EARTH OBSERVATION SATELLITE PROJECTS IN JAPAN

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Commission I

ABSTRACT

The paper deals with the basic policies of earth observation system and earth observation satellite projects in Japan. Two satellites, Marine Observation Satellite (MOS-1) and Earth Resources Satellite (ERS-1) have been approved to launch in 1986 and 1990 respectively.

In addition, the long-term vision for earth observation satellites have been proposed in July, 1983 by the Space Development Commission.

Information in this paper were obtained from governmental reports or committee reports, as the authors have been serving for long years as the members of committees or working groups for making drafts or recommendations to the Government in the field of remote sensing.

INTRODUCTION

Since the launch of LANDSAT-1 was announced by U.S.A., the Space and Technology Agency (STA), the Government of Japan started the Committee on Interpretation Techniques for Earth Resources Satellite Data in 1970. This Committee was responsible for investigations on ERTS imagery since ERTS-1 was launched in 1972.

STA submitted the Prime Minister the Recommendations for Promoting Earth Observation and its Execution System in 1973. According to the recommendations, a report titled " Long-term Vision on Space Development in Japan " was sumitted in June, 1977 by the Space Development Commission.

According to the Space Development Plan approved in 1977, LANDSAT Receiving Station was constructed in 1979. In 1979, the development of MOS-1 was approved as one of Marine Observation Satellite Series.

Since 1977, Inter-ministerial Meeting on Remote Sensing has plyed a role of coodination for comprehensive promotion in the field of remote sensing.

In July, 1983, the Space Development Commission submitted a report titled " Long-term Vision on Space Development in Japan " which was revised from the former report in 1977. In this report, not only remote sensing but also all other space technologies were proposed in the range up to the end of 1990's, that is the end of twenty centuries.

Functions and requirements of next generation's satellites or sensors are now studied under the Committee on Next Generation Earth Observation Satellites which is established in Remote Sensing Technology Center. The authors are serving to the Committee as remote sensing experts.

BASIC POLICIES OF SPACE DEVELOPMENT

The following three policies have been fundamental for space development in Japan.

1) *To develop own technologies* including rocket, three axis attitude control system, sensors, data processing devices, software and so on,

2) *To promote operational utilization* by integrating cooperation between users and developers,

and

3) *To promote international cooperation* to share the roles on space development and data utilization.

ROLES OF EARTH OBSERVATION

The following four roles are expected for Japanese earth observation satellites.

1) Data aquisition of surrounding sea area for fishery and oceanogrphic monitoring as well as domestic land area for land use, vegetation and natural disaster prevention,

2) Gloval information collection including mineral, energy, food etc.,

3) International cooperation to provide developing countries with satellite data, and to exchange or share information with advanced countries, and

4) Promotion of advanced technologies including semi-conductive sensors, data processing system and so on.

USERS OF SATELLITE DATA IN JAPAN

Operational utilization of satellite remote sensing data is limited to meteorology while utilization of LANDSAT data is becomming nearly operational in the specific fields. However, most of esers requeste the improvement of resolution, frequency of cloud free images and accuracy of classification or analysis.

Users of satellite remote sensing data in Japan are classified into the following five levels.

Level 1 : Established users of operational utilization

a. Resources Explorer : reconnaissance survey of mineral resources
b. Agricultural Development Organizations : selection of suitable land
c. Environmental Monitoring Agencies : monitoring of environment
d. Meteorological Agency : meteorological observation and forecast

Level 2 : Assured users of operational utilization

a. Coast Guard Agency : monitoring sea ice
b. Fishery Information Center : sea temperature mapping
c. Land Information Agency : renewal of land information
d. Geographic Survey Institute : small scale image map production

Level 3 : Expected users of operational utilization

a. Fishery Agency : monitoring of inland sea environment
b. Disaster Prevention Center : monitoring of natural disaster
c. Environmental Protection Agency : measurement of pollutants
d. Forestry Agency : monitoring of forest change
e. Farmers Union and Trade Companies : crop harvest forecast

