

## **Effective monitoring module configuration for real-time satellite image reception and distribution operation**

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### **Abstract**

Based on the newly developed Korea satellite operations center (KSOC), most parts of the satellite operation processes are designed as automatic systems, to reduce human error possibility and enhance work efficiency. The received satellite images on the ground station are also automatically delivered to the user in real-time with the minimum human operation while keeping the high value of the satellite image for the user. In the automatic workflow, alert error detection and fast response are essential for prohibiting big latency from an unexpected event. However, there was no system or module to obtain diverse information from different sub-systems while presenting the diverse information concisely in a single monitor. In this paper, we designed a new monitoring module specified in the data distribution mission of KSOC, named the ingestion and distribution monitoring system (IDMS). The developed module is utilized by the real-time operators in KSOC to make sense of any failure immediately on the procedure on the ground station from image ingestion on the antenna facility to distribution toward the user and solve the problem as promptly as possible. Furthermore, this module collecting information from the diverse sub-systems is the main is set to provide the average execution time of each subsystem, to check subsystem performance issues like bottleneck events.

**Keywords:** Data distribution, Ground station, Real-time operation.

### **1. Introduction**

With the beginning of Korea Satellite Operations Center (KSOC) in 2022, a data system (DS) is newly added to KARI's ground system to enhance the capability in data archive and distribution [1]. Specifically, the system, DS, is designed to overcome the time delay issue of satellite data delivery to users, which can be solved by the composition of huge archiving storage and efficient distribution system. Korea multi-purpose satellite (KOMPSAT) data users can obtain their required satellite data from the huge storage through the particularly adapted distribution method. The simple and efficient distribution is mainly based on the automatic system with minimal operator intervention. Even though the total procedure from data ingestion on the antenna to distribution works automatically, each process performs on its own without any point monitoring module to the whole data procedure. Thus, the operator should check every process in each system respectively and integrate the diverse information one by one. For this reason, it is difficult to immediately watch failure at a glance and fast responses to the failure are also limited. So, the 24/7 monitoring module on the whole distribution procedure is essential for this automatic distribution system in KSOC [2].

In this paper, we introduce a newly designed module to monitor the distributing status of all procedures which includes data reception on ground antennas to data distribution toward users, named ingestion to distribution monitoring system (IDMS). IDMS collects information from four systems aligned on the data distribution flow, User support system (USS), Mission control and image reception system (MCIRS), Image processing system (IPS), and Data system. Most information gathered in IDMS is designed in JSON file format to include respective performance information on each system, such as the start and finish execution time of each system. Thanks to this monitoring system for all sequences on data distribution procedures, an operator can maneuverer the problem promptly with minimal effects on distribution missions when the failure alerts turn on the monitor. Furthermore, performance checks on each system, MCIRS, IPS, and DS could be conducted to present the total distribution performance of KSOC.

### **2. Satellite image Distribution in KSOS**

The data system is largely divided into three sub-systems: Data archiving sub-system (DAS), Data service sub-system (DSS), and Service product generator (SPG). DAS is developed to store satellite images in large quantities to support image processing and image distribution services [1]. Meanwhile, SPG is set to generate service tile images using generally level 1 satellite images. The tile map usually is called a service map because users access multi-resolution image maps simply and immediately on the service background map, without any self-processing. The other sub-system, DSS, refers to a data service to effectively distribute images by multi-layering according to access users. The image distribution method performed by DSS is largely divided into two different ways: searching way and

straightway. The first way, searching-based distribution, refers to a method in which users directly search for and receive the data they want or need by comparing the desired region, payload, and cloud-based validity in the DSS system through API or web service. Fig. 1 shows a high-resolution service tile on right-side and searching results on left-side on the web-site. Not only are service tile images from SPG but also level 1 satellite image products are ready to deliver immediately to requesters, if the requesters order the satellite image.

