Local area network and data network for the Advanced Earth Observing Satellite, ADEOS system

Kohei Arai *

* Earth Observation Center,
National Space Development Agency of Japan

Abstract

NASDA is planning the next generation of earth observation satellite, following MOS-1, MOS-1b, JERS-1, so called Advanced Earth Observing Satellite, ADEOS. ADEOS will carry Ocean Color and Temperature Scanner, OCTS, Advanced Visible and Near Infrared Radiometer, AVNIR and Anouncement Opportunity sensors, AO sensors and will require a quick data distribution. Not only direct broadcasting, but also data distribution through a network are usefull for the dissemination of such data. Therefore a data network of which users can access a quicklook image data base in a quasi real time basis is now considered.

In order for the preoperational data handling, a local area network is taken into account for an ADEOS ground facility. The processed data are sent to the film recorder through the LAN together with histograms for the generation of look up table for the gamma correction. Key items of the processed data are also transmitted to the information retrieval subsystem for the registration. The aquired quick look data are transmitted to not only the film recorder but also quick look image data base and the information retreival subsystem in a real time basis.

The aforementioned ideas and concept for the development of the ADEOS ground facility will be described in the proposed paper.

Presented at the ISPRS held in Kyoto, Japan, in July 1988.

1. INTRODUCTION

Primary purposes of the development of the Advanced Earth Observing Satellite : ADEOS are
i) to provide opportunities to onboard mission instruments and collect information using the instruments for the countries in the world,
ii) to ensure earth observing data starting with MOS-1 through MOS-1b, JERS-1,
iii) to establish the fandamental technologies on development of the Polar Orbiting Platform. Outline of the ADEOS system has been introduced in Ref.1.

In order to respond to requirements or social demands for earth observation from space, earth observation system consists of not only satellite but also ground facilities including data networks for transmission of mission data, should be matured and improved. For instance, there must exists a strong desire of real time or quasi real time data transmission for the purpose of finding of the fishery ground area, desaster prevention, monitoring sea ice, and so on. Therefore satellite orbit should be determined to increase the observation frequency, namely, subcycle of satellite orbit should be minimized, futhermore, quick transmission of the mission data such as direct transmission for local users' stations, data transmission of the acquired and processed data through a network, should be taken into account. On the other hand, efficiency of ground facilities on data handling and processing should also be improved.

Regarding with image data networks, NOAA has a plan of NOAA-port (Ref.2), ESA also has a TIROS-net (Ref.3), and NASA has a plan of EOSDIS : EOS Data and Information System (Ref.4) while NASDA has a plan of SODS : Space Operation and Data System (Ref.5).

This paper will deal with local area network for improvement of the efficiency of ground facilities on data handling, and data network for quick data transmission for ADEOS system, and will describe the relationship between SODS and image data network. Furthermore Direct Transmission for Local Users' stations : DTL system for decimated OCTS data transmission will also be descrived.

2. The communication link for ADEOS data transmission

2-1. The ADEOS data link system

The ADEOS data link system is illustrated in Fig.1. Mission data are directly transmitted to receiving stations via X-band, and are also transmitted to the specified receiving stations through the Data Relay and Tracking Satellite : DRTS via Ka-band. As the DRTS, NASDA is now planning ETS-VI (available data rate for mission data transmission will be ristricted by 2.6 Mbps), and EDRTS (available data rate would be 120 Mbps) as is indicated in Table 1. ETS-VI will be launched in 1992 followed by ADEOS in 1993, and EDRTS in 1994. Design life for the ADEOS satellite would be three years. Therefore, until the EDRTS is

launched, only Ocean Color and Temperature Scanner : OCTS data (data rate for OCTS data would be 2.6 Mbps) might be transmitted through ETS-VI. After the lauching of the EDRTS satellite, full operation at data transmission through the DRTS satellites will be available.

The ADEOS satellite will carry not only OCTS but also Advanced Visible and Near Infrared Radiometer; AVNIR featuring CCDs as the core sensors while Announcement of Opportunity : AO sensors will also onboarded on the satellite. These sensor data will be transmitted directly to the receiving stations and will also be transmitted to the specified receiving stations through the DRTS satellites.

