

Plan of Advanced Satellite Communication Experiments using ETS-VI

Tetsushi Ikegami
Kashima Space Research Center
Communications Research Laboratory
Ministry of Posts and Telecommunications
Kashima, Ibaraki, 314 Japan

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Abstract--In 1992, an Engineering Test Satellite VI is scheduled to be launched by an H-II rocket. The missions of ETS-VI are to establish basic technologies of inter-satellite communications using S-band, millimeter waves and optical beams and of fixed and mobile satellite communications using multibeam antenna on board the satellite. This paper introduces a plan of the experiments.

1.Introduction

An Engineering Test Satellite VI (ETS-VI) is a 2-ton class, three axis stabilized satellite as shown in Figure 1, which is scheduled to be launched in 1992 by an H-II rocket. One of main missions of the ETS-VI is to develop basic technologies for advanced satellite communication systems in the future. This paper presents brief introduction for a plan of propagation and communication experiments using the ETS-VI.

2.Experimental system

The major characteristics of the ETS-VI and experimental communication payloads are summarized in Table 1. The ETS-VI has basic missions to establish advanced technologies such as inter-satellite communications, mobile satellite communications and fixed satellite communications (Shiomi et al, 1988) (Nakagawa et al, 1988)(Kitahara et al, 1989). Communications Research Laboratory (CRL) has three missions, and these are summarized as follows.

(1)S-band inter-satellite communications

CRL develops S-band (2.3/2.1GHz) inter-satellite communication payload (SIC) with a multibeam phased array antenna in cooperation with National Space Development Agency of Japan (NASDA). The specification of the SIC is summarized in Table 2. The SIC is compatible with the S-band Multiple Access (SMA) system of NASA's TDRSS. CRL and NASDA plan to conduct fundamental tracking and data relay experiments between ETS-VI and low orbit satellites. The SIC can also be used for the data relay of TDRSS SMA's user satellites. Figure 2 shows a concept of an S-band inter-satellite communication system.

(2)Millimeter wave satellite communications

CRL develops a millimeter wave (43/38GHz) transponder on the basis of research through the ETS-II (1977) and Japanese ECS (1979) satellite programs. The frequencies 43/38GHz are selected considering the atmospheric attenuation allowable in personal satellite communications and the achievable technology level of millimeter devices. The major specifications of the millimeter wave transponder are summarized in Table 3. The objectives of millimeter wave mission are to develop high

data rate inter-satellite communication technology and to study the feasibility of personal satellite communication system. Figure 3 shows a concept of this mission.

(3)Optical inter-satellite communications

CRL develops an optical communication system with a telescope of 75 mm in diameter, which has a beam pointing/tracking mechanism with a gimbal mirror. The onboard optical communication payload (Laser Communication Equipment, LCE) has fundamental optical communication functions with a laser diode transmitter of wave length 0.83 micron, a beam point-ahead mechanism, a receiver of wave length 0.51 micron, modulator/demodulator subsystems, and so on. These feature are summarized in Table 4, and a concept of this mission is shown in Fig. 4.

3.Frequency bands available for propagation experiments

The following frequency bands, which are used for corresponding missions, can be used for the propagation experiments.

2.3/2.1GHz	S-band inter-satellite communications
2.6/2.5GHz	Mobile satellite communications
30/20 GHz	Feeder links for the ETS-VI
32/23 GHz	Ka-band inter-satellite communications
43/38 GHz	Millimeter wave satellite communications
590/360THz	Optical inter-satellite communications

4.Conclusion

Experiments on advanced satellite communications will start in 1992 using an ETS-VI satellite. Propagation experiments are scheduled to carry out with several frequency bands such as 2GHz, 20GHz, 40GHz and 590THz.

References

- Shiomi, T. et al, "Plan of Advanced Satellite Communications Experiment Using ETS-VI," International Symposium on Space Technology and Science (ISTS), Sapporo, May 1988.
- Nakagawa, K. et al, "Fixed and Mobile Multibeam Communications Experiment Payload for ETS-VI," ISTS, Sapporo, May 1988.
- Kitahara, H. et al, "An Overview of Japan's Engineering Test Satellite VI (ETS-VI) Project," ICC'89, 52.3, Boston, June 1989.