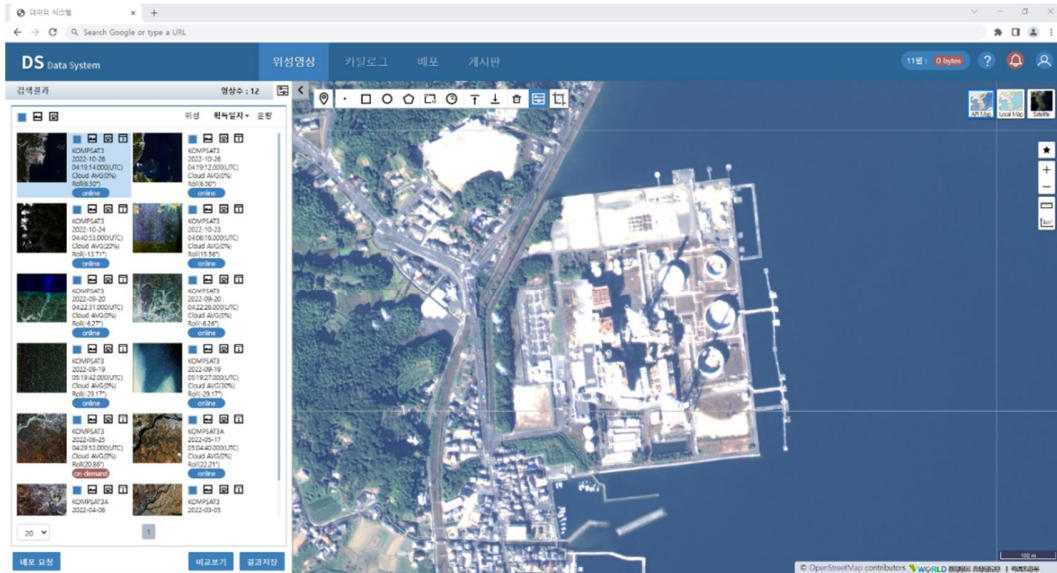


Fig. 1. High-resolution satellite service tile on DSS web-site[ 1 ]

On the other hand, the straight distribution way of DSS is designed to deliver satellite images to authorized users, right after evaluating the validity of received satellite images, standard image processing for valid images based on this, and direct distribution to authorized users. In particular, DSS is designed to deliver not only level 1 satellite images but also level 0 satellite data to users, specifically those who can perform their own image processing according to the user's authority. Depending on the user's authority levels and processing facilities, KSOC provides diverse fitting data formats as the user requests.

