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RA II WIGOS Project Newsletter

DEVELOPING SUPPORT FOR NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN SATELLITE DATA, PRODUCTS AND TRAINING

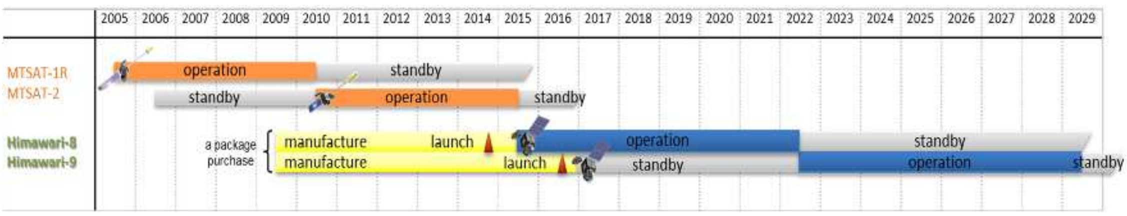
Contents of this issue

JMA's Himawari-9 satellite scheduled for launch on 1 November 2016

The Japan Meteorological Agency (JMA) has announced its plan to launch Himawari-9 on 1 November 2016 as the follow-on satellite to Himawari-8. The new unit has the same specifications as Himawari-8, which is JMA's current operational satellite and the world's first new-generation geostationary meteorological satellite.

Once launched, Himawari-9 will enter a state of in-orbit stand-by as backup for Himawari-8. This will help to ensure the stability of the satellite observation system for the East Asia and Western Pacific regions over the next 15 years (Figure 1). For further information, see http://www.jma.go.jp/jma/jma-eng/satellite/ and http://www.jma-net.go.jp/msc/en/support/index.htm

(Shiro OMORI, JMA)



Figire 1

Himawari-8 Convective Cloud Information Product

Cumulonimbus bringing severe lightning and heavy rain can suddenly develop within as little as 30 minutes, creating disaster condition. The Japan Meteorological Agency (JMA) observes and issues nowcasting on extreme cumulonimbus formation using data from its ground-based weather radar network, but detection of such cumulonimbus over isolated islands and sea areas outside radar observations range remains challenging. Accordingly, Meteorological Satellite Center (MSC) of JMA has developed the Convective Cloud Information (CCI) product for analysis and nowcasting in relation to convective cloud by using observation data from Himawari-8 multi-spectral rapid scan operation. CCI consists of three detection areas; rapidly developing cumulus area (RDCA), mature cumulonimbus (CB) and dense cirrus spread from CB (named as mid/low cloud unknown area).

JMA provides the CCI product as infrared imagery with these three detection areas overlaid at five-minute intervals around Japan (Figure 2). This information is considered essential for aviation safety in Japan.

Notably, RDCA allows developing cumulus detection earlier than data from radar observation because the visible-infrared geostationary satellite can observe a cloud area before the cloud drop reach radar-observable size. Figure 3 shows CCI images and radar echo images with lightning detections overlaid for a heat lightning situation over mainland Japan. The first RDCA appeared an hour earlier than the first lightning strike and 20 minutes earlier than the first radar echo. RDCA supports early detection of convective cloud areas beforehand in such cases featuring rapidly developing isolated cumulonimbus.

Cumulonimbus detection and nowcasting are critical for the aviation services. CCI coverage is currently limited to Japan, but is expected to be extended, especially to incorporate the tropical region. JMA will provide information on the CCI product in its presentation on convective cloud detection based on data from Himawari-8 and other geostationary meteorological satellites at the 7th Asia/Oceania Meteorological Satellite User Conference (AOMSUC-7) in October 2016, in Korea. It is hoped that the information provided will help to stimulate interest in early cumulonimbus detection.

