

# Distributed Satellite Data Center via Network

Mikio Takagi

Institute of Industrial Science, University of Tokyo

7-22-1, Roppongi, Minato-ku, Tokyo 106 Japan

Tel: +81-3-3479-0289, Fax: +81-3-3402-6226, Email: takagi@tkl.iis.u-tokyo.ac.jp

## ABSTRACT

To promote academic researches on earth environment utilizing satellite data, research infrastructure such as satellite data reception, processing, distribution and archival systems should be fully provided. The means to enhance the infrastructure were discussed by a working group and "Satellite Data Center via Network" has been proposed. This concept has three principles;

- (1) To realize necessary functions by organizing experts distributed all over Japan and connecting them by network,
- (2) To realize "Satellite Data Center via Network" for GMS and NOAA Satellites, which are widely used for research, and
- (3) Satellite data set oriented to specific research area should be generated by researchers having definite research purposes in cooperation with researchers in the fields of sensor algorithms and high volume data processing.

Utilization of the Science Information Network (SINET) has been discussed to realize this concept, and to accelerate this project an experiment "Network Utilization for Wide Area Use of Satellite Image Data" under "Co-operative Experiment on Multimedia Communication" has been introduced. And the roles of the Institute of Industrial Science, University of Tokyo to contribute this project has been described.

## Concept of Satellite Data Center via Network

To promote academic researches on earth environment utilizing satellite data, it has been realized through the Special Research on "Higher Order Utilization of Remote Sensing Data from Space" from 1985 for three years and the Priority Area Programme on "Better Understanding of Earth Environment via Satellite" from 1989 for three years, funded by the Ministry of Education, Science and Culture, that the enhancement of research infrastructure such as

- To provide satellite data reception, processing, distribution and archival systems,
  - To provide database to utilize satellite data,
  - To provide and circulate processing algorithms and software,
  - To enrich processing environment,
  - To promote network utilization,
- and so forth is mandatory.

A working group to plan infrastructure was established, supported by the Grant-in-Aid for Scientific Research from the Ministry of Education, Science and Culture last fiscal year and its study is going on this year as well. Most of working group members are young scientists who are using satellite data very actively in their research. Members are

- Yoshiaki Honda (Center for Environmental Remote Sensing, Chiba University),
- Koji Kajiwara (Center for Environmental Remote Sensing, Chiba University),
- Hiroshi Kawamura (Center for Atmospheric

and Oceanic Studies, Faculty of Science, To-  
hoku University),

- Masaru Kitsuregawa (Institute of Industrial  
Science, University of Tokyo),
- Teruyuki Nakajima (Center for Climate Sys-  
tem Research, University of Tokyo),
- Toshio Koike (Nagaoka Technology and Sci-  
ence University),
- Taikan Oki (Institute of Industrial Science,  
University of Tokyo),
- Kinji Ono (National Center for Science In-  
formation Systems),
- Mikio Takagi (Institute of Industrial Sci-  
ence, University of Tokyo),
- Sumio Tanba (Faculty of Engineering, Iwate  
University).

Realizing the software crisis in satellite  
data processing algorithms and the huge data  
crisis in data processing and archives, the con-  
cept of "Satellite Data Center via Network" has  
proposed through the discussions of the work-  
ing group. This concept has the following three  
principles:

- (1) To realize necessary functions, organizing  
experts distributed all over Japan and  
connecting them by network,
- (2) To realize "Satellite Data Center via Net-  
work" for GMS and NOAA Satellites,
- (3) Satellite data set oriented to specific re-  
search area should be generated by re-  
searchers having definite research purpos-  
es in cooperation with researchers in the  
fields of sensor algorithms and huge vol-  
ume data processing.

