Automated Image Receiving and Processing System for Landsat 7

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Abstract: The Landsat Program is the longest running enterprise for acquisition of imagery of the Earth from space. The first Landsat satellite was launched in 1972 and the most recent, Landsat 7, was launched on April 15, 1999. The Landsat satellites have acquired millions of images. The Landsat 7 receiving station is installed at more than 25 sites and will be installed in Korea.

This paper will address the work being carried out for the development of image receiving and processing system for the Landsat 7 image data, which will be used at ground station of Landsat 7 in Korea.

Key Words: Landsat 7, receiving and archiving system

1. Introduction

The Landsat Program is the longest running enterprise for acquisition of imagery of the Earth from space. The first Landsat satellite was launched in 1972 and the most recent, Landsat 7, was launched on April 15, 1999. The Landsat satellites have acquired millions of images[1].

The Landsat 7 system consists of Landsat 7 satellite, MOC (mission operation center), DAAC (distributed active archive center) and ground station. The Landsat 7 satellite provides a 150Mbps downlink to the IGSs (international ground stations). The MOC is responsible for command and control of the Landsat 7 satellite and for scheduling of data acquisition, and serves as the focal point for the IGS interface. The DAAC archives Landsat 7 Level 0R data, metadata, and browse data. The DAAC supports users queries and distributes data to users[2].

The ground station is divided into two classes: 1) the LGS (Landsat Ground Station) is the data receive site located at EDC (EROS Data Center) for the USA, 2) the IGSs are ground stations except LGS. The IGSs receive real-time Landsat 7 data and archive and process it for their own use[2]. The IGS is installed at more than 25 sites and will be installed in Korea.

This paper will address the work being carried out for the development of Korea IGS. The development work is still undergoing.

The paper is organized as follows. Section 2 explains the Korea IGS under development. Section 3 describes the current progress and future researches. Conclusion will be given in Section 4.

2. Image receiving and processing system

This section introduces requirements and describes the overview of an automated image receiving and processing system for Landsat 7(hereby, the system) under development.

2.1 Design concepts and requirement

The system was designed to meet the following three design concepts: maximum automation, integrity, cost effectiveness, and expandability.

We derive the requirement specifications from the user's requirement. Some important requirement specifications to accomplish are as fellows.

- Real-time data receiving and storing at the rate of 150Mbps
- Self diagnosis for each resources
- Automatic catalog generation
- Generates log for each event, report for order and statistics
- Utilize imported data such as ancillary, orbit and other

satellite images

- Processing data received for three minutes within 4 hours
- Selective storing and management for image product

2.2 Overview of the system

The system is divided into four sub-systems. Fig. 1 describes the block diagram about four sub-systems. The LMIS (Landsat 7 MOC Interface S/W) can communicate between MOC and the system. The LRAS (Landsat 7 receiving and archiving S/W) can receive, display and archive image data from an X-band antenna in real-time. The LCAP (Landsat 7 catalogue and product generation S/W) makes catalogues, metadata and image products from received satellite image. The LFTM (Landsat 7 File Transfer Management S/W) transmits the image products to external site.

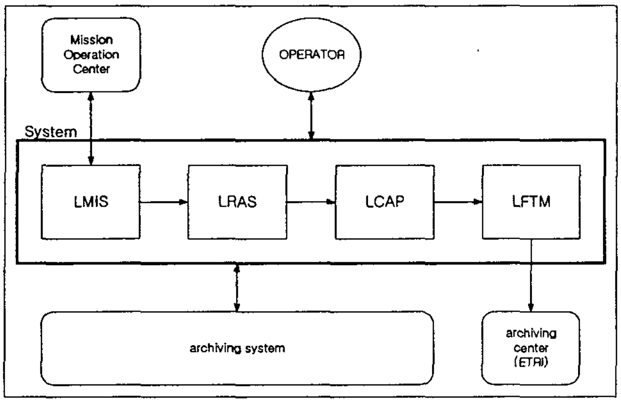

Fig. 1. Block diagram of the system

The system shall interface with other elements such as MOC, operators, archiving system and archiving center, which will be located at ETRI. The MOC receives the information about receiving station and gives the approved pass schedule and image processing information to the system. The operators can order the processing and check the result. The archiving system permanently piles up the satellite images and image products that are produced by the system. The archiving center, which will be located at ETRI (Electronics and Telecommunications Research Institute), receives the image products from various sources, stores and provides them to end users.