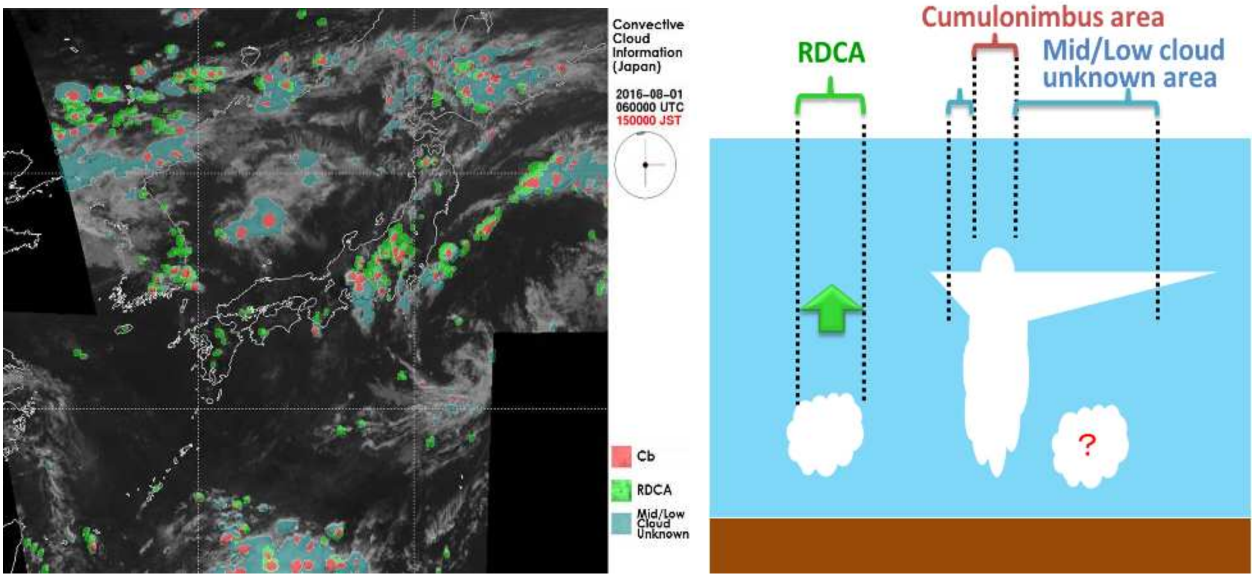


Figure 2 Convective cloud information and conceptual image of a detection area

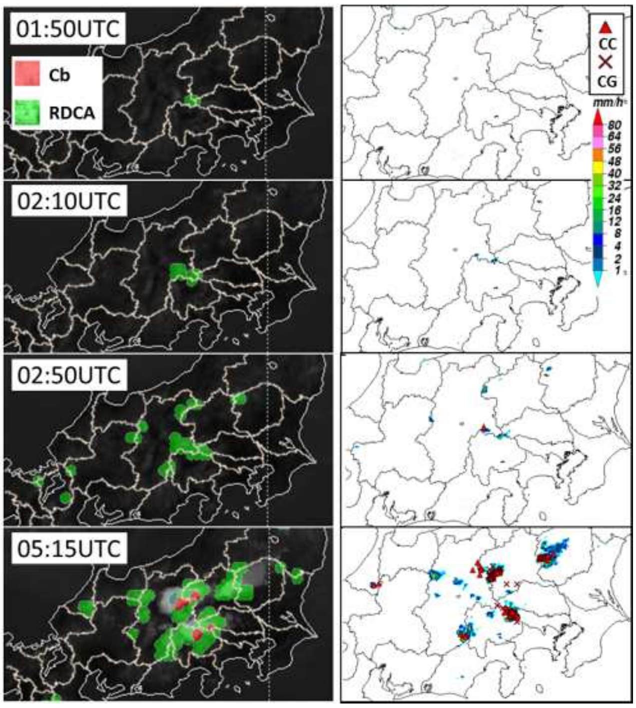


Figure 3 Heat lightning on August 4, 2015. Left: CCI images; right: radar echo images with lightning detection overlay

