

Data Processing System for Advance of Earth Observation Data

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Abstract

Earth images observed from a satellite (satellite data) contain distortions due to the characteristics of the satellite-borne sensors, which makes it necessary to correct the satellite data with a data processing system so that the users can utilize the data effectively. The data processing system has previously been developed individually for each satellite or per sensor but, in the future, it is desirable to unify the data processing system into a single set of packages (image processing PKGs) that can be used commonly regardless of the satellites and sensors installed in them. NEC is planning to promote the use of satellite data by applying the common image processing package to the satellite data processing system.

Keywords

data processing, Earth observation satellite, sensor, Earth observation data satellite data, package (PKG), multi-mission

1. Introduction

Earth images observed by satellite-borne sensors (satellite data) are processed by the data processing system. The data processing system has previously been developed individually for each satellite or per sensor but, in the future, it is desirable to unify the data processing system into a single set of packages (image processing PKGs) that can be used commonly regardless of the satellites and sensors installed in them. This paper introduces the details of the newly developed image processing packages and discusses the future deployment perspectives of NEC image processing packages.

2. What is a Data Processing System?

Raw satellite data cannot be used effectively because it contains sensitivity anomalies that influence the image brightness, etc. This is due to the specific properties of each sensor and also to the geometric distortion due to the oblique image capturing angle of the satellite. In order to deal with this issue and to generate usable data, the data processing system of the ground-based component of the satellite system corrects the sensitivity deviation and geometric distortion that is present in

the satellite data. **Fig. 1** shows the positioning of the data processing system's role in the ground component of the satellite system.

Since the introduction of the MOS-1, Japan's first earth observation satellite, the NEC Group has been responsible for the image processing of most of the Japanese earth observation satellites and it has developed, for example, the ground data processing systems of the ALOS, GOSAT and GCOM-W1. The satellite data collected by each earth observation satellite is received by the parabola antenna of the earth station and then

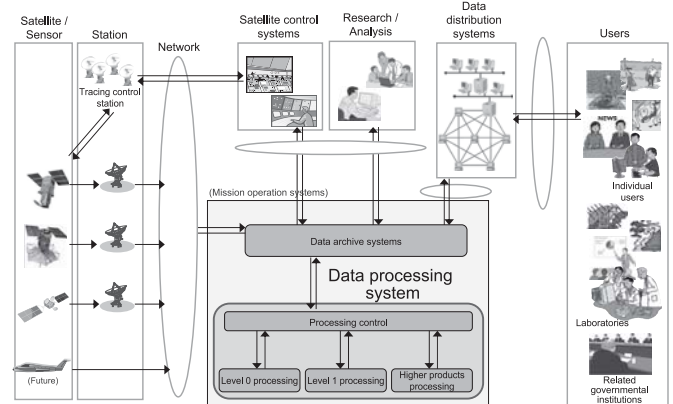


Fig. 1 Positioning of the data processing system.

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transmitted from the earth station to the data processing system. The data processing system generates the required satellite products by processing the received satellite data via level 0 processing for extracting packets, the level 1 processing for correcting distortions and other required higher products processing such as compilation of information via DEM (Digital Elevation Model). The generated satellite products are saved and are also offered to the user via data distribution systems.

The NEC Group has constructed many data processing systems for earth observation satellites such as the ALOS and GOSAT as described above. However, as these systems were made to the specific processing requirement of each sensor in each satellite, it has hitherto been necessary to newly develop each key function when building a new system for a new satellite. This has meant that a large development expense has been incurred each time a system is constructed. In addition, since recent data processing systems are required to be multi-mission systems that are compatible with multiple satellites, the traditional system development method is no longer able to cope with the requirements of present day users. What is required for the development of future data processing systems is to package the data processing system by gathering those functions that can be used commonly by different satellites into common function blocks so that multi-mission systems can be implemented with lower costs.

3. Outline of Our Image Processing Packages

We package the job controller functions and level 1 specific processing functions of the data processing system into the job control PKG and level 1 processing PKG respectively. We decided to package the data processing system based on the data processing systems previously developed by the NEC Group and also in consideration of the requirements that would be posed for satellite data processing systems in the future. As a result, we categorize the functions that can be used commonly by data processing systems of multiple satellites (common function block) and those that should be designed according to the sensors of each satellite (sensor-unique function block) and implement the common function blocks into the image processing packages accordingly.

As our basic packaging policy, we are planning the implementation of four features. These are reliability, scalability, operability and cost reduction. **Table** shows details of these implementations.