### 3. Monitoring Module for real-time satellite image distribution

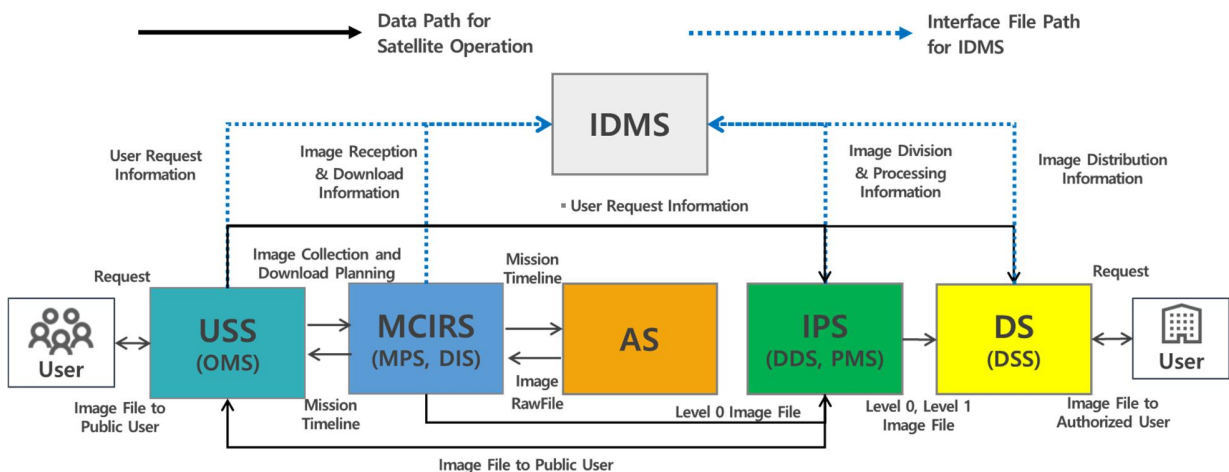


Fig. 2. Data paths for satellite operation and interface file paths for IDMS

Fig. 2 presents data paths for satellite operation and interface file paths for IDMS. The thick black line in Fig.2 indicates data or request path for satellite operation; meanwhile, the dashed blue line in the figure shows the interface file for IDMS to monitor satellite operation from image ingestion on the antenna facility to data distribution. In particular, the black line in Fig. 2 only presents the procedure related to the data distribution from data request, thus specific sub-system like DSS is directly related to data distribution toward the user. To check the status of all procedures for image distribution, this monitoring module IDMS collects several interface files from four different systems, USS, MCIRS, IPS, and DS as shown in Fig. 2, which include the execution time to represent success or failure on each procedure.

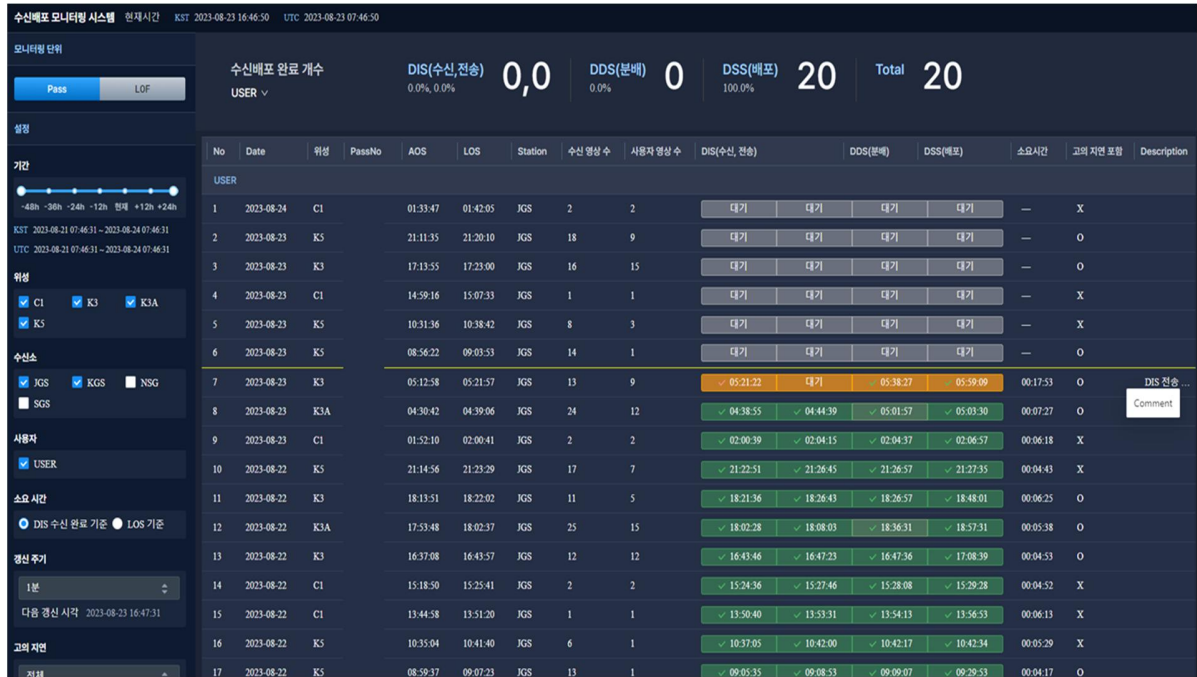


Fig. 3. IDMS service web-page

Fig. 3 shows a graphic user interface (GUI) service on a web page for IDMS. There are manual buttons on the left side of the page to select diverse conditions to monitor at a glance. A user of IDMS can monitor the distribution results by selecting one of two monitoring units, the pass unit and the image unit. Manual buttons consist of diverse types considering operators' convenience to monitor the situation at a glance, related to the period of ingestion time, satellites, ingestion ground station, and monitoring user. The upper-written number on the page in Fig. 3 presents the real-time statistics.