Level 4 : Users of semi-operational utilization

a. Coast Guard Agency : current mapping
b. Environmental Protection Agency : monitoring of oil spill
c. Meteorological Agency : improvement of weather forecast
d. Ministry of Public Affairs : damage mapping by natural disasters
e. Ministry of Agriculture, Forestry and Fishery : crop identification
f. Japan International Cooperation Agency : resources management
g. Ministry of International Trade and Industry : industrial pollution control
h. Local Governments : regional survey and planning

Level 5 : Users for academic purposes

a. Solid Earth Physics : research on geoid and earth movement
b. Oceanography : research on ocean dynamics
c. Meteorology : research on heat exchange, polar ice, desertification, atmosphere etc.

LONG TERM EARTH OBSERVATION SATELLITE PROJECTS IN JAPAN

Three earth observation satellite series are proposed as follows;

1) Marine Observation Satellite (MOS) Series
2) Earth Resources Satellite (ERS) Series
3) Geostationary Earth Observation Satellite (GEOS) Series

Though only MOS-1 (1986) and ERS-1 (1990) are approved by the Government of Japan at the present(1984), the log term plan up to the latter half of 1990's is now being discussed in the Committee on " Next Generation Earth Observation Satellites ".

The term is divided into three terms as follows;

1) Latter half of 1980's

This term is defined as experimental stage for launching satellites, testing sensors and distributing data to various users. MOS-1 and ERS-1 will be launched in 1986 and 1990 respectively.

2) Former half of 1990's

This term is defined as engineering test stage. MOS-2 and MOS-3 will be launched. ERS-2a and ERS-2b as well as GEOS-1 will be launched in this term.

3) Latter half of 1990's

This term is defined as operational stage. Therefore multiple satellites will be launched to increase frequency of data aquisition. MOS-4a and 4b, MOS-5a and 5b, as well as ERS-3a and 3b and GEOS-2 will be launched in this term.

Earth Observation Technology Satellite (EOTS) for testing high resolution sensors and for developing on-board processing system will be launched in the end of 1990's.