Basic functions of "Satellite Data Center  
via Network" are as follows:

- (1) Original Data Archive (ODA)  
Direct reception of GMS and NOAA satel-  
lite observation data and their archives
- (2) Quick Production Generation (QPG)  
Offering routinely processed satellite data  
on a daily basis
- (3) Satellite Data Set Generation (SDSG)  
Development, generation and evaluation  
through research utilization of satellite da-

ta set for research use

(4) Product Archive (PA)

Archive of Quick Products and Satellite  
Data Sets and offer them for researchers  
through anonymous ftp or CD-ROM in  
easily usable form.

(5) Information System (IS)

Offering information on various kinds of  
functions of satellite data center and re-  
garding to satellite data.

(6) Software and Intelligence Support (SIS)

Offering various kinds of related software  
and knowledge.

The concept of "Satellite Data Center via  
Network" is shown in Fig.1. Two facilities,  
which are receiving NOAA satellite data, i.e. ;  
the Institute of Industrial Science, University  
of Tokyo and the Center for Atmospheric and  
Oceanic Studies, Tohoku University, will act as  
Original Data Archive (ODA) and Quick Pro-  
duction Generation (QPG). And facilities,  
which are engaging in research on earth envi-  
ronment, will generate data set derived from  
satellite data for their specific research fields;  
for example:

- Faculty of Engineering, Iwate University for  
sea surface temperature validation,
- Center for Atmospheric and Oceanic Studies,  
Faculty of Science, Tohoku University for  
oceanography,
- Nagaoka Technology and Science University  
for snow and ice,
- Center for Environmental Remote Sensing,  
Chiba University for vegetation,
- Institute of Industrial Science, University of  
Tokyo for hydrology,
- Center for Climate System Research, Uni-  
versity of Tokyo for meteorology,  
and so on.

The network is based on the Science Infor-  
mation Network (SINET), which is dedicated  
to academic research and operated by the Na-  
tional Center for Scientific Information Sys-  
tems (NACSIS). Via this network each center  
can be accessed each other and not only domes