3.1 Job Control PKG

The job control PKG provides the mechanism for running image processing operations simultaneously on several computers.

This PKG collects the information necessary for the level 0 processing, level 1 processing and higher products processing based on processing requests from the data distribution systems and users and gathers the work orders that compile the information required for each type of processing. It then distributes the work orders to the level 0 processing, level 1 processing and higher-order processing in order to control

Table Implementations of image processing packages.

No	Implementations	Details
1	Reliability	Software that has been proven in the past is incorporated as modules. Such proven software may also be used by subsequent satellites.
2	Scalability	Computers for processing can be configured in a scalable manner according to the amount of processing required for the satellite data. Varying the file settings is only necessary for subsequent satellites.
3	Operability	In normal operation, processing that emphasizes throughput (multiple data is processed in a day) is executed. In an emergency, turnaround time-emphasized processing (each data is processed in a shorter period) is executed.
4	Cost reduction	Employing COTS and open source software extensively. Software that is already developed or proven can be used in subsequent satellites.

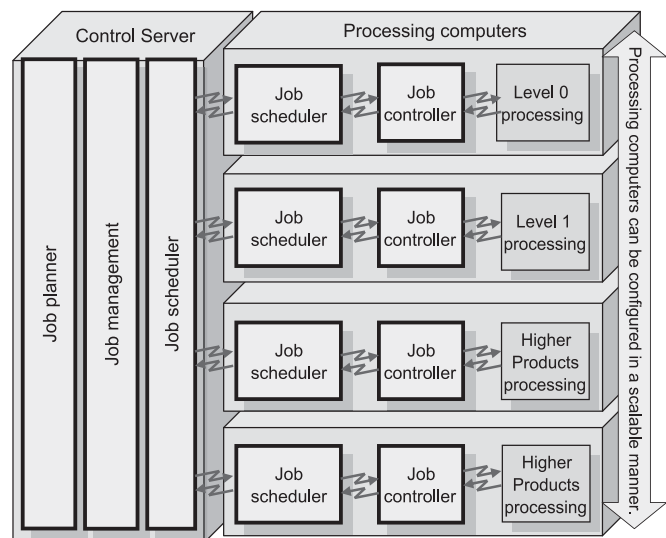


Fig. 2 Configuration of the job control PKG.

them. Fig. 2 shows the configuration of the job control PKG.

(1) Job planner function

This function compiles the work order according to the processing requests sent from the data distribution system or users.

As the processing flow of the job planner function varies depending on the details of each processing, it is not possible to accommodate the entire function in the common function block. Therefore, we distinguish the functions into unique functions and others, or common functions and implement the common functions in the job control PKG and the unique functions as package plug-ins.

(2) Job management function

This function executes a job (image processing) when it is triggered by the job planner function or when an external event is received and manages the progress of the job.

As the entire management progress function can be accommodated in the common function block, it is included in the job control PKG.

(3) Job scheduler function

This function identifies a computer with available CPU resources and invests a job automatically in it.

The job scheduler function is implemented using open source software and is included in the job control PKG as a common function.

(4) Job controller function

This function controls the execution of an image processing program or of serial/parallel executions and the queuing of multiple image processing programs.

The job controller function is implemented using modules of past data processing systems as the assets, and these modules are included in the job control PKG as common functions.

3.2 Level 1 Processing PKG

The level 1 processing PKG creates the level 1 products from the level 0 data, orbit data and attitude data according to the level 1 processing work order created by the job control PKG.

Fig. 3 shows the configuration of the level 1 processing PKG.

(1) Pre-processing function

This function acquires the information required for level 1 processing that includes the level 0 data, sensor data (telemetric data), orbit data and attitude data, and prepares them so that they can be used as input data.

We include the pre-processing in the level 1 processing PKG because it can be dealt with by setting the items that vary

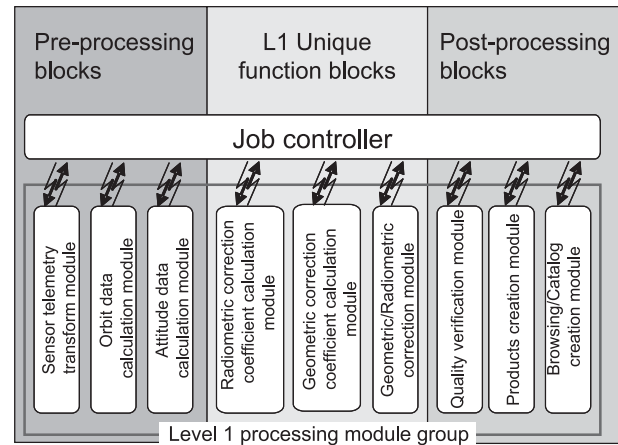


Fig. 3 Configuration of Level 1 Processing PKG.

depending on sensors as parameters.