(Yasuhiko SUMIDA, JMA/MSC)

The Geo-KOMPSAT-2(GK2) Ground System

Introduction

The COMS (Communication, Ocean and Metrological Satellite), Korea's the first geostationary observation satellite, has been operated successfully for the meteorological and ocean observation mission since 2010. The meteorological imager of COMS observes the full Earth every 3 hour, the northern hemisphere 4 times per hour, and the Local Area maximum 8 times per hour at 128.2 degree east longitude. At NMSC (National Meteorological Satellite Center), received raw meteorological observation data is converted to calibrated image data as well as extracted meteorological products and broadcast data (LRIT/HRIT) through the spacecraft to the domestic and foreign user stations. The ocean color imager of COMS, the first ocean imager on the geostationary orbit in the world, performs regular observation 8 times per day over oceans near the Korean Peninsula. Raw ocean payload data is processed at KOSC (Korea Ocean Satellite Center) and converted to calibrated image data and various ocean products.

Currently, the GK2 program is being conducted to take over the role of COMS. The GK2 series is composed of two satellites; GK2A satellite for meteorological mission and GK2B satellite for ocean and environmental monitoring missions. The GK2A will be ready for launch in 2018 and GK2B in 2019. The GK2A/2B will include advanced three payloads (AMI: Advanced Meteorological Imager, GOCI-II: Geostationary Ocean Color Imager-II, GEMS: Global Environmental Monitoring Sensor) which are capable of higher temporal, spatial, and spectral performance when compared to the current COMS system.

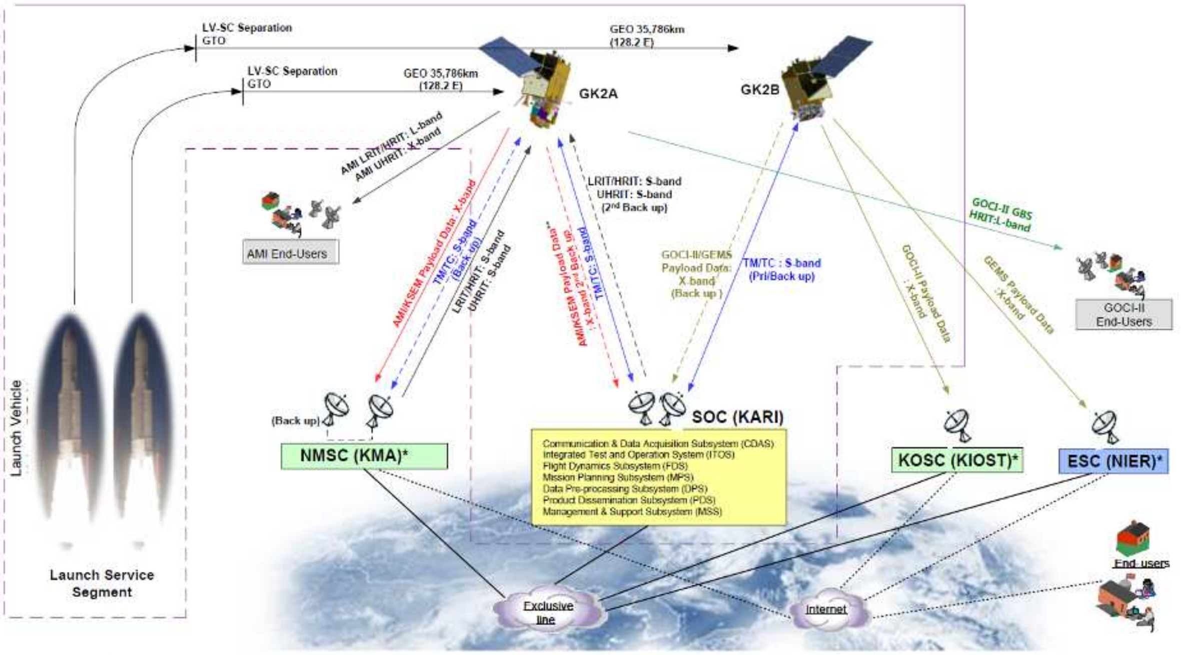
The ground system for GK2A/2B has to control two satellites on the same geostationary orbit and process three payload data from receiving up to broadcasting under the timeliness requirements will be located at KARI. Many part of GK2A/2B ground system development output will be installed and operated at users' organizations such as NMSC and KOSC as well.