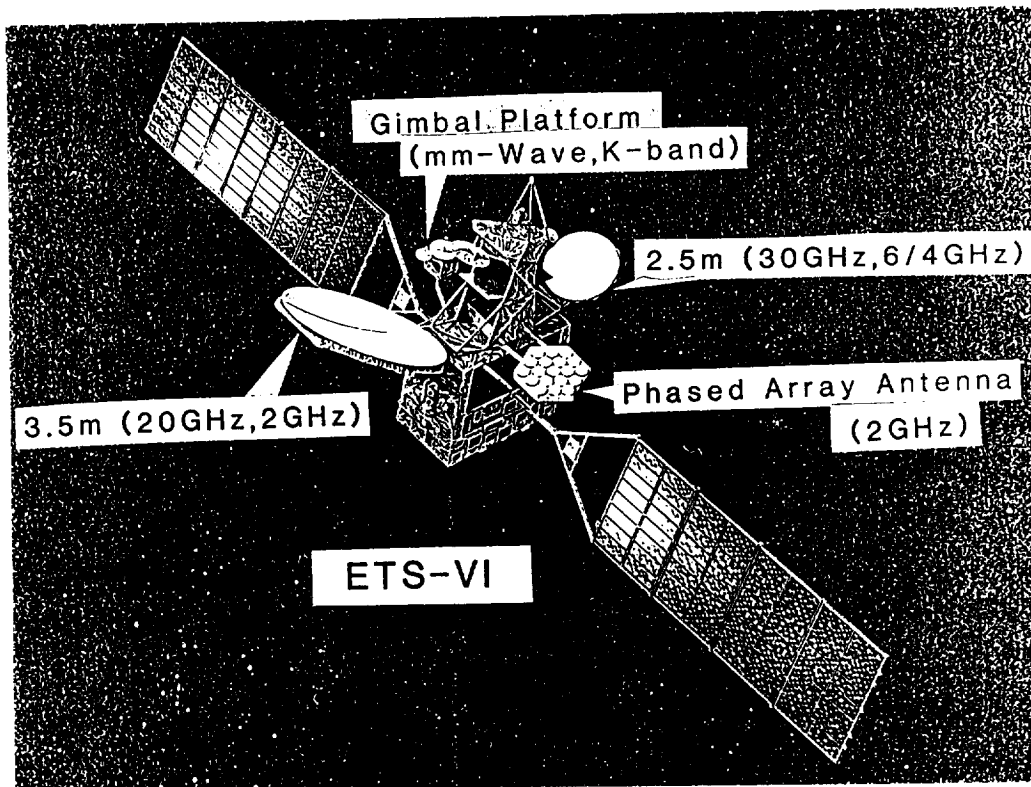


Fig. 1 ETS-VI

Table 1 Features of ETS-VI

Bus System	
Shape	Rectangular body with deployable solar paddles
Weight	Approx. 2 tons (beginning of life) Payload capacity 660 kg
Attitude Control	3-axis-stabilization
Life	10 years for satellite bus
Electric Power	4100 W (end of life at summer solstice)
Launch Vehicle	H-II rocket
Launch Date	Summer 1992
Payloads for Communications Experiment	
	Fixed and Mobile Satellite Communications
	S-band Inter-satellite Communications
	K-band Inter-satellite Communications
	Millimeter-wave Satellite Communications
	Optical Satellite Communications

Table 2 System performance of SIC

Frequency (GHz)	Forward	2.1034-2.1094
	Return	2.2845-2.2905
Data Rate	Less than 1.5 Mbps	
Modulation	PCM-PSK/SSMA	
Bandwidth	6 MHz	
Antenna	Multibeam Phased Array	
Field of View	20 degrees (covering satellites below 1000 km altitude)	
Return Link	Number of Beams	2
	Minimum Gain	27.4 dB (FOV)
	Polarization	LHC
Forward Link	Number of Beam	1
	Minimum Gain	27.1 dB (FOV)
	EIRP	35.5 dBW
	Polarization	LHC

