CGMS-45 KMA-WP-01

Prepared by KMA,
Agenda Item: D.10
Discussed in Plenary

KMA REPORT ON THE STATUS OF CURRENT AND FUTURE SATELLITE

In response to CGMS action/recommendation

COMS (128.2^{o}E) MI is currently operational and data are distributed via landline and satellite over Western Pacific region, and COMS GOCI over East Asian region.

The progress of the development of GEO-KOMPSAT-2A (meteorological mission) and -2B (ocean and environmental mission) scheduled to be launched in November of 2018 and 2nd half of 2019, respectively.

*COMS : Communication, Ocean and Meteorological Satellite
*GOCI : Geostationary Ocean Colour Imager
*KARI : Korea Aerospace Research Institute

Report on the status of current and future satellite systems

1 INTRODUCTION

COMS (Communication, Ocean, and Meteorological Satellite), the first Korean geostationary meteorological satellite, was launched successfully on June 27th, 2010 and has been operating at a longitude of 128.2°E since April 1st, 2011.

2 CURRENT SATELLITE SYSTEMS

Sector	Satellite in Orbit P=pre-operational Op=operational B=back-up L=limited availability	Operator	Location	Launch date	Details on near real time access to L0/L1 data (Link)	Environmental payload and status
West Pacific	COMS (Op)	KMA, KIOST	128.2°E	26/06/2010	HRIT specification LRIT specification	5-channel VIS/IR Meteorological Imager (MI), Geostationary Ocean Colour Imager (GOCI) Direct Broadcast via HRIT/LRIT

2.1 Status of current GEO satellite systems

2.1.1 Mission objectives, payload/instruments, products

COMS meteorological mission is performed by MI (Meteorological Imager) with one visible channel and four infrared channels (Table 2.1).

The COMS MI observation data are disseminated to M/SDUS (Medium/Small Scale Data Utilization Stations) users in H/LRIT (High/Low Rate Information Transmission) formats within 15 minutes after the end of image scanning. Also, we provide high quality COMS MI level 1B data through land-based network via NMSC (National Meteorological Satellite Center) website (http://nmsc.kma.go.kr/jsp/homepage/eng/main.do) and FTP.

In this report, we introduce the current status and future plans of COMS MI operation performance and data services.

Table 2.1 : The channels of COMS/MI

Channel	Wavelength (㎛)	Spatial Resolution (km)
VIS	0.675	1 x 1
SWIR	3.75	4 x 4
WV	6.75	4 x 4
IR1	10.8	4 x 4
IR2	12.0	4 x 4

VIS: Visible SWIR: Shortwave Infrared
WV: Water Vapor IR: Infrared

The GOCI has 500m×500m pixel resolution (GSD) and a coverage area of 2,500km×2,500km covering Korea, Japan, the eastern coast of China, GOCI can acquire 16 slot images and compose one complete image of the GOCI coverage area at a center of 36˚N and 130˚E as shown in Figure 2.1. In addition, Table 2.2 presents the general specification of GOCI, which has an operational life of 7.7 years, and GOCI receives images eight times a day in hourly intervals from 00:15 GMT to 07:45 GMT.

Table 2.2: General Characteristics of COMS/GOCI

GOCI on COMS	
Volume Size(mm^3)	1,000 x 760 x 896
Weight	< 83.3 kg
Power	< 125 W
Digitization	12 bits
Resolution (GSD)	500 m @ point of 130°E, 36°N
Observation Period	1 hour (8 times earth observation per 1 day)
Field of regard	Local Area (2,500 km x 2,500km, Center: 130°E, 36°N)
Mission Life Time	7.7 years