GK2A/2B Ground System

This section outlines 4 ground centers for GK2A and GK2B within Korea and focuses on SOC ground system introduction.

A. GK2A/2B Ground Centers

The GK2A/2B will have ground systems designed to support missions and operations over 10 years, respectively. It is composed of the Satellite Operations Center (SOC), National Meteorological Satellite Center (NMSC), Korea Ocean Satellite Center (KOSC), and Environmental Satellite Center (ESC), as shown in Figure 4. The SOC provides the functionality to operate the GK2A/2B satellite by receiving and transmitting commands to satellites. The NMSC, KOSC, and ESC converts payload data from the satellite into calibrated data. The AMI and GOCI-I/GOCI-II image data are disseminates to end users via the GK2A. The SOC and NMSC/KOSC/ESC will exchange the satellite operations data or image data using the terrestrial data. When required from NMSC, the SOC can resume backup xRIT(LRIT/HRIT/UHRIT) broadcasting service. The each ground center will be integrated by their oraginzations' responsbility before the satellite launch.



* Users' Ground Station and relevant interfaces under users' responsibility
** Storage only for KSEM data

Figure 4 **GK-2A and -2B System Architecture**

Ground systems of each ground center will guarantee the high reliablity afforded by their redundant configuration. Moreover, the SOC will have backup data preprocessing of the AMI/GOCI-II/GEMS payload data. In case of GK2A, the backup satellite operation systems will be installed at remote site, NMSC but its operations will be permitted by the SOC operators.

B. SOC Ground System Confiruation

The SOC will be located in Daejeon and fully operated by KARI. It serves the satellite operations and backup data preprocessing with two 9 meter diameter antennas for GK2A and GK2B respectively. The GK2A and 2B use S-Band, X-Band, and L-Band communication frequencies. X-Band is used for the downlink of payload data and the downlink of UHRIT dissemination channel.

The SOC is composed of following subsystems as shown in Figure 5.

- CDAS (Communication and Data Acquisition Subsystem) for TTC and imagery data
- ITOS (Integrated Test and Operation System) for TM/TC processing
- MPS (Mission Planning Subsystem) for Mission Scheduling
  : Two MPSs for GK2A and GK2B satellite
- FDS (Flight Dynamics Subsystem) for Maneuver Planning
- DPS (Data Pre-processing Subsystem) for Radiometric Calibration
- : Three dedicated DPSs for AMI, GOCI-II, and GEMS
- INR (Image Navigation and Registration) for Geometric Calibration
- : Three dedicated INRs for AMI, GOCI-II, and GEMS
- PDS (Product Dissemination Subsystem) for AMI xRIT Broadcasting
- : One PDS for AMI payload
- MSS (Management and Support Subsystem) for Unified Monitoring and Management to SOC operators

