INTRODUCTION OF COMS IDACS SYSTEM FOR METEOROLOGCIAL AND OCDAN MISSION

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ABSTRACT: KARI is developing Image Data Acquisition and Control System (IDACS) for pre-processing meteorological and ocean data acquired on geostationary orbit. This paper describes the functions and architecture of IDACS and gives its operation policy including backup operation to overcome limitation of single-configured antenna system. The COMS IDACS provides the capability to receive the raw sensor data and disseminate processed MI data to users via a satellite. From the processed image data, users can produce a set of meteorological and ocean products for a wide range of applications. Most of IDACS subsystems are being developed by Korean technologies and experience acquired from previous projects. In case of COMS geometric correction software module, as it is closely dependent on the characteristics of imagers and spacecraft bus system, it is being co-developed with overseas prime contractor who develops spacecraft bus system.

KEY WORDS: COMS, Ground System, Pre-processing, LRIT, HRIT.

1. INTRODUCTION

The COMS system has following three primary objectives, a meteorological service, ocean monitoring, and Ka-Band satellite communications. To implement the missions, COMS space segment is composed of a geo-stationary spacecraft and three payloads: Meteorological Imager (MI), Geostationary Ocean Color Imager (GOCI), and Ka-band Communication Payload.

On ground, various systems are being developed to control/monitor COMS space segment and process data from payloads. As major ground systems, there will be "Image Data Acquisition and Control System (IDACS)" for data processing, "Satellite Ground Control System (SGCS)" for satellite controlling and "Communication Test Earth Station" for Ka-band satellite communication.

Among them, this paper focuses on IDACS system which is installed at MI and GOCI data processing center, Meteorological Satellite Center (MSC) and Korea Ocean Satellite Center (KOSC). Input data of IDACS, raw data of two payloads (MI and GOCI), is acquired in one data stream from on-board Meteorological Ocean Data Communication Subsystem (MODCS) which provides downloading raw data to ground and relaying processed MI data (LRIT/HRIT) from ground to end users. The downloaded raw data will be CCSDS formatted.

MI will generate raw data in one visible (1 km resolution) and four infrared channels (4 km resolution) with various observation modes including full Earth disk. A new ocean imager which be settled on geostationary orbit and cover Korean Peninsular and around oceans in 6 visible channels (0.5 km resolution) and 2 infrared channels (0.5 km resolution) is being developed for COMS system.

The raw data is preprocessed in IDACS via geometric/radiometric correction and delivered to users by using new dissemination data formats, the Low Rate Information Transmission (LRIT) and High Rate Information Transmission (HRIT) which is compatibility with the global specification recommended by Coordination Group for Meteorological Satellites (CGMS) in order to increase the interoperability between member nations.

IDACS is designed to process data in real-time from raw data reception to LRIT/HRIT dissemination and enable to process both MI and GOCI payloads.

Most subsystems of COMS IDACS are being developed by Korean technologies based on experience from previous similar project. In case of geometric correction software (INRSM, Image Navigation and Regi-stration Software Module), as it is closely dependent on characteristics of imagers and bus system, it is being co-developed with overseas prime contractor who developed spacecraft bus system.

In this paper, overview and the development status of IDACS will be presented. It also provides its backup operation policy to guarantee high performance reliability.

2. OVERALL ARCHITECTURE

The senor data (MI and GOCI) is acquired from the satellite by the DATS (Data Acquisition and Trans-mission Subsystem) and raw data is transmitted to the IMPS (Image Preprocessing Subsystem). Additional data required by the INRSM of IMPS is produced by SGCS (Satellite Ground Control System) and input through the PMM (Product Management Module). These data cover orbit determination/prediction, on-board time synchro-nization, and payload operation planning.