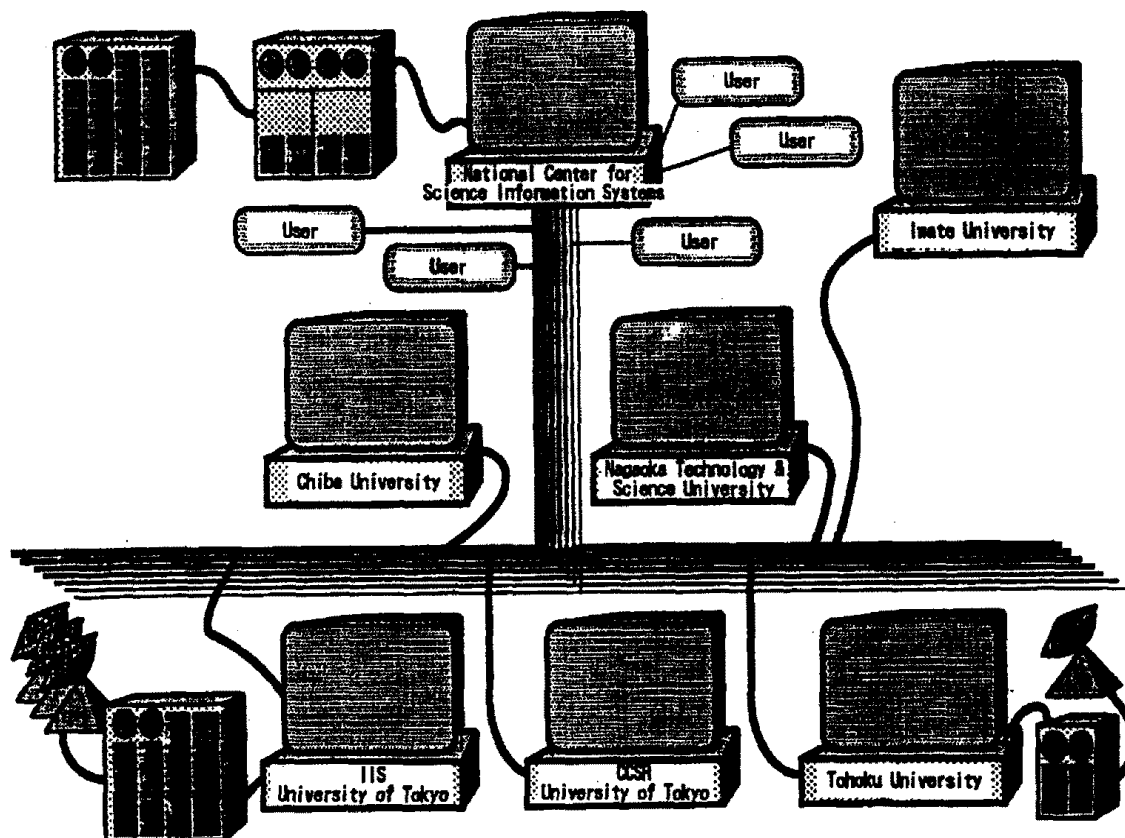


Fig. 1 Satellite Data Center via Network

tic users but also foreign users all over the world can access each center via the Internet. Also, the National Center for Scientific Information Systems will play a role in satellite data server.

### Earth Environmental Satellite Image Network

It becomes possible for academic researchers all over Japan to access data centers via the Science Information Network (SINET). Although the band width of the trunk line of the SINET becomes wider and wider, the band width at the end is still narrow. Since a large amount of data is exchanged between data centers, wide band networks between data centers are highly requested.

To accelerate the concept of "Satellite Data Center via Network", a proposal to join the "Cooperative Experiment on Multimedia Communication" between NACSIS and Nippon Telegram and Telephone Company (NTT)

started since April, 1995, was submitted to and approved by NTT. This proposal is named as "Network Utilization for Wide Area Use of Satellite Image Data" (Earth Environmental Satellite Image Network).

It is planned in this project, to receive operational NOAA satellites and GMS and Seastar to be launched, to process the received data, and to distribute them in real time to research facilities. At the research facilities the data are processed according to their research topics such as meteorology, oceanography, hydrology, vegetation and so on, and data sets are generated and offered and distributed satellite data centers are realized. Also, experiment on mutual utilization of earth environmental information via network will be done. Through this experiment it is expected not only to promote academic researches on earth environment, but also to show the results to the society, and to demonstrate that only through utilization of wide band communication it be-

comes possible to transmit a huge volume of data like satellite data and to realize a new concept of "Satellite Data Center via Network".

In the "Cooperative Experiment on Multimedia Communication", 10 cities are assigned by NTT and experiments will be done connecting these cities by 156 Mbps lines. But, cities such as Morioka (Iwate University), Nagaoka (Nagaoka Technology and Science University) and Kasuga (Research Institute for Applied Mechanics, Kyushu University), where very important facilities are located in our concept of "Satellite Data Center via Network", are not included in these assigned 10 cities. Therefore, it was asked for NTT to provide special lines to these facilities and NTT made a special offer to us in connecting these locations by 6 Mbps lines with their high expenses.

The network is shown in Fig. 2. In the network, the main facility in this experiment is

the Institute of Industrial Science, University of Tokyo and such facilities as Center for Climate System Research, University of Tokyo, Faculty of engineering, Iwate University, Center for Atmospheric and Oceanic Studies, Tohoku University, Nagaoka Technology and Science University, Center for Environmental Remote Sensing, Chiba University, National Center for Science Information Systems, and Research Institute for Applied Mechanics, Kyushu University, consist of distributed satellite data centers and are connected via a star-like network centered at the institute of Industrial Science, University of Tokyo.

Optical fibers have been cabled to each site by NTT October, 1995 and each site is preparing the internal cabling, its ATM switch and interface, and necessary equipment now by its own budget. It is expected to operate the network coming April.