2.3 H/W architecture of the system

The H/W architecture of the system is shown in Fig. 2.

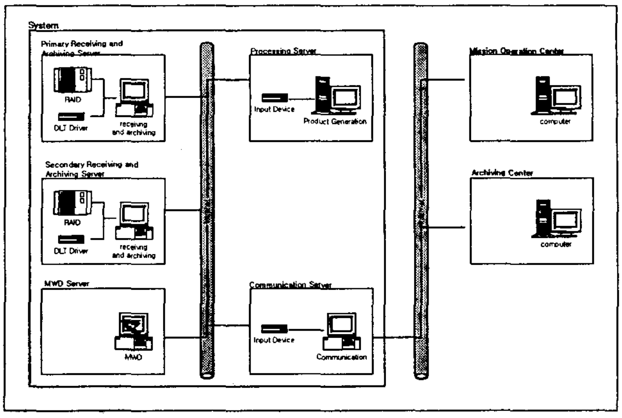

Fig. 2. H/W architecture of the system

The system has three parts: 1) the LRAS, which is the left side (primary/secondary receiving and archiving server, MWD server) of the system in the figure, 2) the LCAP, which is the right upper side (processing server) of the system in the figure, and 3) the LMIS and LFTM which is the right lower side (communication server) of the system in the figure. There are large amount of data exchange between sub-systems. Therefore, the fastest networking is required.

The LRAS can be consists of three PCs (personal computer) and a high-performance disk storage device. Two of three PCs are for receiving and archiving, and the other for MWD (moving window display). Each PC has a DRC (data receiving card) to convert incoming 1500Mbps serial data into byte data. The primary and secondary receiving and archiving servers can constitute hot stand-by redundancy because the signal from satellite does not have another chance if the receiving system misses it.

The LCAP has a SGI computer and storage devices. The LMIS and LFTM can share a single PC (Personal Computer) and input device. The LMIS and LFTM communicate external sites via internet using FTP.

2.4 S/W architecture of the system

The block diagram of the system is shown in Fig. 3.

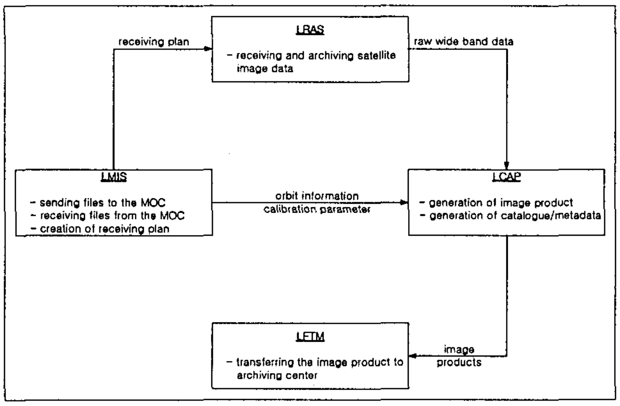

Fig. 3 Block diagram of the system

The conceptual operation sequence of the system is as fellows: 1) the LMIS receives the contact schedule and create the receiving plan form it, 2) the LRAS receives and archives satellite image data transmitted at 150Mbps, 3) the LCAP generates products and store it, and 4) the LFTM transmit the product to external sites. The detailed process of the system is addressed in sub-section.

2.4.1 LMIS

Fig. 3 illustrates the block diagram of the receiving and archiving sub-system.

