3 axis	TBD	TBD	TBD	27 repeaters. S/C will use beam separation and dual polarization	Down at 4 and at 11 GHz. Uplink at 6 and at 14 GHz.	2.28 GHz effective



Table 2-3. Commercially Sponsored Communications

SATELLITE	SPACECRAFT DATA								PAYLOAD CHARAC		
	Sponsor and Manufacturer	Launch Date and Launch Vehicle	Launch and On-Orbit Weight (lbs)	Orbit and Design Life-Time	Stabilization	Power Source	Power Capacity	Location and Inclination	Communication Sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth
Unnamed Three-Satellite System	Satellite Business Systems (SBS); Manufacturer not specified to date	Primary launch first quarter 1979. Secondary launch second quarter 1979. Third flight model is ground spare. Thor-Delta 3914 (AKM)	2000; 1115	Geo-synchronous; 7 years.	Spin or 3 axis, TBD.	Solar array; Ni-Cd batteries	TBD; partial eclipse capability	Primary at 122° W, secondary at 110° W. Station keeping to be $\pm 0.05^\circ$ E-W and N-S.	Single conversion. Medium level, linear solid state drivers.	Uplink center frequencies (GHz): 14.031, 14.092, 14.153, 14.214, 14.275, 14.336, 14.397, 14.458 Downlink center frequencies (GHz): 11.731, 11.792, 11.853, 11.914, 11.975, 12.036, 12.097, 12.158. T, T&C uplink at 6.0 and 14.0 GHz. T, T&C downlink at 4.19775, 4.19725, 11.701 and 12.199 GHz. Back-up telemetry is 4.19725 GHz.	8-54 MHz channel for total of 500 MHz.

ally Sponsored Communications Satellite Characteristics (Cont'd)

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PAYLOAD CHARACTERISTICS							OPERATIONAL DATA			
Communication sub-system	Repeater and TT&C Frequencies	RF Channel Bandwidth	Beacon	Antenna	Power Amplifier	EIRP	System Figure of Merit (C/T)	Satellite Status	Operational Capability	Notes
Single conversion. Medium power, linear mod state variables.	Uplink center frequencies (GHz): 14.031, 14.092, 14.153, 14.214, 14.275, 14.336, 14.397, 14.458 Downlink center frequencies (GHz): 11.731, 11.792, 11.853, 11.914, 11.975, 12.036, 12.097, 12.158. T, T&C uplink at 6.0 and 14.0 GHz. T, T&C downlink at 4.19775, 4.19725, 11.701 and 12.199 GHz. Back-up telemetry is 4.19725 GHz.	8-54 MHz channels for total of 500 MHz.		One 60 cm. parabolic receive antenna. One or two 65 cm. parabolic transmit antennas. Transmitted signals are linearly polarized parallel to equatorial plane. Received signals are linearly polarized and orthogonal to the downlink signals. Each antenna will have dual feeds with shaped beamwidths of 2.8°. Will use one broad beam 4 GHz transmit antenna, one broad beam 6 GHz receive antenna, one broad beam 12 GHz receive antenna.	12-20W TWTA's (includes 4 spares) Total RF output communications power will be 2W in the 4 GHz band, and 0.1W in the 12 GHz band.	42 dBW in Region 1; 38 dBW in Region 2.	-2 dB/K in region 1; -6 dB/K in region 2	In proposal stage	Data rate will approach 41 Mbps per transponder.	Region 1 is in eastern Kentucky. Region 2 is centered in southern Pennsylvania and in Utah. See Ref. (31)

## GLOSSARY

"A"	refers to flight model "A" of a program series
AC	area coverage
A/C, a/c	aircraft
ADM	advanced development model
Ag-Cd	silver-cadmium
a/k/a	also known as
AKM	apogee kick motor
Alle	Soviet A-2 -e launch vehicle
AMSAT	Radio Amateur Satellite Corporation
ATS	Applications (Advanced) Technology Satellite
ave.	average
bps	bits per second
BOL	beginning of life
BW	bandwidth, beam width
CH	channel
CIA S.p.A.	Compagnia Industriale Aerospaziale
cm.	centimeter
C/L, C-L	C-band to L-band
comsat	communication satellite
CONUS	Continental United States
CP	circular polarization
dB	decibel
dBi	decibels of antenna gain referred to isotropic radiator
dBm	decibels of power referred to one milliwatt
dBW	decibels of power referred to one watt
DCA	Defense Communications Agency
DNC	defocused narrow coverage
DOD, DoD	Department of Defense

GLOSSARY (Cont'd.)

domsat	domestic communication satellite
down (link)	spacecraft transmitting
DSCS	Defense Satellite Communications System
E., E	east
EC	earth coverage
EDM	engineering development model
EIRP	effective isotropic radiated power
EOL	end of life
ESE	east-southeast
ESRO	European Space Research Organization
Est., est.	estimated
ET	earth terminal
E-W	east-west
F. A. A.	Federal Aviation Administration
FDM	frequency division multiplexing
FDMA	frequency division multiple access
FM	frequency modulation
F-1	refers to flight model "1" of a program series
Fr/FRG	France/Federal Republic of Germany
ft.	foot, feet
Gbps	gigabits per second
G. E.	General Electric Co.
GHz	gigahertz
GSFC	Goddard Space Flight Center
HAC	Hughes Aircraft Company
Hz	hertz
IF	intermediate frequency
IMPATT (diode)	impact avalanche transit time diode

GLOSSARY (Cont'd.)

$^{\circ}\text{K}$	degrees kelvin
kbps	kilobits per second
kHz	kilohertz
km.	kilometers
kW	kilowatt
L/C, L-C	L-band to C-band
lbs	pounds
LES	Lincoln Experimental Satellite
LHCP	left-hand circular polarization
m	meter, meters
M1	Molniya 1
MA	module A, model A
MB	module B
MBA	multiple beam antenna
Mbps	megabits per second
MHz	megahertz
MIT	Massachusetts Institute of Technology
MMD	mean mission duration
MMW, mmw	millimeter wave
mW	milliwatt
N., N	north, nitrogen
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NATO	North Atlantic Treaty Organization
NB	narrowband, narrow beam
Ni-Cd	nickel-cadmium
N-S	north-south
PA	power amplifier

GLOSSARY (Cont'd.)

preamp	preamplifier
PSK	phase shift keying
RCA	Radio Corporation of America
reve, rcvr	receive, receiver
Ref.	reference
RF	radio frequency
RHCP	right-hand circular polarization
S., S	south
S/A, s/a	same as
SAMSO	Space and Missile Systems Organization
SB	spot beam
SBS	Satellite Business Systems
S/C, s/e	spacecraft
SCPC	single channel per carrier
SED	SED Systems, Ltd.
SHF	super high frequency
Si	silicon
SPAR	SPAR Aerospace Products, Ltd.
STS	Space Transport System (Shuttle)
TAD	Thrust-augmented Delta
TBD	to be determined
TC	telemetry and command
TDA	tunnel diode amplifier
TDMA	time division multiple access
TRW	TRW Systems Group
T, T&C	telemetry, tracking and command
TTY	teletype

GLOSSARY (Cont'd.)

TWT, TWTA	traveling wave tube (amplifier)
UHF	ultra high frequency
U.K.	United Kingdom
up (link)	spacecraft receiving
U.S.A.F.	United States Air Force
U.S.N.	United States Navy
VHF	very high frequency
vocoded	voice coded
W., W	west, watt
WB	wideband, wide beam
WNW	west-northwest
xmit, xmtr	transmit, transmitter
2/10	2 meter-to-10 meter
70/2	70 centimeter-to-2 meter

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