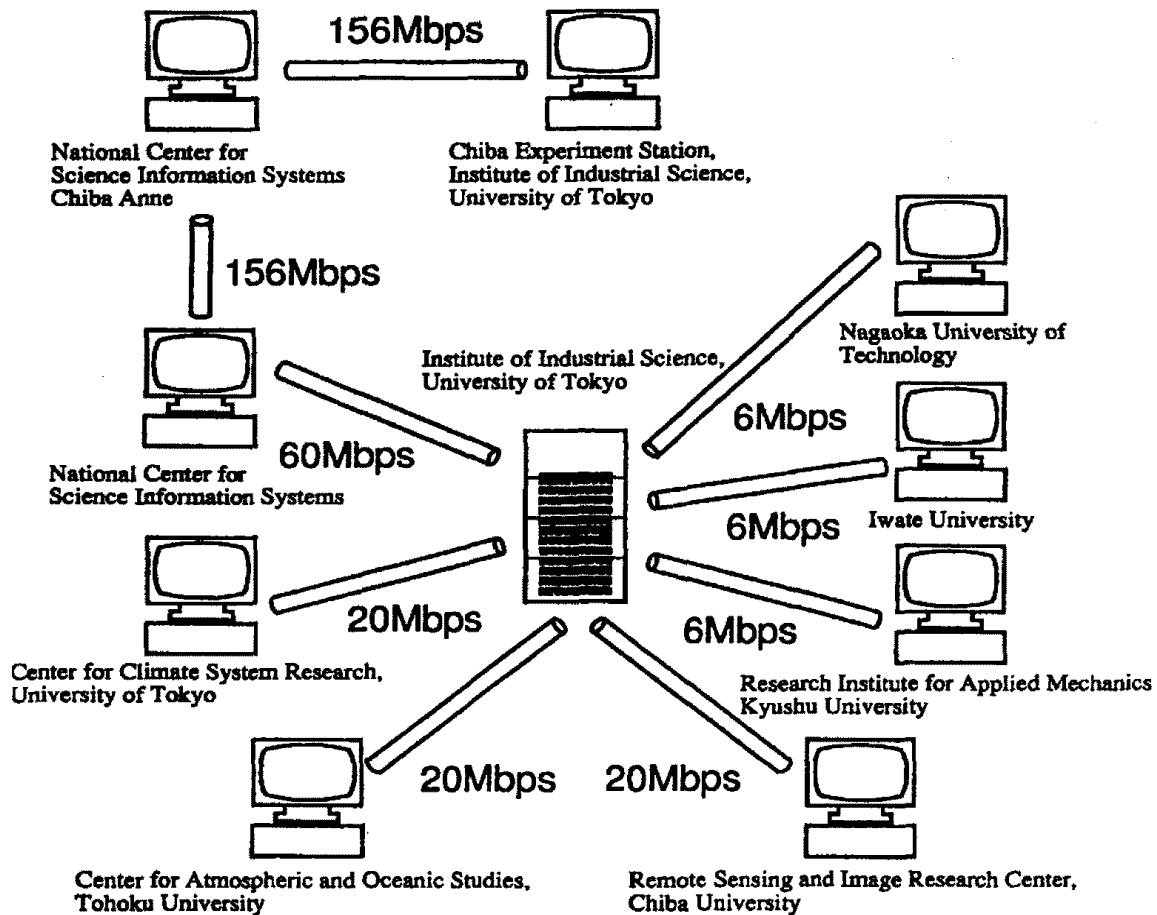


Fig. 2 Network for Multimedia Experiment on Satellite Data

## The Role of the Institute of Industrial Science, University of Tokyo as a Satellite Data Center

The Institute of Industrial Science, University of Tokyo started to receive NOAA data since 1980 has stored and distributed the data to academic researchers without any charge. Its archival data volume reaches more than 2 TB. Since April, 1992 our station is sending every daytime NOAA satellite data to EROS Data Center to contribute to the "1 km AVHRR Land Project", which collects daily daytime NOAA data all over the world for the International Geosphere Biosphere Program (IGBP) to monitor worldwide daily land vegetation with 1 km resolution.