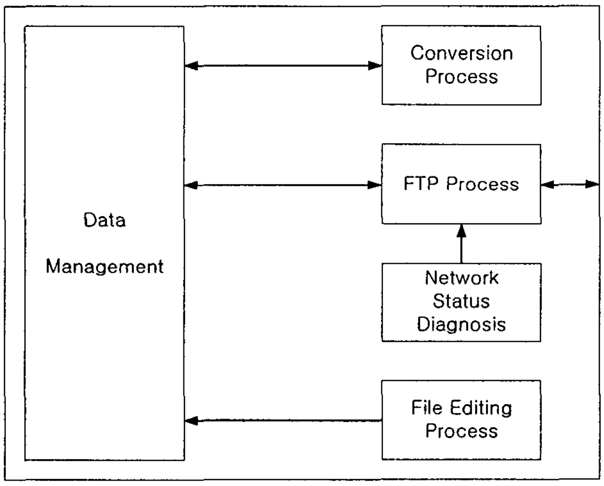

Fig. 4. Block diagram of LMIS

Each IGS must provide the station information to MOC in early operation and variation. To provide this information to the MOC, the LMIS can edit the files and transmit it. The generated files are automatically transmitted to MOC and the history is preserved. The MOC generates and locates the receiving plans and image process information into reserved directory. The LMIS brings the data generated by MOC periodically and changes into the system recognizable format. Some of data are delivered to the other sub-systems and the other data processed by the LMIS.

2.4.2 LRAS

The block diagram of the receiving and archiving sub-system is shown in Fig. 5.

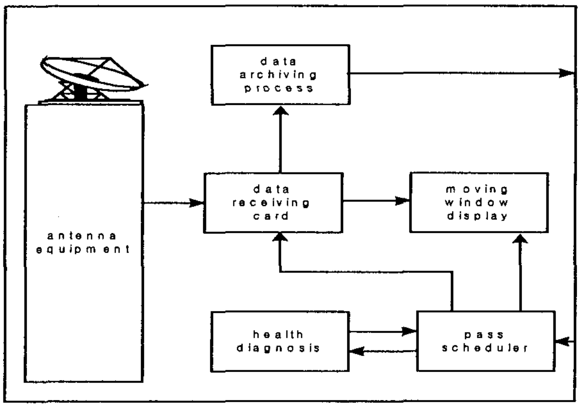

Fig. 5 Block diagram of LRAS

The LRAS receives and archives satellite image data transmitted at 150Mbps in real-time, performs MWD. The LRAS subsystem consists of two S/W modules: pass scheduler and data processor.

The pass scheduler can schedule antenna system for down-link reception, handle multiple reception of work orders, perform health diagnosis, maintain RAID capacity and perform RAID-to-DLT backup and restoration. Necessary is the efficient management of storage devices. The pass scheduler was designed to manage the storage devices with hierarchy and to perform the backup of data stored as requested. The health diagnosis check the status of the server whether can receive or not.

The data processor stores the data to RAIDs in real-time, performs real-time MWD. It also performs playback MWD of the data already stored in RAIDs.

2.4.3 LCAP

The block diagram of the LCAP is shown in Fig. 6.

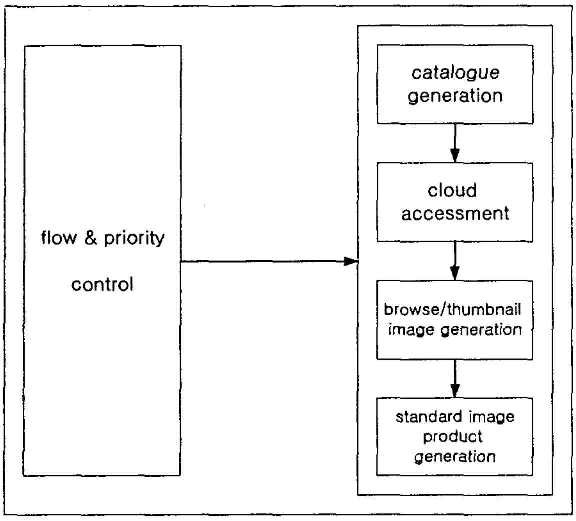

Fig. 6 Block diagram of LCAP

The LCAP generates catalog, browse images, thumbnail images and standard Landsat 7 image products. A user can select the product level for automated processing. Cloud assessment can be done automatically, semi-automatically and manually. Also user can configure browse image level.

Finally the produced image products are permanently archived into archiving system or delivered into archiving center to meet the user's demand. The transmission to archiving center be performed by LFTM.

2.4.4 LFTM

The block diagram of the LFTM is shown in Fig. 7.