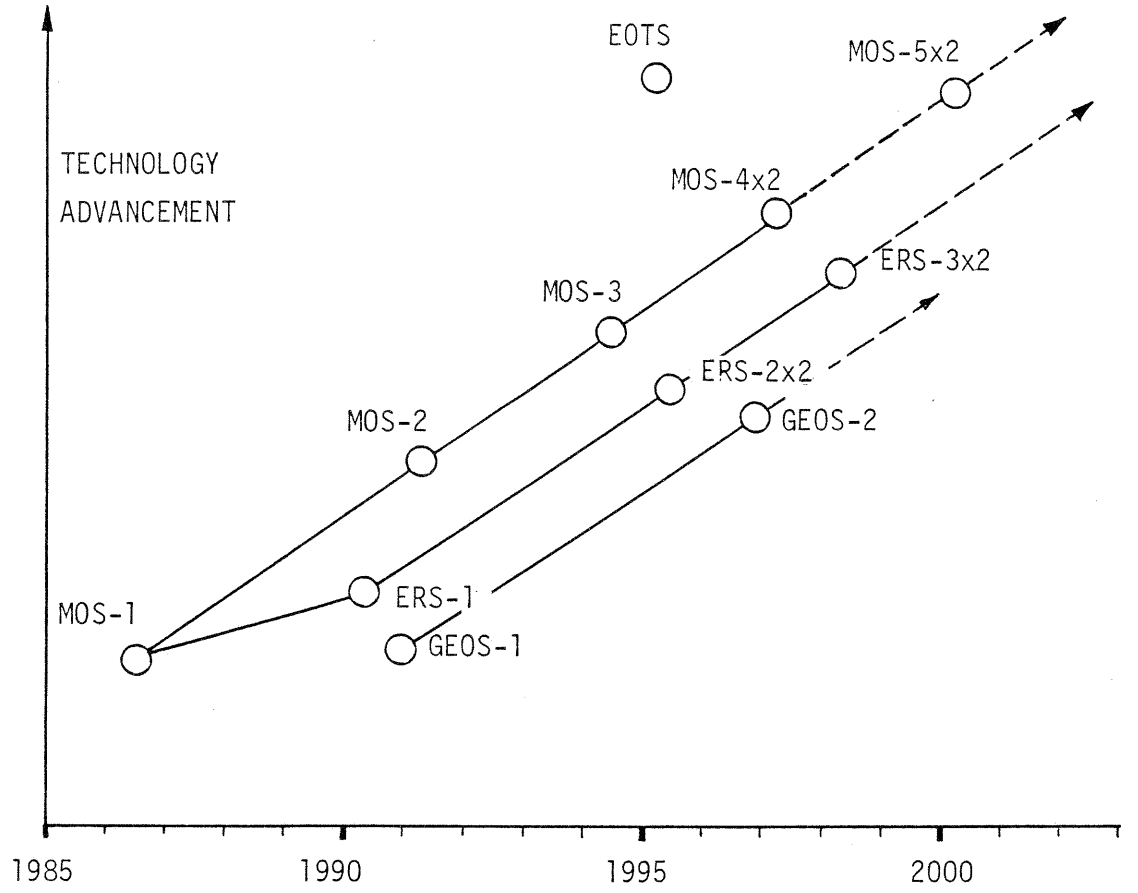

Figure 1 Earth Observation Satellite Series in Japan

Figure 1 shows the relation between earth observation satellite series and technology advancement.

Table 1, Table 2 and Table 3 summarize the major characteristics of MOS, ERS and GEOS series respectively.

MARINE OBSERVATION SATELLITE (MOS) -1

The National Space Development Agency (NASDA) will launch MOS-1 in 1986 under the direction of the Science and Technology Agency (STA), the Government of Japan.

Three sensors will be borne in MOS-1 as discribed below.

1) MESSR (Multispectral Electronic Self Scanning Radiometer)
2) VTIR (Visible and Thermal Infrared Radiometer)
3) MSR (Microwave Scanning Radiometer)

These sensors are now in the stage of flight model after completing Bread Board Model(BBM), Engineering Model(EM) and Proto-Flight Model(PFM).

The performance tests for these sensors will be done by using aircraft in the end of 1984. NASDA has called for investigators to aprticipate in the performance tests for these sensors by the end of February, 1984.

Table 1 Marine Observation Satellite Series

Year	Satellite	Purposes	Applications	Orbit	Sensors
1986	MOS-1	* Land cover * Turbidity * Sea temperature * Vapor	* Land survey * Fishery * Environment * Meteorology	* Sun synchronous * 900 KM * 18 days * 750 KG	* MESSR: 4 bands, 50 M * VTIR: 4 bands * MSR: 2 channels * DCS
Former Half of 1990's	MOS-2	* Sea temperature * Vapor * Cloud * Sea topography	* Fishery * Disaster prevention * Sea status monitoring * Meteorology	* Sun synchronous * 900 KM * 6 days/2 orbits * 900 KG	* Altimeter * VTIR * MSR * DCS * Data recorder
	MOS-3	* Sea topography * Sea wind * Chlorophyl * Sea temperature	* Safety control * Disaster prevention * Meteorology * Fishery	* 800 KM * 6 days/2 orbits * 1.4 TON	* Altimeter * Scatterometer * MSR * CZCS * DCS * Data recorder
Latter Half of 1990's	MOS-4a,b MOS-5a,b	* Ships * Sea wind * Sea topography * Chlorophyl * Sea temperature * Salinity	* Safety control * Navigation * Disaster prevention * Fishery * Meteorology	* 800 KM * 4 days/2 orbits * 2.2 TON	* SAR * Altimeter * Scatterometer * MSR * CZCS * DCS * Data recorder