Since the NOAA receiving station was getting older, it was replaced and two receiving systems were installed March, 1995; one for HRPT data from NOAA satellite and from Seastar (SeaWiFS data) and the other for stretched-VISSR from GMS, to supply the data from most important three satellites for environmental monitoring to academic researchers.

And more powerful data processing and file server systems have been installed at the same time. It is expected to serve as Original Data Archive (ODA) for GMS, NOAA and SeaWiFS data. The total data volume becomes more than 3 GB per day (2.2 GB for GMS, 600-800 MB for NOAA, and 100-300MB for SeaWiFS) and more than 1 TB per year. As for the function of Quick Production Generation (QPG), quicklook images of NOAA satellite and GMS are currently supplied by facsimile and through Scientific Information Network by WWW and gopher. There are a lot of access (access more than 80,000 from more than 60 countries between February, 1995 and September, 1995). See Gopher [gopher://gopher.tkl.iis.u-tokyo.ac.jp/Images/](http://gopher.tkl.iis.u-tokyo.ac.jp/Images/) or World Wide Web <http://www.tkl.iis.u-tokyo.ac.jp/SatIAN/>. More region oriented or mission oriented quicklook images will be provided. And near

realtime Satellite Data Set Generation (SDSG) of secondary physical parameters such as cloud mask, detection of snow cover, land surface temperature, sea surface temperature, vegetation index and so on are under planning. As for Product Archive (PA) functions, a hierarchical data archival system is under construction.

The system is shown in Figure 3. Its database management system consists of a SPARCcenter 2000 (10 CPU's with 1 GB memory) for processing and hierarchical peripheral memories, in which 8 mm tape juke boxes with 10 TB for raw data, a 2.3 TB D1 tape juke box and 80 TB D3 tape juke boxes, to be installed at the end of March, 1996, with very fast data transfer rate and 401 GB disc arrays for temporal archives are provided. And parallel computers; Convex Exemplar SPP/XA (4 nodes) and IBM 9076 SP2 (16 nodes), are installed for processing of huge volume of satellite data. Its equipment is centralized considering efficiency. Various kind of access methods to the system are provided; in the institute main users via CDDI (100 Mbps) and ordinary users via LAN, users in the "Cooperative Experiment on Multimedia Communication" via ATM, ordinary academic users via SINET, and outside users via INS-1500.

A cooperative experiment plan between NACSIS and us is carried on. In this plan, a file server will be installed at our laboratory in the Chiba Experimental Station and connected by an optical fiber (156 Mbps) to the Annex of NACSIS located in the same campus, then ordinary academic users will be able to access the system via NACSIS directly. At present when an academic user in remote site wants access to our system, the following connection should be established; that is, his terminal to his local computer center, to a major computer center, to NACSIS, to the Computer Center of University of Tokyo, to the Computer Room of the Institute of Industrial Science, to the internal LAN of our institute, and to our file server.