2-2 Direct Transmission for Local Users

In order for real time data transmission, decimated OCTS data will be transmitted directly to the Local Users' stations such as fishermans' ships, etc, via UHF band.

(1) Channel Selection

Chrolophil concentration : Cc, in general, can be expressed by the following equation.

$$Cc = a \left(B1 / B4 \right)^{b} \qquad (1)$$

where a and b are coefficients, and B1 and B4 are Digital Count Values : DCVs of band 1 and 4. OCTS will have 6 bands in the visible wavelength region, while 2 bands for near infrared, 1 band for middle infrared, and 3 bands for thermal infrared. On the other hand, it is difficult to have a wide bandwidth in the UHF-band for the direct data transmission to local users. Therefore DTL system will deal with 2 channels of the decimated OCTS data. One of those is the channel cooresponding to the chrolophil concentration expressed by equation (1). The other is one of the thermal infrared bands data. The expected specification of OCTS is shown in Table 2.

(2) Decimation and adjustment of the pixel interval

Instantanuous Field of View : IFOV of OCTS would be 0.85 mrad corresponding to approximately 690 m on the ground at nadir viewing. On the other hand, the acceptable ground resolution of OCTS type of sensors is around 4 km. Therefore the decimation factor of 6 is determined. IFOV on the ground is changed by not only the viewing angle but also tilt angle so that the pixel interval will be adjusted by using Look Up Tables : LUTs to compensate the pixel intervals in the scanning direction.

(3) Bandwidth and Modulation scheme for DTL

Data rate of the decimated OCTS data would be 20.6 kbps. Modulation scheme would be PCM(Bi-phase) - PM with the modulation index for PM of 1.2 radian so that bandwidth would be 181.28 kHz.

3. Local Area Network : LAN for ADEOS ground facility

3-1 Block diagram of the ground facility for ADEOS system

Fig. 2 shows the system block diagram of the ADEOS ground facility. In the time frame of ADEOS operation, Earth Observation Center : EOC of NASDA will acquire the data from LANDSAT-6, SPOT-4, JERS-1, ADEOS, and will also receive the relayed mission data through ETS-VI and EDRTS satellites. Antenna system at EOC will be composed with two antennas for direct reception of mission data via X-band with a buckup function, and two antennas for the reception of data relay and tracking satellites (East and West). These antenna sytems will be supervised by Mission Management Organization : MMO. MMO will gather information and mission requests from Spacecraft Control Center through SODS, Ground Stations : GSs and Users through NOAA-port, TIROS-net, and the other links or networks, and will make operation schedules for ground facility then distribute to each subsystems in a real time basis through LAN. The acquired high bit rate data will be stored in HDDTs in a real time basis for the data will also be processed quick look images and quick look imagery data will be transmitted to the Mass Storage System : MSS as a quick look image data base through LAN in a real time basis. Therefore users may access the quick look image data base with an authorized users' ID codes. Meanwhile low bit rate data will be stored in optical disks in a real time basis and then processed at a small sized processors. At this moment, optical tape is one of the tradeoff items as an archiving media.

3-2 Data should be transmitted

Data types, required data rate, amont of data should be transmitted are shown in Table 3. Amont of quick look image is data transmitted within a day, through LAN are shown in Table 4. In Table 3, decimation factors for AVNIR and OCTS are, respectively, 10 and 6 in both line and pixel directions. Therefore the standardized low bit rate networks such as the ethernet (the effective transmission rate is about 1 Mbps) would be enough. In the future (the time frame for POP), LAN futuring optical fiber with the transmission rate of 100 Mbps will be installed at EOC. At that time, the ethernet will be connected with a node of the optical fiber LAN.

4. Data Network System : DNS

4-1 Baisc idea for DNS

(1) Utilize the established or installed networks such as telephone links with MODEMs, VAN : Value Added Networks, WAN Wide Area Networks,and so on.

(2) Basically users access to the catalog data base and quick look image data base will be installed at EOC. EOC will not transmit such types of data.