Table 2 Earth Resources Satellite Series

Year	Satellite	Purposes	Applications	Orbit	Sensors
1990	ERS-1	* Geology * Land use * Vegetation * Chlorophyl	* Resources inventory * Land survey * Fishery * Environment * Disaster prevention	* Sun synchronous * 570 KM * 42 days * 1.4 TON	* SAR: L band, 25M * VNIR, 4 bands, 25M * Data recorder
Former Half of 1990's	ERS-2	* Geology * Land use * Vegetation	* Resources inventory * Agriculture * Land survey	* Sun synchronous * 900 KM * 48 days/2 orbits	* SAR: L band, 25M * VNIR, 6 bands, 15M * Data Relay System
Latter Half of 1990's	ERS-3	* Geology * Land use * Vegetation * Chlorophyl * Temperature	* Resources inventory * Agriculture * Land survey * Environment	* Sun synchronous * 700 KM * 18 days/2 orbits * 2.0 TON	* SAR: L band, 25M * VNTIR: visible -3 bands (15 M) NIR-3 bands (100 M) TIR-3 bands * VNIR , 4 bands, 50M * Data Relay System

Table 3 Geostationary Earth Observation Satellite Series

Year	Satellite	Purposes	Applications	Orbit	Sensors
Former Half of 1990's	GEOS-1	* Chlorophyl * Cloud * Sea temperature * Red tide * Sea color * Atmosphere	* Oceanography * Meteorology * Disaster prevention * Environment * Fishery	* Geostationary * 36,000 KM * Real time * 1.0 TON	* VNIR, 4 bands, 1 KM * TIR, 4 bands, 5 KM * MSR: 18, 24, 31 GHz * DCS
Latter Half of 1990's	GEOS-2	* Chlorophyl * Cloud * Sea temperature * Current	* Oceanography * Disaster prevention * Fishery * Environment	* Geostationary * 36,000 KM * Real time * 2.0 TON	* VIR; V/NIR: 4 bands, 1KM TIR: 4 bands, 3KM * SAR, X band, 25 M * MSR: 5,10,20,30 GHz * DCS * Data Relay System

1) *MESSR (Mutispectral Electronic Self Scanning Radiometer)*

MESSR is a pushbroom scanner with Charge Coupled Device (CCD) image sensor. The major characteristics are summarized in Table 4.

Figure 2 shows three folded non linear gain curves which will be adopted to two visible bands in order to permit high gain for low reflection range, for examples, water body and vegetation.

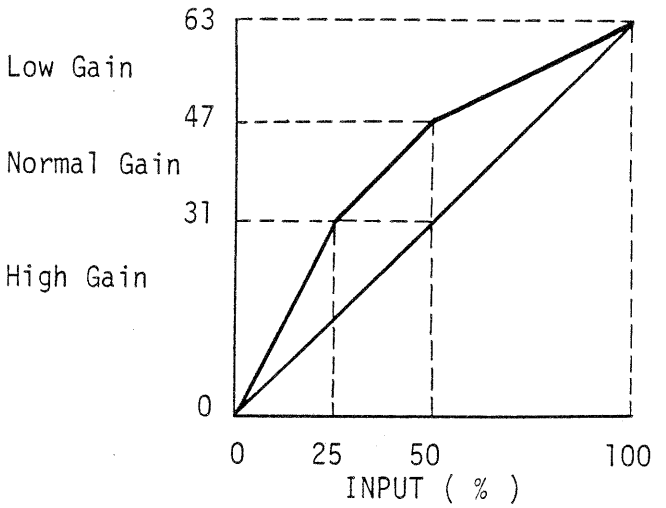

Figure 2 Non Linear Gain Curves for MESSR

2) *VTIR (Visible and Thermal Infrared Radiometer)*

VTIR is amechanical scanner for marine observation in the wide area with rather low resolution IFOV. The major characteristics are shown in Table 5.

3) *MSR (Microwave Scanning Radiometer)*

MSR is not an imaging sensor but a sensor for atmospheris correction by detecting liquid cloud and water vapor.

MSR has two channels of 23.8 GHz for liquid cloud and 31.4 GHz for water vapor. IFOV of MSR is 32 KM for 23.8 GHz and 23 KM for 31.4 GHz respectively for the swath width of 320 KM.