### 3.1 User Request Information from USS

Order management system (OMS), which is one of the sub-systems in USS, plays the role of collecting and managing user requests, and a matching tag on these requests is made in OMS. The tag is key to continuously track following the whole procedure on the ground station. In IPS and DS, this matching tag sending from OMS is utilized to conduct their mission to each satellite data, adaptively. In the view of IDMS, the user request information assigned from USS is needed to classify the listed images, as followed by the operator's control.

### 3.2 Image Reception Information from MCIRS

MCIRS is the key system in KSOC, in the view of satellite mission operation as mission planning and satellite data ingestion. The mission planning sub-system in MCIRS conducts mission planning based on image collection and download plan from USS, providing mission timeline file. Thus, the image download plan in the mission timeline makes the antenna focus on the flying satellite to contact, and OMS in the USS waits for the image ingestion for order management. The satellite images with matching tags to be distributed can be listed in IDMS with the download plan time, presenting the waiting satellite data list as scheduled time. In Fig. 3, the gray-colored rows on the upper side of the figure indicate the waiting satellite data lists to be ingested soon.

In addition, the data reception on the ground station is set as the role of MCIRS, either. The antenna facility on the ground station is controlled by MCIRS, to receive satellite raw images followed by a mission timeline, and the received satellite raw image is transmitted toward MCIRS. The data ingestion sub-system (DIS) in MCIRS has the role of merging the raw data to level-0 satellite data. Contrary to the Level 1 image product, the Level 0 image is the basic level for reproducing Level 1 satellite images, which is widely used by public users [3, 4]. The automatic operation information related to the reception process and merge is important information for monitoring the status of the distribution procedure in IDMS, so thus IDMS collects information on the performing time from the MCIRS.

### *3.3 Image Division and Processing Information from IPS*

To achieve useful satellite image files, it is essential to achieve high-level image processing on received and merged Level 0 data. IPS provides image processing on the Level 0 data to produce Level 1 data. If a user requests Level 1 or upper-level satellite data, image processing on IPS is essential. Even if the user requires Level 0 data, IPS is required to perform the image division among diverse transferred satellite Level 0 data from MCIRS. The execution time for separation and image processing is submitted to IDMS to indicate the real-time status of the data distribution procedure.

### *3.4 Image Distribution Information from DS*

Following the previous procedure, the satellite data is ready to be distributed toward user environment, which is normally outside of the KSOC. Thus, the distribution circumstance could be unstable due to the in-to-out networking system. So, the data distribution system, named DSS, equips a stable and double-checking distribution program. The execution time for distribution is stored in the IDMS database, with other execution times from MCIRS and IPS. Using this diverse execution information, it is possible to analyze the performance of each procedure. With the stacked execution time of the whole procedures in IDMS, the total procedure duration from reception on the Antenna to data distribution to the user's environment is under a 5-minute average, for the Level 0 data.

## **4. Results**

In order to achieve the ultimate goal of satellite operation in KSOC, it is important to build all processes automatically. The automatic system is simple but it is sure to support monitoring all automatic procedures in a scene efficiently. In this paper, we introduce a newly developed monitoring system to indicate the whole procedure for satellite image reception on the ground antenna to the final distribution system toward the user environment. Each information assigned on respective systems is gathered at the monitoring system, IDMS, and the system shows the status of every collected and downloaded satellite image file and execution time. Using this efficient monitoring system, real-time operators in KSOC can check the unexpected situation on data distribution in real-time and solve an error situation as promptly as possible.

## **References**

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