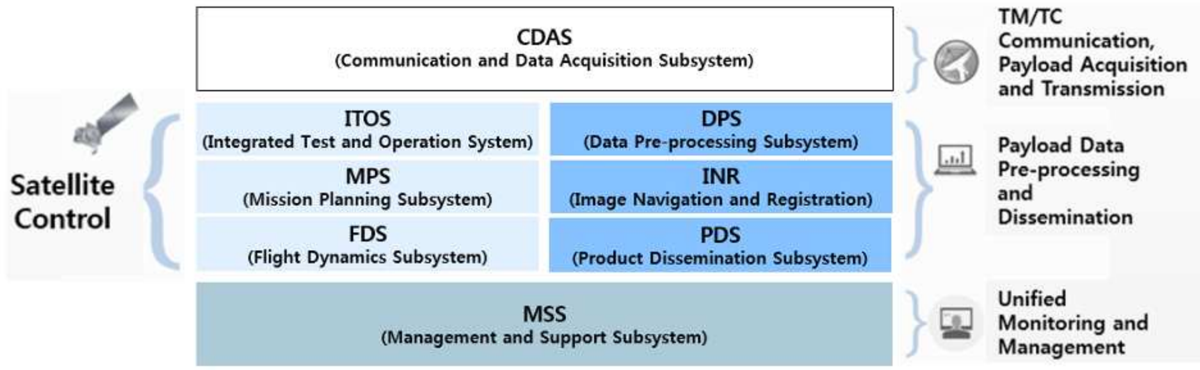


Figure 5 GK2A/2B Ground Centers

C. SOC Ground System Development Plan

Most ground subsystems of SOC are required to process both GK2A and 2B satellite data during the mission life time. Therefore possible subsystems are being development to cover both satellites as possible, though GK2A and GK2B satellite launch schedules are different. Some subsystems are dedicated for each payload data and payload development schedule. Unified subsystems for GK2A and 2B can be operated as separated systems, menu/function for each GK2A and 2B by configurations.

The SOC ground SW development is in progress with command components in order to improve development efficiency and consistent results among subsystems. Functionalities and interfaces which are required repetitively to all ground SW are developed as "common components" to be reused to all ground SW development. Common components can be categorized for entire GK2A/2B GS and for GK2A GS only, GK2B GS only as follows. There common components will be implemented in Java language for SW reusability.

- Common Components for GK2A/GK2B GS
  - Handling components of Log, Status, Audio/Video alarm
  - Access components of Data I/O, DBMS, User Authentication
  - Common Interface components (FTP, Socket, RPC, REST API etc.)
  - Common UI components (Graphic control, User Login, Search control etc.)

- Common Components for GK2A GS
  - Access components for GK2A S/C, AMI Configuration and Telemetry
  - AMI image products components
  - Interface data components for GK2A GS SW

- Common Components for GK2B GS
  - Access components for GK2B S/C, GOCI-II, GEMS Configuration and Telemetry
  - GOCI-II, GEMS image products components
  - Interface data components for GK2B GS SW

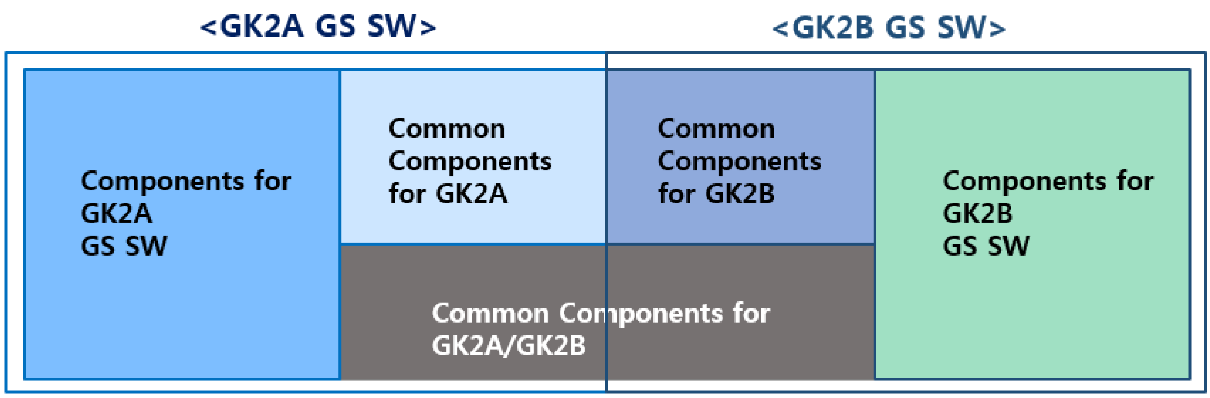


Figure 6 Common Components Concept for SOC Ground SW Development

Major Differences between COMS and GK2 Ground System

Comparing to the existing COMS system, the GK2A/2B ground system is required in the functional and performance aspects as follows,