(3) Data link between SODS and EOC will be neccesary for the purpose of the site diversity function for acquired data from DRTS satellites.

4-2 Users to access

Users who wish access to the data bases can be categorized into the following four types.

(1) The specified users : with the specified links

(2) General users : with the telephone links

(3) External users in the forein contries (EOSDIS, NOAA-port, TIROS-net, etc) : through the KDD Vienus-p links for instance

(4) Internal users (SODS, etc) : optical fiber links, or communication satellite channels, and so on.

5. Concluding remarks

A conceptual design of ground facility for ADEOS system is now on going. For more detailes, we will report at the other opportunity.
Earth observation system, essentially, can world wide observation. In some application fields, there must exist a strong desire of data transmission in real time or quasi real time basis. In order to encourage users community, and to improve efficiency of ground facilities on data handling, world wide remote sensing data networking is getting more important.

References

(1) Koizumi, S and K. ARAI, A future program on remote sensing satellite in Japan - Advanced Earth Observing Satellite : ADEOS - , International Space Year Conference in Hawaii, 19 - 21 Aug. 1987.

(2) NOAA, CEOS Working Group on Data meeting, 1987.

(3) ESA, CEOS Working Group on Data meeting, 1987.

(4) NASA, CEOS Working Group on Data meeting, 1988.

(5) NASDA, personal correspondence, 1988.