MI/GOCI Level 1B products, result of IMPS, are directly output to Level 2 product extraction system, CMDPS (COMS Meteorological Data Processing

System) in case of MI and GDPS (GOCI Data Processing System) in case of GOCI data in real-time. In parallel, INRSM output is transmitted to LHGS for generating LRIT/HRIT. For LRIT generation, additional data will be input to LHGS (LRIT/HRIT Generation Subsystem). Finally generated LRIT/HRIT is delivered into DATS to be uploaded to spacecraft.

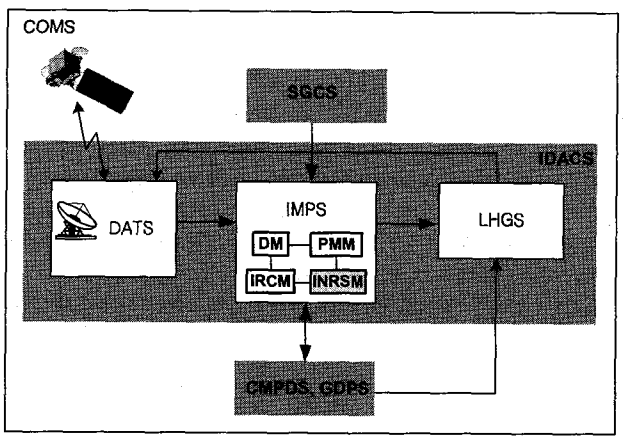

Figure 1. IDACS Configuration

3. IDACS SUBSYSTEMS

IDACS consists of 3 subsystems: DATS, IMPS, and LHGS. IMPS is composed of 4 sub-modules: Decomposition Module (DM), Image Radiometric Correction Module (IRCM), INR Software Module (INRSM), and Product Management Module (PMM).

3.1 DATS

The function of DATS is the acquisition of sensor data signal and transmission of LRIT/HRIT data. It also performs control and monitoring for the entire IDACS.

For the acquisition of sensor data via L-Band downlink and processing, DATS performs following front-end processing functions:

- Acquisition and amplifying sensor data signal
- Down-conversion
- Demodulation
- Bit synchronization
- Frame synchronization
- De-randomizing
- Reed-Solomon decoding

The raw data, result of front-end process, are separated into MI and GOCI data and transferred to the IMPS for data pre-processing. For the transmission of LRIT/HRIT via S-Band uplink, the DATS performs the following functions:

- LRIT/HRIT reception from LHGS
- Convolutional encoding
- BPSK (LRIT) and QPSK (HRIT) modulation
- Up-conversion
- Amplification

3.2 IMPS

The IMPS provides the functionality of geometric and radiometric correction into raw data and generates level 1B product as final result. In order to perform user dissemination service in real-time, INRSM output (MI level 1B block) in block units are sent to LHGS for LRIT/HRIT generation. The final MI level 1B product is generated at PMM from INRSM output (MI level 1B) consisted of entire image and additional information. Then it is transmitted to CMDPS for extracting meteorological products. The GOCI level 1B product is also generated at PMM from INRSM output (GOCI level 1B) and sent to GDPS for further data analysis. The IMPS is composed of following software modules in data processing order from raw data to level 1B product.

- Decomposition Module (DM)

The DM receives raw data via PMM which is interfaced with external systems. As raw data contains all observation data including image, fill and auxiliary data, from raw data, DM will generate level 0 product which is easy data format for further data processing.

- Image Radiometric Correction Module (IRCM)

The first image processing applied to level 0 product is radiometric correction. As a result, level 1A product is generated in IMPS.

- INR Software Module (INRSM)

After radiometric correction, level 1A product is geometrically corrected in INRSM developed by prime contractor. Its result is referenced as INRSM output, geometrically corrected image. For INRSM processing, the SGCS ancillary data should be input from SGCS. These data includes extracted TM, ephemeredes, and event files as already mention in section 2. INRSM will be interfaced with PMM for input and output data exchanges from external systems.