- Satellite collocation operation for COMS and GK2A/2B
- Manual/automatic optional operation in mission scheduling and flight dynamics
- GEMS (Hyper-spectral payload) preprocessing added
- Increased payload data volume more than 20 times in case of AMI
- Faster AMI timeliness requirement compared to the current COMS' requirement from 15minutes to 3 minutes (Calibration and broadcasting shall be completed within 3 minutes after the full Earth observation)
- New ultra-HRIT broadcasting service to disseminate the all AMI L1B product in the DVB-S2 protocol
- Compatible LRIT/HRIT services with the current COMS' services

In addition to things mentioned above, there're more different items. The Ka-Band communication payload (communication missions) does not exist in the GK2A/2B satellites but the GEMS (environmental monitoring missions) will be embarked to GK2B.

The AMI will exhibit higher performance in temporal, spatial, and spectral resolution in comparison with the COMS Metrological Imager (MI). The GK-2A AMI will provide 16 spectral bands in the visible, near-IR, and IR spectrum, 5 times better than current COMS MI. Its spatial resolution will be improved 2 times better capability of COMS. Moreover, the AMI can observe the full disk image as short as 10 minutes, 3 times faster than current imager. Large amount of AMI raw data will be delivered to ground in X-Band.

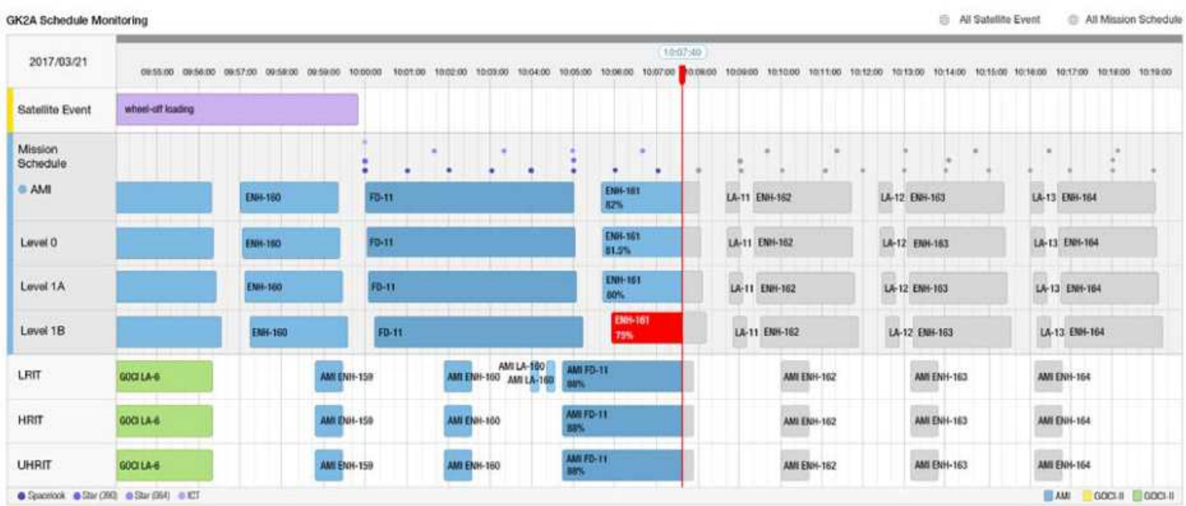


Figure 7 GK2A MSS GUI

For SOC which performs satellite operations and data preprocessing, entire SOC ground system and satellites operational status will be displayed in comprehensive configurations as shown in Figure 7. Based on the COMS ground system experience, operator friendly functions such as report generation and primary/backup synchronization functions will be added to GK2A/2B ground system.