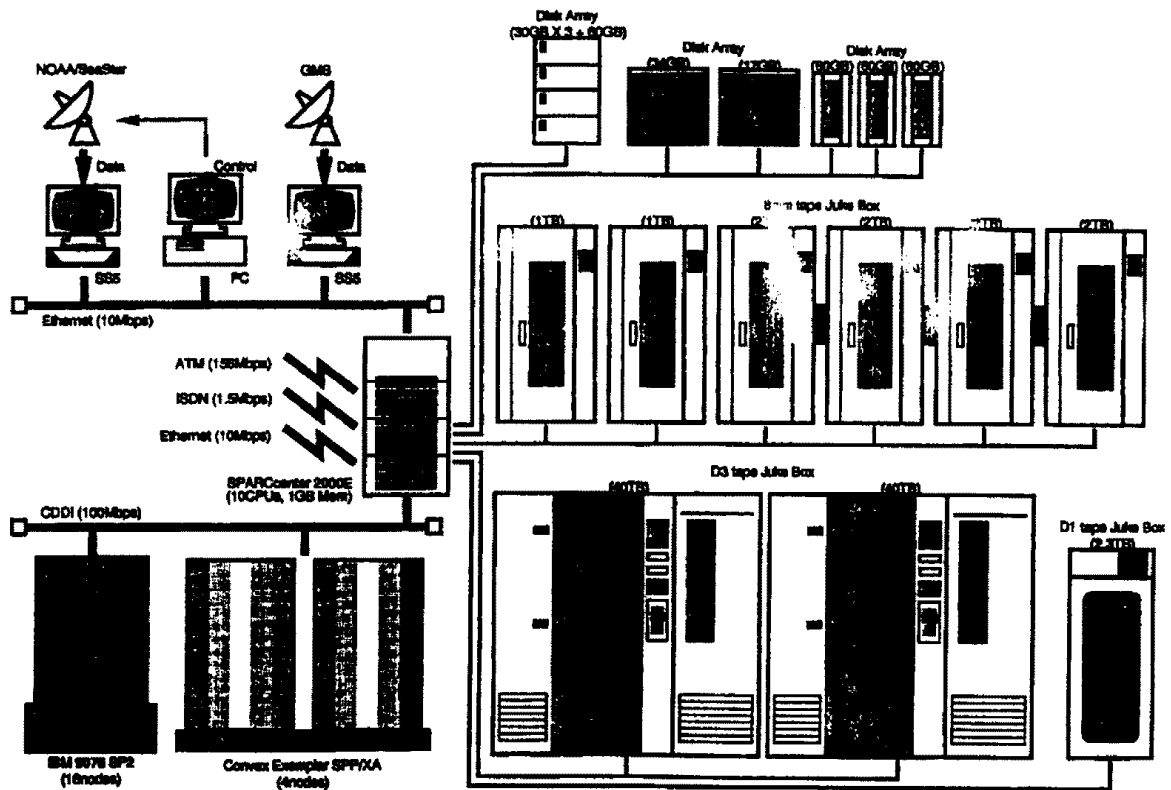


Fig.3 Satellite Data Reception, Processing and Archival System

And he retrieves our data and the retrieved data flows to the opposite direction to his terminal. Once a large data such as satellite data flows on the network, the link between the Computer Center of our university and the Computer Room of our institute at 1.5 Mbps will be a bottle neck and the data flow may be a heavy load to the links after NACSIS.

The fiber link will be cabled by NACSIS by the end of March and the system will be installed in the fiscal year of 1996. When this plan is realized, satellite data will be transferred to NACSIS via high speed link, and via NACSIS to its Annex via existing 156 Mbps line and to our laboratory and the archives at the Chiba Experimental Station will act as duplicated and up-to-date archives. Then, academic users all over Japan can access our data directly via NACSIS without coming through links after NACSIS and satellite data distribution to users becomes more easier. As the result, it is expected that researches on global environment using satellite data can be promoted more intensively.

### Conclusion

The Concept of "Satellite Data Center via Network" to promote academic researches on global environment utilizing satellite data has been introduced.

To realize this concept, utilization of the Science Information Network (SINET) has been discussed and to accelerate this project an experiment "Network Utilization for Wide Area Use of Satellite Image Data" under "Co-operative Experiment on Multimedia Communication" has been introduced. And the activities of the Institute of Industrial Science, University of Tokyo to contribute this project has been described.

Our institute will act as a data center in the Priority Area Programme on "Better Understanding of Water and Energy Circulation in a Continental Scale Based on Satellite Remote Sensing" starting from April, 1996 for three years and as a center of Active Information Network of Asian Monsoon Experiment (GAME) in Global Energy and Water Cycle Experiment (GEWEX).