Technical Conditions for Large Volume Data Handling on Future Earth Observation Ground System

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Abstract

The increase of earth observation data raises a problem how to cope with and handle a large amount of data at future ground segment.

Necessary technical solutions from viewpoints of earth observation ground system design and recent related progressive technologies are briefly described.

1.Introduction

One of recent earth observation activity tendencies is the increase of data quantity and variation. The international earth observation program is proceeding in new concept of such as polar orbiting platform type's spacecraft and various sensors on space station.

The earth observation spacecraft transmits a large amount of earth observation data for downlink at high bit rate to ground station. This large-volume data transmission raises a problem in terms of the design and operation of the data handling facilities.

Some technical solutions from system design viewpoints are suggested for this problem. They are sophisticated data processing unit such as new array processor and recording media like optical disk. The other solution is the data relay satellite which links the space segment and ground segment,and makes a realtime,large volume data acquisition at high speed.

2.Large volume data stream from spacecraft

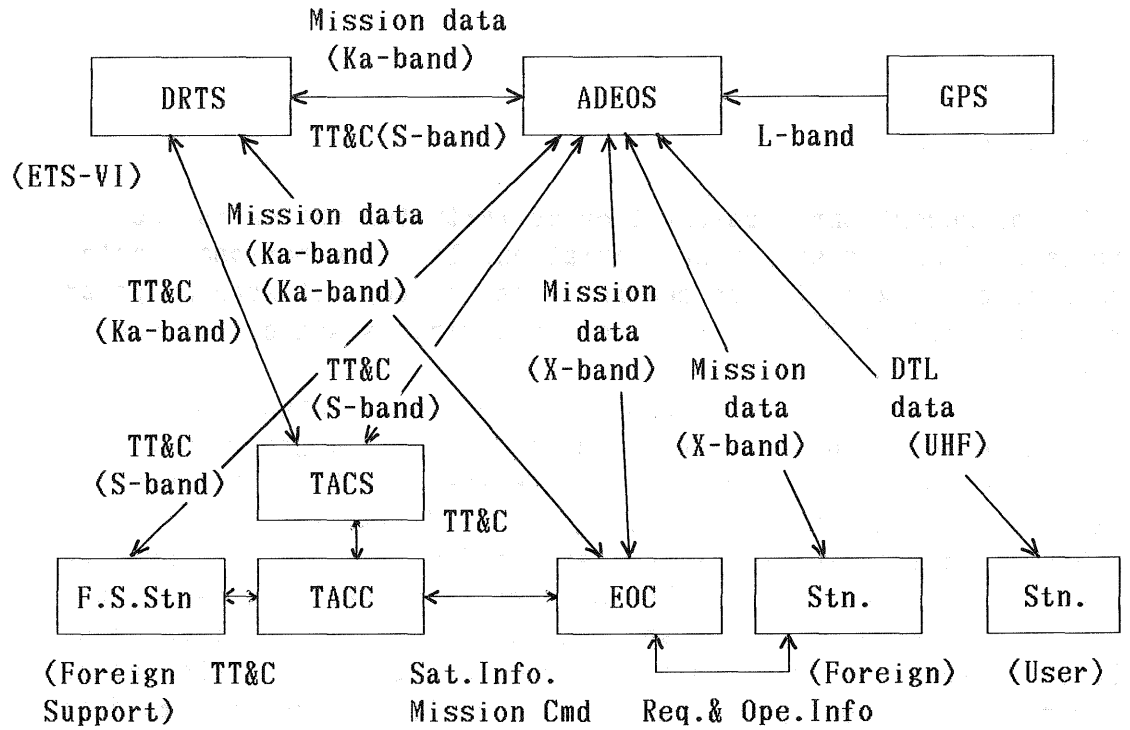
The data transmission rate (bps: bit per second) of spacecraft indicates the characteristics of data stream and quantity. Recently planned typical earth observation satellites tend to adopt much higher data rate. For instance of Japan's Earth Resources Satellite-1 (JERS-1) which is scheduled to be launched in 1992, the data rate of its SAR image data is 60 Mbps(30Mbps*2ch) using X-band (8Ghz) downlink.