- Product Management Module (PMM)

The PMM will manage all internal and external interfaces as shown in Figure 2 and monitor entire image processing of IMPS via collected status data within IMPS. It displays radiometric and geometric quality and allows off-line controlling algorithms/database of IRCM and INRSM. Besides that, it is responsible for managing data input/output of IMPS, therefore generating MI and GOCI level 1B product, the final result of IMPS is performed at PMM. The generated level 1B products are transmitted to level 2 extraction systems (CMDPS, GDPS) through PMM and radiometric information from CMDPS is also reflected to IRCM at PMM.

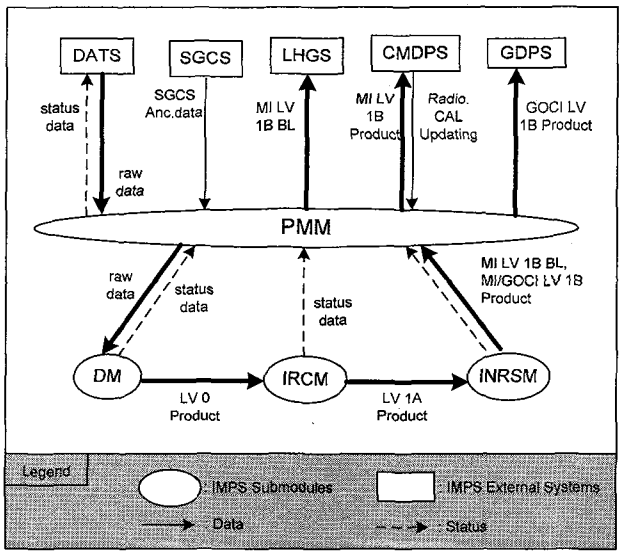

Figure 2. IMPS Interfaces

3.3 LHGS

The LHGS performs the LRIT/HRIT formatting for user dissemination service according to the COMS LRIT /HRIT Specification. INRSM output (MI level 1B block) is bounded into a number of segments and then encoded and transmitted to the satellite via DATS.

Each segment and its associated header information are combined into an HRIT or LRIT file. The image data in these files can be compressed by using JPEG compression algorithm, and/or encrypted (Data Encryption Standard) before encoding into the output data stream to the DATS.

4. OPERATION

IDACS will be installed at MSC, KOSC, and SOC. MSC is primary MI data processing center, and KOSC is primary GOCI data processing center. Therefore, IDACS at MSC and at KOSC will perform MI and GOCI data processing respectively. Backup IDACS will be installed at Satellite Operation Center (SOC). The MSC, KOSC, and SOC will be communicated via ground networks.

4.1 Nominal Operation

Under nominal operation, no failures at any ground centers, IDACS systems at each ground center will be operated as shown in Figure 3.

- IDACS at KOSC
  : GOCI data preprocessing
- IDACS at MSC
  : MI data preprocessing
  : LRIT/HRIT generation and transmission
  : Supporting data for LRIT generation to SOC
- Backup IDACS at SOC
  : MI/GOCI data preprocessing
  : LRIT/HRIT generation
  : Transmission of MI LV 1B product to MSC

To perform COMS missions, the availability of receiving raw data is considered as the most important thing. As every COMS ground center will have single-configured antenna system, in order to prevent any losses of raw data at MSC and KOSC preparing for the worst, backup IDACS at SOC will receive both of MI/GOCI data under normal operation, independently with no relationship of availability of primary site. Because real-time processing is more required to MI data, SOC transmits MI level 1B product to MSC continuously and generate LRIT/HRIT. But their dissemination at SOC is only possible in case of MSC is unavailable. To support backup LRIT generation at SOC, MSC transmits additional data for LRIT generation except image data, such as level 2 meteorological product, Numerical Weather Prediction data, binary data, and etc.

GOCI level 1B product is not transmitted under nominal condition, but archived so that they will be delivered to KOSC on request. Thanks to SOC's hot backup processing, continuous meteorological/ocean observation is possible without any effect from the system error or natural disasters such as earthquake occurred on the other system.