(2) Level 1 unique function

This function uses the input data prepared by pre-processing and applies correction of the distortion contained in the satellite data (geometric/radiometric correction processing). Since the level 1 unique algorithm varies between sensors, this function block inevitably includes processing specific to each sensor. Therefore, we use a common processing method for the intermediate file I/O that interfaces the pre-processing and post-processing for inclusion in the level 1 processing PKG so that only the processing algorithm is changed.

(3) Post-processing

This function creates the level 1 data by converting the geometric/radiometric-corrected data into the specified data format. At the same time, it also creates the level 1 catalogue and level 1 processing result.

Just as for the pre-processing, we include the post-processing in the level 1 processing PKG because it can also be dealt with by setting the items that vary depending on sensors as parameters.

3.3 Package Features

(1) Reliability

The job scheduler function in the job control PKG uses open source software which is proven as a job scheduler. The job controller function uses modules that are proven in operations with past data processing systems.

The combination of proven software improves reliability

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without compromising functionality.

(2) Scalability

The job control PKG enables multi-mission operations and accepts various satellites by varying the parameters independently from the specifications of each satellite. The job scheduler function makes it possible to configure the processing computers in a scalable manner according to the amount of satellite data processing required by each mission. To facilitate the addition of sensors in the future, the level 1 processing PKG makes the pre-processing and post-processing variable by parameter settings and isolates the sensor-specific processing as a plug-in to the level 1 specific processing function.

(3) Operability

The job scheduler function has a switching function for selecting whether satellite data is processed by placing importance on the throughput or turnaround time. When the processing of throughput time is emphasized, the processing of an item of satellite data is allocated to a single computer to enable the parallel processing of multiple satellite data items using multiple computers. When the processing of turnaround time is emphasized, an item of satellite data is processed by multiple computers so that the processing time taken per single satellite data item may be reduced compared to the processing emphasizing throughput.

High-speed processing is possible by executing the turnaround time-emphasized processing as priority over the throughput-emphasized processing by assigning priorities to the job waiting queues. When more emergent image processing is required, for example in the case of a disaster, this function makes it possible to process the image data of the disaster-stricken area quickly in priority over any other data. For emergency operation as in this case, the job scheduler function checks the emergency operation queue first of all and, if there is any emergency operation waiting in the queue, this function lets the processing computer(s) process it as priority. Fig. 4 shows the operational sequence of emergency operation.

(4) Cost reduction

The production cost of the sections controlling the computer environment is reduced by extensively utilizing open source software.

Gathering the functions that can be used commonly by data processing systems of multiple satellites into a common function block will also contribute to a reduction in the manufacturing costs of the data processing systems of future satellites.

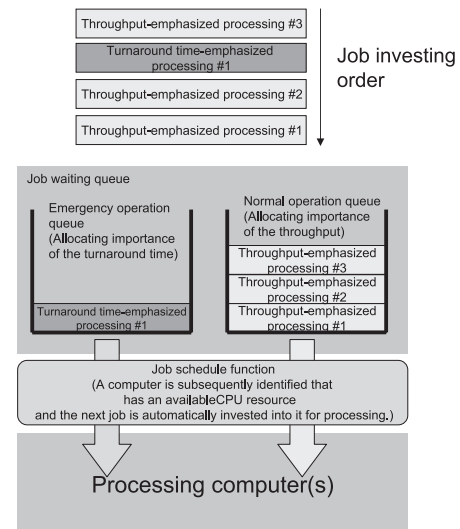


Fig. 4 Emergency operation.

4. Future Perspectives

In the development of packages for future data processing systems, we plan to refine the required functions such as the common function block of the job planner function of the job control PKG and the post-processing function of the level 1 processing PKG.

We are also planning to construct a display to assist the operator in the form of a web user interface and to include it in the image processing package by providing optimum control of the data processing system, even from a remote location using a web browser.

5. Conclusion

This paper introduced the packaging of our data processing systems. Such packaging makes it possible to provide users with universal data processing systems with high reliability and scalability. In addition, it also allows a vendor working on systems developments to improve system convenience and to reduce costs.

From the NEC perspective, we intend to also promote the use of satellite data by using image processing packages as the basis for building the satellite data processing systems of the future.

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