The Advanced Earth Obserbing Satellite (ADEOS) which is scheduled to be launched in 1993 has 60Mbps data rate for two channel of X-band(8GHz:50MHz bandwidth) downlink. This capability can be applied to mission data transmission (core sensors,OCTS and AVNIR data or AO sensor data).

In addition ADEOS can access,at 120 Mbps data rate,the Data Relay and Tracking Satellite (DRTS) which are scheduled to be launched in 1994 and 1996 respectively.

For the International Polar Platform (IPOP) program,the polar platform is planned to be launched in 1995-1997,which has 300Mbps data transmission rate.

Obviously, those spacecrafts show the tendency of increasing data rate.(Ref.[1])



TACC:Tracking and Control Center, GPS:Global Positioning System
TACS:Tracking and Control Station,DTL:Data Transmi.for Local users

Fig-1: Radio link on ADEOS system

Table-1 Technical Solutions for Large Volume Data handling for ground system
(Large Volume of Data)

Required factors	Required technologies	Remarks
* Large capacity	*Data transmission (Wideband receiver/ High frequency) *New recording media (Large volume data recording) *Memory capacity of image processor *Memory capacity of Dinamic RAM *Data archiving	*Data relay satellite (DRTS)to ground seg. (Large volume data) *Optical disk(CD-ROM, CD-WORM),DAT,Optical tape, HDDT etc. *Standardization *32MB(exist.),128MB(Po-ssibility for SAR) *DRAM:4Mbit(exist.), 16Mbit(few yrs later) *Depends on data recording media
* High Speed	*Data transmission (Real-time transmit.) *Data recording *Data processing (Computing speed/Processing ability) *Product producing (Data distribution)	*Data relay satellite (DRTS)to ground seg. *Bit synchronizer, *Super computer. (2GFLOPS/exist.10GFL-OPS/proposal forSAR) *System configuration. Resampling.etc
*High Density	*New recording medium (High density digital recording) *IC memory tip *Data compression (Band compression)	*Ditto(with"Large capacity") *Standardization, *$4x10^{6}$ transisters: (0.8micron/Design rule) *Minimum digital bits
Relative Items	(Refer to Table-2)	

Table-2: Relative Items on Future Ground System for EOS(*1)

Relative Items	Required technologies	Remarks
*Multiplisity of Data	*New sensor data Processing method. *Standardization, Sensor parameters	*New type sensors *Absolute calibration method, WRS etc.
*Realtime Transmission	*Data network *Direct broadcast *Quicklook image data base, *On-line data retrieval,	*I/F with SODS(*2) NOTA port,TIROS net. *VHF/UHF,High vision, *Optical disk(Juke box type) *Large capacity memory for commercial line,
*Automatic & Self control	*Local Area Network (LAN) *Automatic operation on computer system .	* Quicklook data and processed data transmission, *Operator's busy task reduction,
*Plural satellite on receiving.	*Automatic control for mission scheduling, *Telescience *Artificial Intelligence	*Automatic evaluation for prelim.data, (Cloud cover rate,etc) *Simultaneous operation of plural satellite. *Mission command scheduling.

(*1)Earth Observation Satellite
(*2)SODS:Space Operations Data System

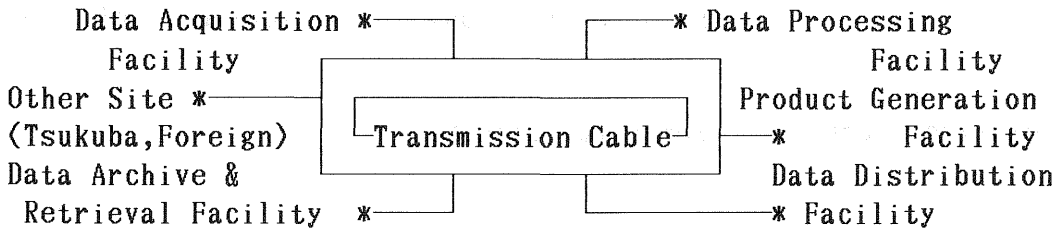


Fig-2. Concept of Local Area Network (LAN)

3.Factors for technical solutions

The technical solutions are required for this problem in designing future earth observation ground systems. Required are the following three main factors as initiative concepts,shown in Table-1.