GK2 Broadcasting Service

The GK2A satellite will be equipped with an on-board transponder for data direct broadcasting like the COMS. The AMI/GOCI-II imagery data, AMI level 2 product and value-added data will be disseminated to end users. The GK2 broadcasting service can be categorized into 3 service channels depending on data rate and contents: LRIT, HRIT and UHRIT.

The GK2 LRIT (Low Rate Information Transmission) and HRIT (High Rate Information Transmission) will take over the current COMS' LRIT and HRIT broadcasting service. The GK2 ground system will process down- sizing of AMI imagery data in close bands with current MI to generate approximately identical contents and formats. Not to make any technical problems to existing COMS end-users systems, the GK2 LRIT and HRIT will be downlinked to end users system through same RF characteristics and data format. The current COMS provides LRIT and HRIT broadcasting service in L-Band from 2011 for free but user registration is required to key information from KMA (Korean Meteorological Administration). The UHRIT (Ultra-UHRIT) will be newly added as a means of AMI imagery data dissemination in full resolutions and channels using DVB-S2 (Digital Video Broadcasting-Satellite-Second Generation). The current COMS end-user can receive GK2 LRIT/HRIT signals but users who want to receive new UHRIT channel are required X-Band reception system and processing system including DVB-S2 equipment. Table 1 shows the GK2 LRIT, HRIT and UHRIT downlink characteristics. Detailed sequences of AMI observation/dissemination mode and time frames are under consideration by KMA.

	LRIT	HRIT	UHRIT
Downlink Frequency	1692.14 MHz	1695.4 MHz	8307.5 MHz
Max. Data Rate	256 kbps	3 Mbps	31 Mbps
Coding	RS(255, 223,4) + Conv(1/2, K=7)	RS(255, 223,4) + Conv(1/2, K=7)	BCH + LDPC 2/3 of DVB-S2 standard
Polarization	Linear in EW	Linear in EW	LHCP
Modulation	NRZ-L/BPSK	NRZ-L/QPSK	NRZ-L/8PSK
Compression	Yes	Yes	Yes
Encryption	Yes	Yes	Yes

Table 1. GK2 Broadcasting Downlink Chracteristics

Conclusion

The SOC ground system for GK2 is required to be operated 24hr/365days and to control 2 satellite, and high-resolution/large amount of data preprocessing during lifetime. The required data preprocessing time has been shorten though image resolution and data amount have been increased. Therefore proper distributed processing, automatic recovery mechanism, optimized file transfer methods are being selected by related prototyping tests.

The SOC ground system for GK2A will be integrated in 2017 and SOC for GK2B will be integrated in 2018. During the GK2A IOT phase, GK2B SOC systems are supposed to be integrated and tested. The overlapped period in the SOC ground system development schedule for GK2A and 2B can get solved by using efficient development policy such as common component modules and unified operations system development. The unified operations system and automatic processing in mission planning/flight dynamics are expected to reduce burden for 2 satellite operations.

Like the usual satellite project, the ground system development is required to be operated continuously more than design lifetime of the GK2 satellites. In the ground system development, the satellite and ground system abnormal cases and prevention/recovery configuration has to be considered and planned. As the hardware performance will be improved better and better as time goes by, the easy SW installation method, the selection of efficient DBMS and filing system will be selected to consider future hardware migration which can be happened during the lifetime.

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From the Co-editors

The co-editors invite contributions to the newsletter. Although it is assumed that the major contributors for the time being will be satellite operators, we also welcome articles (short contributions of less than a page are fine) from all RA II Members, regardless of whether they are registered with the WMO Secretariat as members of the WIGOS Project Coordinating Group. We look forward to receiving your contributions to the newsletter.
(*Dohyeong KIM, KMA, and Hiroshi KUNIMATSU, JMA*)

RA II WIGOS Project Home Page

http://www.jma.go.jp/jma/jma-eng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html

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