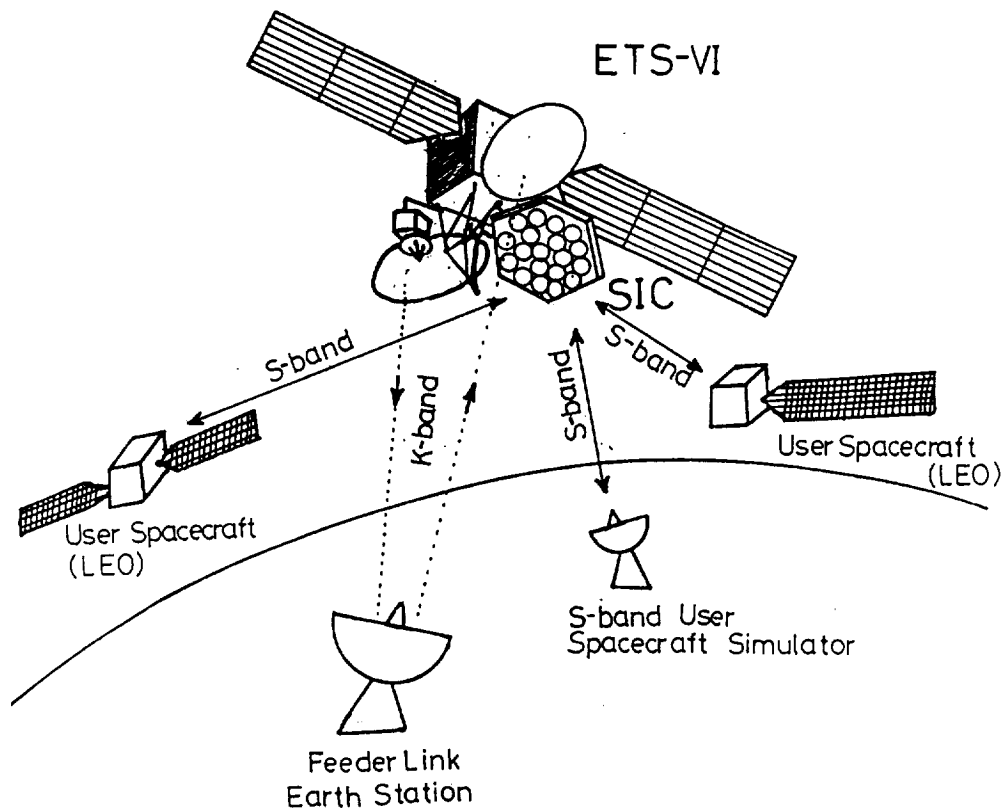


Fig. 2 S-band inter-satellite communications

Table 3 Specifications of ETS-VI millimeter-wave transponder

Frequency			
Receive	43.0	GHz	
Transmit	38.0	GHz	
IF	1.98	GHz	
Receiver NF (LNA front-end)	6.0	dB	
Transmit Power (SSPA)	0.5	W	
Local Oscillator Stability	3×10^{-7}	(-10 to +40 deg C)	
Phase Noise	-75	dBc/Hz	