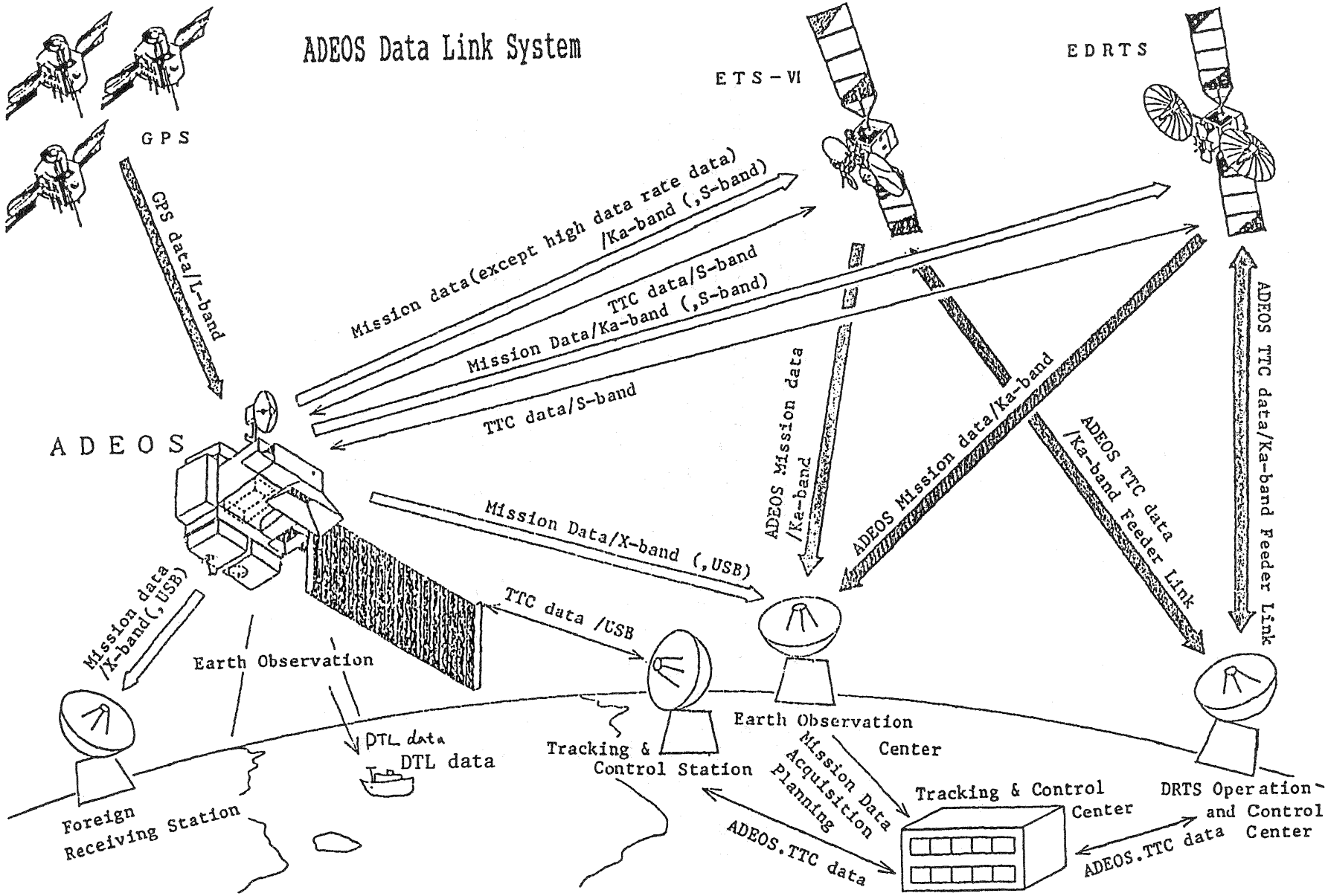

Fig. 1 The ADEOS Data Link System

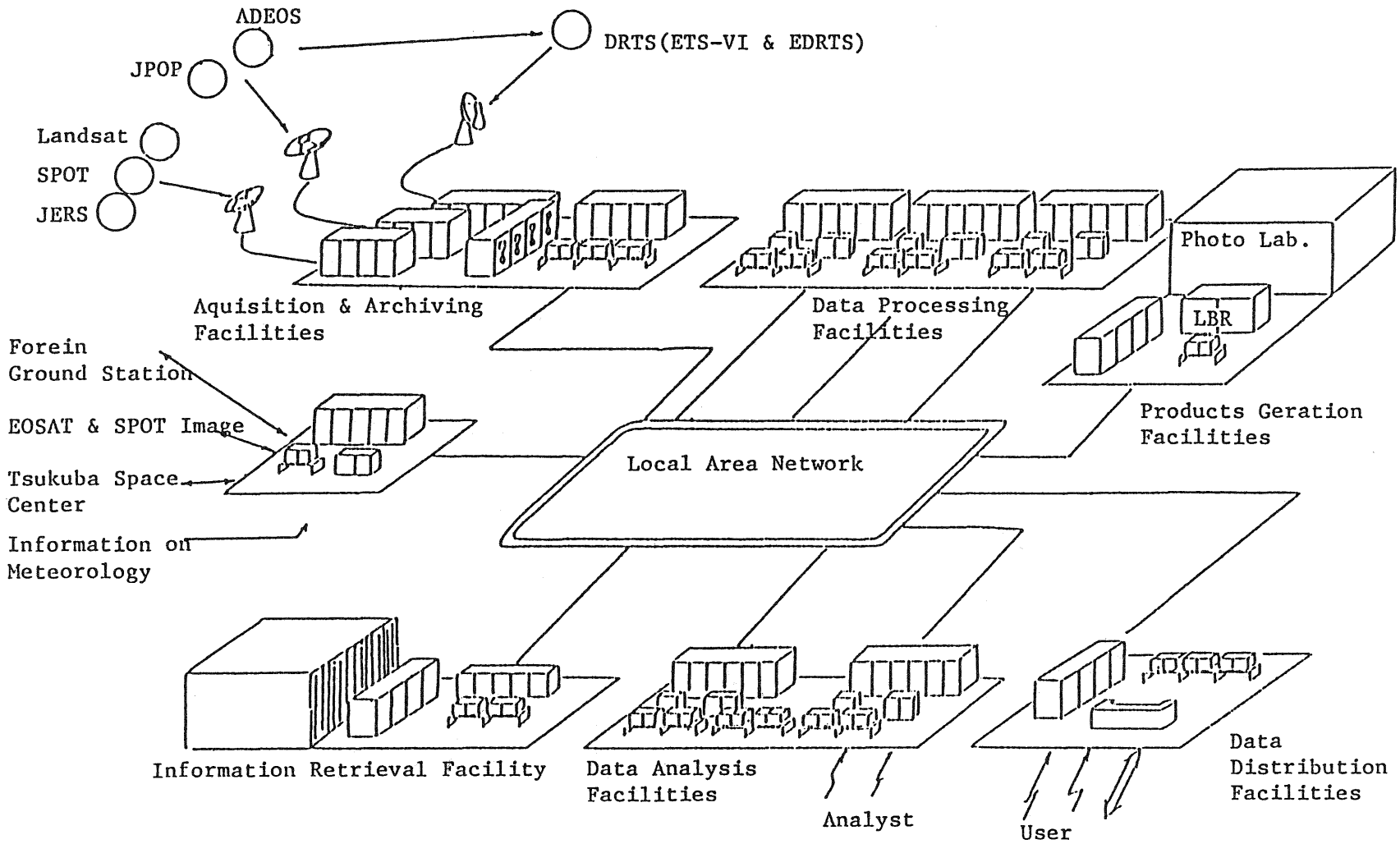

Fig. 2 Data acquisition System for ADEOS

Table 1 Communication Link to Access to ADEOS

Item	Frequency band	Data Rate	Content
VIA EDRTS	Ka band A - E:S band E - G:Ka band	120 Mbps 1 - 2 Kbps	Mission data TTC data
VIA ETS-VI	Ka band A - E:S band E - G:Ka band	2 Mbps 1 - 2 Kbps	A part of Mission data TTC data
EOC/Forein Ground Station	X band	60 Mbps x 2	Mission data
TACS/Forein Tracking Station	USB	1 - 2 Kbps	TTC data
Direct Access	UHF or VHF	1 - 100 Kbps	DCS or DTL data

A - E:ADEOS to EDRTS or ETS-VI
E - G:EDRTS/ETS-VI to DRTS ground station

Table 2 Specification of OCTS

Item	Specification(Goal)
Wave Length Region	Visible:6 bands, Middle IR:1 band, Near IR:2 bands, Thermal IR:3 bands
Scan Angle	Approximately +/- 40 deg.
IFOV	0.85 mrad(1.7 mrad for mid. IR)
Tilting Angle	+/- 20 deg.(5 deg. step)
Scanning Sytem	Mechanical Mirror Vibration
Optics	Reflection type
Weight	Approximately 180 kg
Power Consumption	Approximately 240 W