* Large capacity
* High speed
* High density

These factors should be examined for the large capacity,high density and compact recording media, and large capacity memory device in computer system and high speed image processor. Also they have overlap functions and correlations.

The other items for system design of ground segment are shown on Table-2. Based on these main factors and relative items the following required technologies should be reviewed for this problem.

(1) Realtime data acquisition

High rate data stream from spacecraft is acquired by the receiving subsystem with parabolic antenna and recording subsystem. These co-coupled work subsystems are necessary to quickly acquire the realtime data in case of the data relay satellite in terms of global acquisition. Required technologies include wideband receiver in high frequency and bit synchronizer in realtime recorder. This bit synchronizer in recording subsystem is required to synchronize quickly with bit pattern on spacecraft's high rate data stream.

(2) New recording media

Actual data recording media are represented by High Density Digital magnetic Tape (HDDT), Computer Compatible magnetic Tape(CCT) and photograph. HDDT is used for realtime recording of high rate data stream from spacecraft. CCT is used for processed data recording. CCT products are distributed to reseachers and engineers to analyze the data at present. However, according to recent technical innovation, CCT is no longer an appropriate media in future because of bulkiness and smaller capacity.

New recording media is expected to have much larger capacity and high density in a smaller archiving space. There are two kinds of media, disks and tapes for this purpose. These are the optical disk (including CD-ROM,CD-WORM), Digital Audio Tape(DAT) and optical tape.

For the present, the optical media is a spotlighted solution for future large capacity recording. Recently the optical disk is prevail ing as a popular media in the name of compact disk. The capacity of optical disk is about 400 Mbyte/oneside(5.25 inch),while the CCT has 40 Mbyte/2400 feet(9track). The optical disk thus has merits of

capacity and compactness compared with CCT. But current optical disk can record only one time. Capability of its plural recording (write/erase) is now being developed.[2][4] The Earth Observation Center (EOC/NASDA) is tentatively using the optical disk for recording subsystem of MOS-1 quicklook data.

Although optical tape has a very large capacity (1TeraByte), its data transmission speed is smaller than any other new media. Optical tape is useful for long term archiving. This medium is tentatively in use in CCRS (Canada).

High Density Digital magnetic Tape (HDDT) is still usable for realtime data recording in future with its large capacity for non distribution product.

Table-3: Data recording media

Media	Capacity	Density	Compact-ness	Remarks / Preservation
(1) CCT	40 Mbyte (*1)	1.6 kbit/ inch	*not com- pact	*Refresh.every 2-3 yrs
(2) HDDT	1 Gbyte (*2)	33kbit/in -ch	*not com- pact	*for realtime recording
(3)Optical disk	400Mbyte (one side)		*compact	*5.25inch(*3), onetime write
	1.3Gbyte (one side)		*nearly compact	*12inch(*4), onetime write
(4)Optical tape	1 Tbyte (*5)			*better for longterm archv
(5) DAT	1.4GByte		* very compact	*Rewinding time.

(*1):2400ft/9trk, (*3):standardized, (*5):Data rate(no fast)
(*2):9200ft/28trk,(*4):non standardized,

(3) High speed computer system and image processor

Higher computing speed is required to process the large volume image data. Existing multi-purpose computer has the maximum computing speed of approximately 20 MFLOPS (Million Floating-point Operations Per Second). Recent super computer has a capability of 2 GFLOPS (Giga FLOPS).[3] Near future capability of super computer is planned to have 10 GFLOPS.[4]

The processing speed can be increased by improving system through -put such as system configulation and resampling technology.