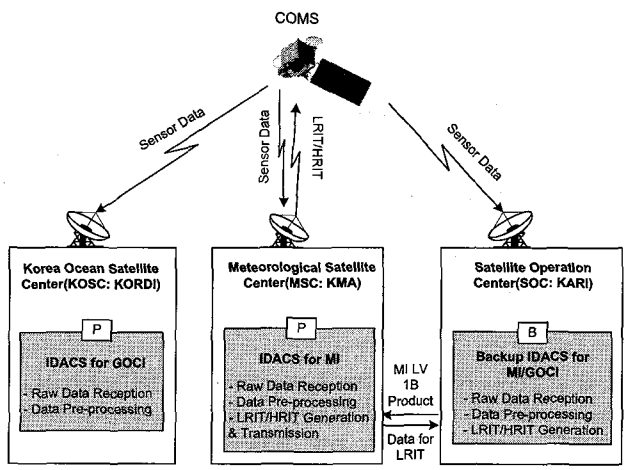

Figure 3. GS Interfaces under nominal operation

4.2 Backup Operation

4.2.1 When MSC is unavailable

Failure cases which can be occurred at MSC are shown as followings,

- Case 1: Failure at antenna system of DATS
- Case 2: Failure at RF/MODEM/BB of DATS
- Case 3: Failure at IMPS
- Case 4: Failure at LHGS

Except case 1 with single-configured antenna system, the operation can be switched to backup systems at MSC. As a solution for case 1 and when backup systems don't work, dissemination of LRIT/HRIT will be started at SOC after request from MSC. But no additional interfaces are needed for backup operation against MSC's unavailability as shown in Figure 4. Figure 4 assumes that the worst case of IDACS backup operation, i.e., no communication between satellite and KOSC/MSC.

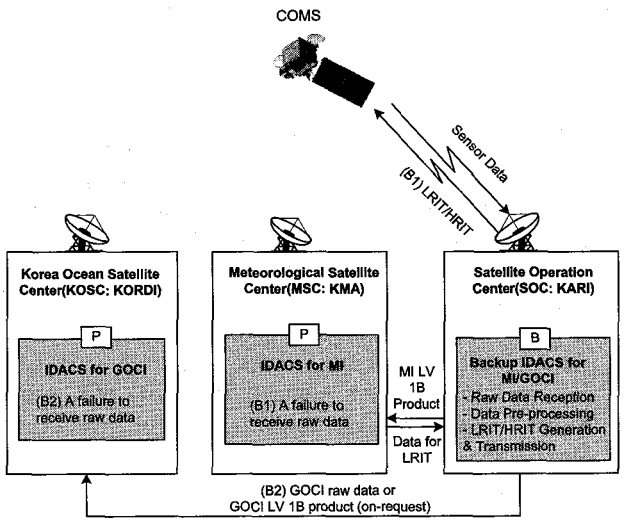

Figure 4. GS Interfaces under backup operation

4.3 When KOSC is unavailable

Failure cases which can be occurred at KOSC are shown as followings,

- Case 1: Failure at antenna system of DAS
- Case 2: Failure at RF/MODEM/BB of DAS
- Case 3: Failure at IMPS

If systems have backup systems, when failure occurs, the operation will be continued at backup systems. When KOSC cannot acquire raw data, because of antenna system failure, SOC can provide GOCI raw data or GOCI Level 1B product on request from KOSC as shown in Figure 4.

5. CONCLUSION

This paper describes the functions and operation policy of IDACS. The main task of IDACS is transformation of MI/GOCI sensor data into level 1B products. These tasks require radiometric and geometric corrections that have to be performed in real-time. The data processing is monitored continuously and switching to backup hardware of DATS is also possible at control and monitoring system in IDACS. From result of IDACS, pre-processed level 1B product which covers from Korean peninsular to full Earth, users can produce a set of meteorological/ocean products with high quality for a wide range of applications.

The implementation and verification of IDACS will have been finished until first quarter of 2008 under co-cooperation with Korean domestic companies to be ready before successful launch of COMS.