Table 3 Data types and the required data rates

Data	Amont	Frequency	Media	Data Rate
Satellite Operation Schedule	30 KB	2 / day	Telephone link	1200 bps
Orbital Elements	1 KB	2 / day	"	"
Data Reception Requests	30 KB	1 / day x 10 St.	"	"
Data Processing Requests	1 KB	1 / day x 100	"	"
On-line retrieval	300 KB	1 / day x 100	"	"
Satellite Operation Requests	30 KB	2 / day	"	"
Acquisition Schedule	30 KB	1 / day	LAN	100 Kbps
Data Processing Schedule	30 KB	1 / day	"	"
Orbital Elements	1 KB	20/ day	"	"
Path Bliefing Message	30 KB	1 / day	Telephone Link	1200 bps
Telemetry Data	20 KB	4 / day	LAN	100 Kbps
Q/L Data	300 KB	4 / day	"	"
Data Acquisition History	1 KB	4 / day	"	"
Data Recording History	1 KB	4 / day	"	"
Processed Data	250 MB	4 / day	"	"
Auxial Data for Photo Products	1 KB	10/ day	"	"
Data Processing History	1 KB	10/ day	"	"
Media Conversion History	1 KB	10/ day	"	"

Table 4 Q/L Data Amont Within a Day

	AVNIR data	OCTS data	NSCAT data
Case 1	3.4 GB	0.264 GB	0.953 MB
Case 2	0.8 GB	0.025 GB	0.042 MB

Case 1.: The relayed data through DRTS are included
Case 2 : Without consideration of DRTS data