Figure 3 shows the data format for image data taken by MESSR and VTIR.

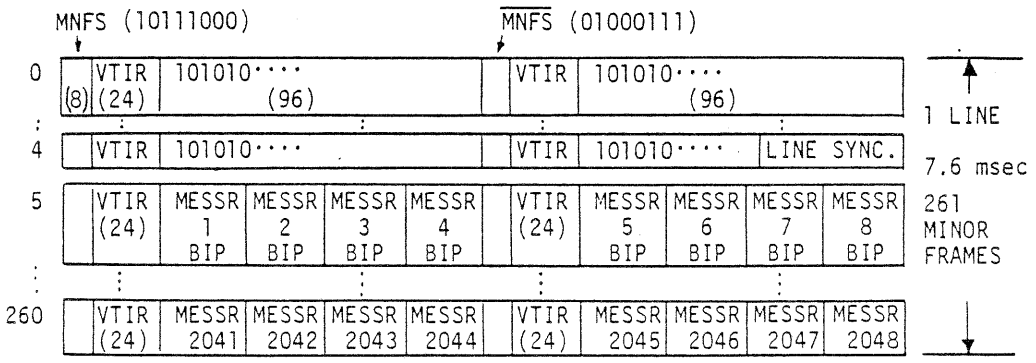

Figure 3 Data Format for MESSR and VTIR Image Data

Table 4 Major Characteristics of MESSR for MOS-1

Spectral bands	1. 0.51 - 0.59 um 2. 0.61 - 0.69 um 3. 0.72 - 0.80 um 4. 0.80 - 1.10 um
Swath width	2x 100 KM
Detector	2x 2048 CCD/ band
IFOV	55 urad. or 50 M on the ground
Quantizing bits	6 bits
Photo sensivity	± 30 %
Data rate	8 Mb/s
Signal to noise ratio	38 dB : designed 37 dB : observed
Scanning period	7.6 msec
Output frequency	8 GHz (X band)
Output power	4 W
A/D Conversion	non linear for visible bands (1&2) linear for IR bands (3&4) (see Figure 2)

Table 5 Major Characteristics of VTIR for MOS-1

Spectral bands	1. 0.5 - 0.7 um 2. 6.0 - 7.0 um 3. 10.5 - 11.5 um 4. 11.5 - 12.5 um
Swath width	1500 KM
IFOV	900 M for visible band 2700 M for thermal IR bands
Quantizing bits	6 bits
Data rate	0.8 Mb/s

EARTH RESOURCES SATELLITE (ERS) -1

ERS-1 has been approved by the Government of Japan to launch in 1990. Though the final design of sensors and other paprameters are not yet finalized, the preliminary design was proposed as shown in Table 6.

Two sensors of SAR (Synthetic Aperture Radar) and VNIR (Visible and Near Infrared Radiometer with 25 m resolution will be borne in ERS-1.

Table 6 Major Characteristics of ERS-1

Launching year	1990
Altitude	570 KM
Orbit	Sun synchronous
Attitude control accuracy	± 0.3°
Sensors	
1) SAR	
Swath width	75 KM
Resolution	25 M
Data rate	60 Mb/s
Band	L band (1275 MHz)
Off nadir angle	33°
Polarization	H-H
2) VNIR	
Swath width	150 KM
Resolution	25 M
Data rate	60 Mb/s
Bands	1) 0.45 - 0.52 um 2) 0.52 - 0.60 um 3) 0.63 - 0.69 um 4) 0.76 - 0.95 um
FOV	15.4°
CCD	2048 elements x 3

REFERENCES

1) Space Development Division, Space and Technology Agency; "Utilization Vision on Earth Observation Satellites"; Oct., 1982

2) Space Development Commission; "Long Term Vision on Space Development in Japan"; July, 1983

3) R.Kuwano et al. ; "Multispectral Electronic Self Scanning Radimeter for MOS-1"; NEC Research & Development, No.64, Jan., 1982

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