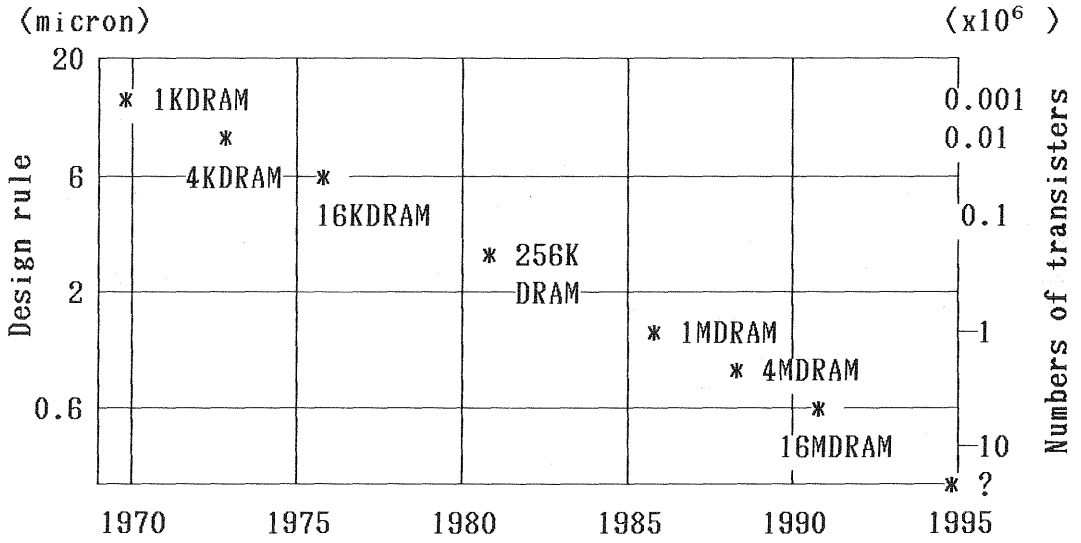


Fig-3: Trend of IC memory capacity and density (DRAM),[4]

Large volume data processing subsystem should have an appropriate configuration. Entire large volume of image data cannot be stored in the internal memory. Accordingly the image data should be stored in the external memory unit temporarily and be processed successively.

The fundamental point is to make configuration that a high speed internal memory function should be set at central position.[5] Computer,image processor,external large volume memory units and input-output(I/O) units should be set around high speed internal memory.

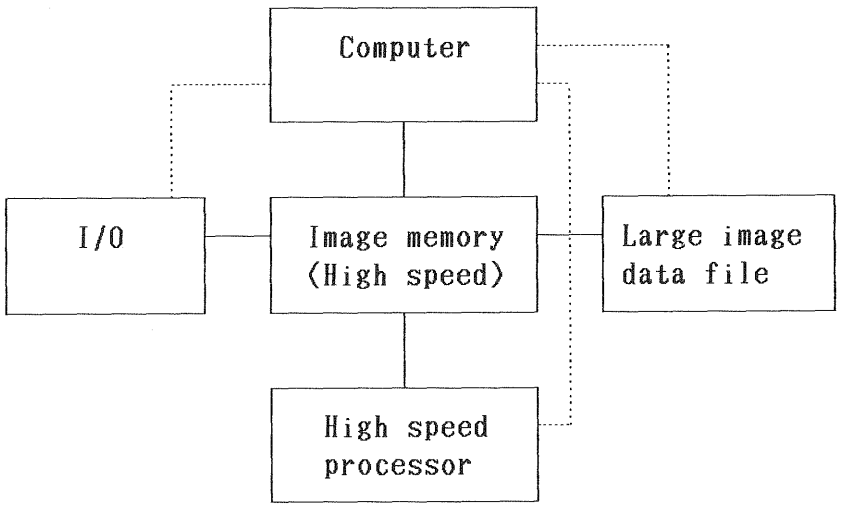


Fig-4. Concept of high speed processing system for large volume of data

4. Conclusion

In the sysrtem design of the earth observation ground system,which handle large volume data, three factors such as large capacity,high speed and high density are important.

However many other relevant important technologies should also be studied, including local area network (LAN) using optical communication technology,automatic control and operation using concept of telescience based on the artificial intelligence (AI).

The standardization of the technologies for large volume data handling is also to be considered for various observation activities in the future. The first wave of large volume data era for earth observation has already come in front of us.

Referncesx

[1] NASDA/EOC:Present status on Earth Observation Data Activities in Japan:CEOS·WGD Fourth meeting in UK(February 23-25,1988).

[2] S.Komatsu&members:CD-ROM and its Application Systems:Hitachi Hyoron,Vol.69/No.11,Nov.1987.

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[4] NASDA/EOC&Contractors: ERS-1 Ground System Design Study:March'88

[5] NASDA/EOC&Contractors: Study Report for Future Earth Observation Information Receiving and Processing System:March,1988