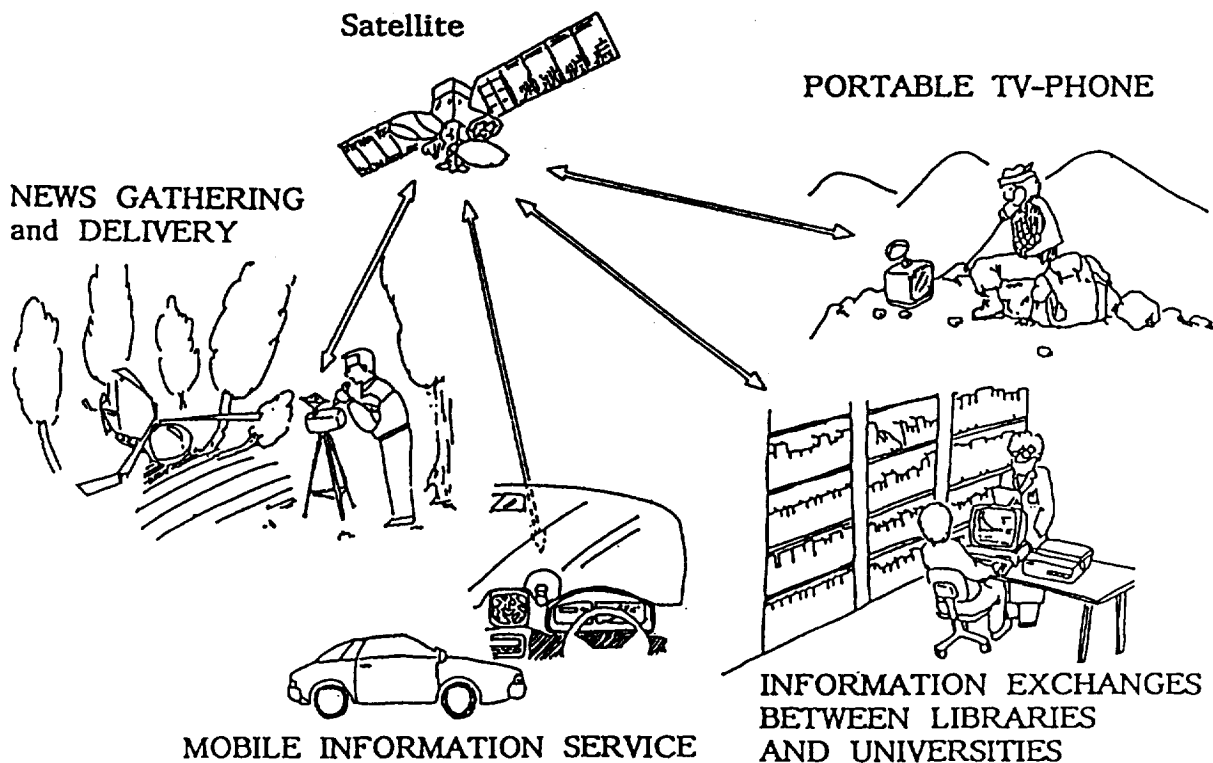


Fig. 3 Millimeter-wave personal communications via ETS-VI

Table 4 Main Features of LCE

Antenna	75 mm diameter telescope FOV 0.46 deg	
Tracking and Pointing	Coarse	Two-axis gimbal mirror and CCD sensor Beam steering angle 3.0 deg
	Fine	Fine-pointing mechanism with mirrors and 4QD (FOV: 400 microrad) Pointing accuracy 2 microrad
	Point-ahead Mechanism	mirrors on laminate-actuators
Receiver	Wave length	0.51 micron
	Bit rate	1 Mbps
	Detection	Direct detection by APD (FOV:200 microrad)
Transmitter	Redundant laser diodes(AlGaAs)	
	Wave length	0.83 micron
	Transmit power	10 mW
	Bit rate	1 to 10 Mbps
Modulation	Intensity Modulation with Manchester code	

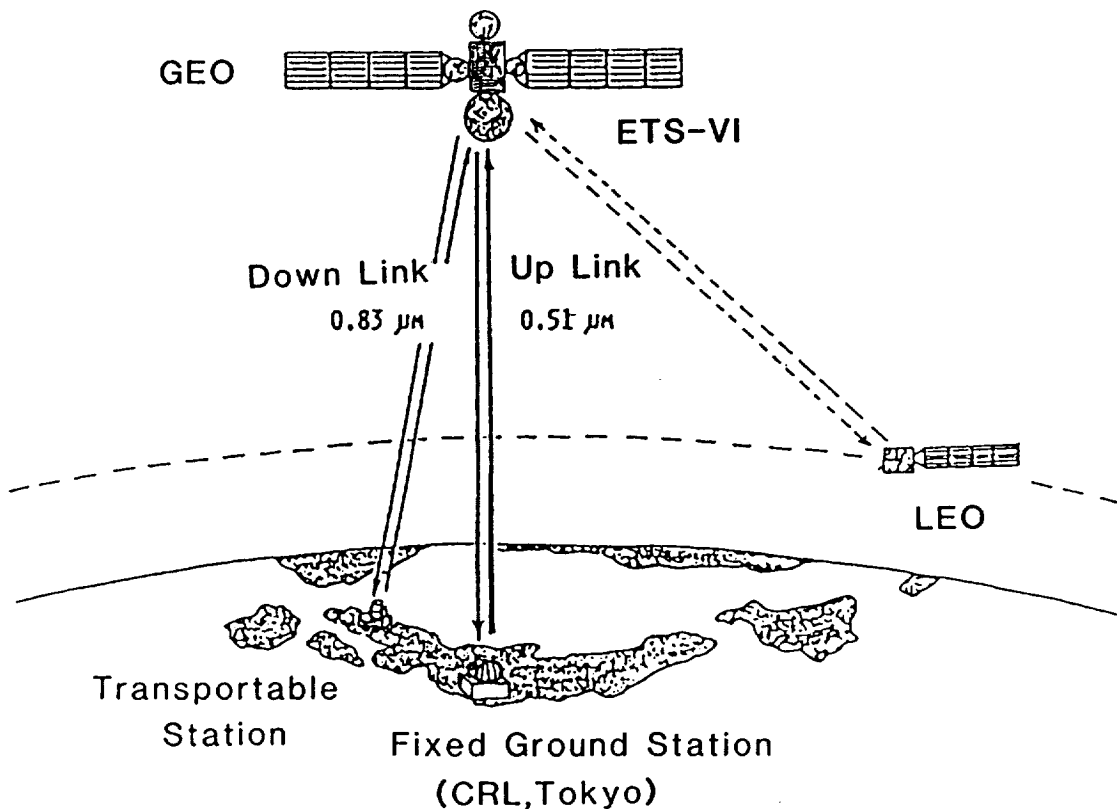


Fig. 4 Experimental system of optical satellite communications