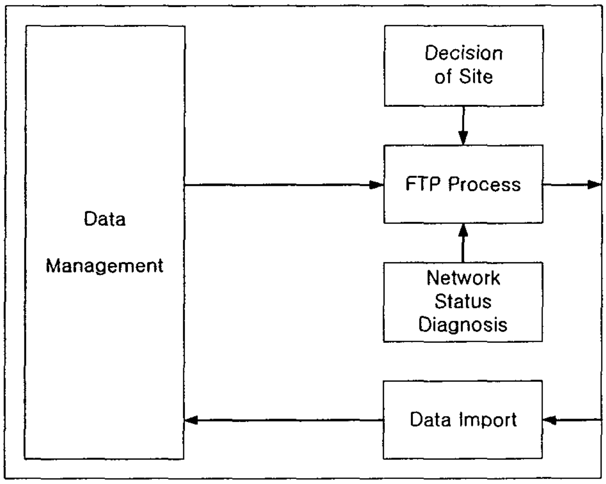

Fig. 7 Block diagram of LFTM

The major role of LFTM is safely sending the image products to external sites. To transfer the image products, the LFTM has the following functions: 1) data import from the input device, 2) decision of the external site to transfer because image products are transmitted various servers depend on product formats, 3) re-sending the image product in case of failure transferring.

3. Progress and Future Researches

This section describes the system development phase, explains the outputs of each stage and progress.

Currently the system development work is on going. The system, which will be tested at factory, will be appearing by December in 2002. The system can be operated after pilot test early in 2003.

3.1 Analysis

To accomplish the user's requirement, a number of requirement specification derived from it. The number of requirement specification is shown in Table 2.

Table 2. The number of requirement specification derived from requirement

Sub-system	# of req. spec.	Division at user's req.	Notes
Data receiving card	4		H/W
LRAS	39	Receiving and Archiving	S/W
LCAP	39	Product Generation	S/W
LFTM	12	Scheduling	S/W
LMIS	20	Scheduling	S/W

3.2 Design

The design phase divided two sub-phases in the system development: 1) basic design, and 2) detailed design.

We make the following documents in basic design phase: 1) entity list, which enlists the DB tables or files, 2) event list, which finally become menus or periodic task, 3) data flow diagram, 4) event scenarios, which describes the algorithm, and 5) basic design analysis document, which used to judging the conflict between basic design items.

We write the following documents in detailed phase: 1) GUI, which displays necessary menu and GUI components for each windows, 2) class list, 3) class diagram, which reveals the relations between classes, 4) interface control document, which contains DB content and interface protocol between sub-systems, and 5) detailed design analysis document, whose role is same as the basic design analysis document.

The summaries of the detailed design are shown in Table 4.

Table 4. The summaries of the design

Sub-system	# of GUI	# of classes	# of class diagram
LMIS	13	76	2
LRAS	29	88	5
LCAP	19	136	20
LFTM	9	53	2

3.3 Implementation

The system development is under-going implementation and the development environment is as follows.

Table 5. The system development environment

Sub-system	Machine	Operating system	Language	Database
LMIS	Independent	Independent	Java	JDBC
LRAS	PC	Windows	C++	Oracle
LCAP	SGI	IRIX	C++	Oracle
LFTM	Independent	Independent	Java	JDBC

We select the Java for development language of LMIS and LFTM. The S/W developed with Java language gives many opportunities for selection of economic operation environment.

3.4 Testing

The step of the testing is as follows: 1) FAT (factory acceptance test), 2) SAT (Site Acceptance Test), and 3) end-to-end test (or pilot test). The normal operation can be performed after successful end-to-end test.

The test engineer makes test scenarios to testing the system for each steps. Each test scenario consists of goals, related requirements, input and output data, test procedure and pre-condition. Test engineer will conduct the testing based on the test scenarios.

The FAT be going to test at development site by December in 2002. The SAT and end-to-end will be tested at installation site.

4. Conclusion

This paper briefly introduced the development work for Landsat 7 ground receiving system. The summaries of the paper are as follows: 1) the system will be developed by December in 2002, 2) the system will operate early in 2003, 3) the system can produce Landsat 7 standard products and be delivered to archiving center.

By 2015, seven KOMPSATs with various remote sensing sensors and six KAISTSATs with scientific payloads are to be launched. We hope our work stated here can help developing future ground receiving stations for succeeding Korean satellites.

Acknowledgements

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References

[1] 12th Landsat Technical Working Group (LTWG) Documentation. June 17-21, 2002

[2] Goddard space flight center, "Landsat 7 to International Ground Station (IGS) Interface Control Document," Revision E, July 2001