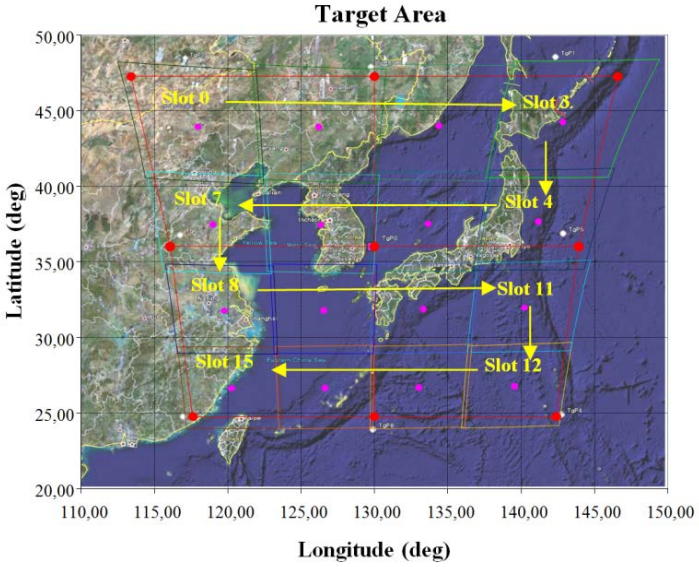


Figure 2.1: The target area of GOCI

2.1.2 Status of spacecraft

Since April 2011, the COMS mission is under the normal operation 24 hours a day 365days a year. The normal operation of the COMS is conducted by the Korea Aerospace Research Institute (KARI) using the Satellite Ground Control System (SGCS) in the Satellite Operation Center (SOC) of the KARI.

The COMS spacecraft is currently under normal operation without any problem to support the meteorological observation mission and the ocean monitoring mission.

2.1.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

There was the interruption of COMS MI imaging from Aug. 31 2016 06:27 (UTC) to Aug 31. 2016 09:00 (UTC), which is due to the SEU (Single Event Upset : the state change in digital flip-flops due to high energy particles). During that period, there was no significant space weather event detected. The high energy particle flux was under 20pfu at the energy above 2MeV and under 0.4 pfu at the particles with the energy above 10MeV. However, on-board FDIR (Fault Detection Isolation and Recovery) system indicated that an SEU was recorded at the time of the problem. Hence it is concluded that the SEU may have produced the faulty Telecommand loading and MI stop imaging.

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

1. Date and Universal Time of the anomaly	**2. Fully specified location of the anomaly** (spacecraft location)	**3. Velocity or orbital elements at time of the anomaly**	4. Eclipse state of the vehicle (full, penumbra, partial, none)	5. Vector to Sun in spacecraft coordinates	6. Velocity vector of spacecraft in spacecraft coordinates	7. Initial guess at type of anomaly (See taxonomy below)	8. Estimated confidence of that guess	9. Anomaly category (e.g., affected system or kind of disruption)	10. Vehicle identity	11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.)
2016-08-31 06:27(UTC**)**	128.2°E over the equator	**GEO**	none	-	-	**SEU**	SEU	Interruption in imaging	COMS	Daytime normal operation , no severe impact by space weather expected at all

Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

1. Electrostatic discharge (charging)
    - 1.1 Surface charging
        - 1.1.1 Plasma sheet (subauroral)
        - 1.1.2 Auroral
    - 1.2 Internal charging
        - 1.2.1 Subsurface charging (e.g., beneath blanket)
    - 2.2 Heavy ions
        - 2.2.1 Galactic Cosmic Rays
        - 2.2.2 Solar energetic particles
        - 2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
    - 3.1 Long-term dose accumulation (multiple causes combined)

1.2.2 Deep charging (e.g., inside a box)

2. Single-Event Effects

2.1 Protons

2.1.1 Solar proton event

2.1.2 Geomagnetically trapped protons

3.2 Short-term (days or less) dose accumulation

3.2.1 Solar protons

3.2.2 Geomagnetically trapped protons

3.2.3 Geomagnetically trapped electrons

2.1.4 Ground segment matters

The success rate of MI H/LRIT broadcast can be the standard of operation and real-time data service. We analysed the success rate from April 1, 2011 to March 31, 2017. The success of broadcast means that MI H/LRIT image data dissemination is completed within 15 minutes after the end of image scanning.

- Period: 04.01. 2011 ~ 03.31. 2017 (72 months)
- Success rate of broadcast: 97.49 % (179,799/184,434)

The broadcast failure cases were caused by ground system anomaly such as antenna and pre-processing system faults.

2.1.5 Data transmission

The observed meteorological data by COMS MI are broadcast to medium/small-scale data utilization stations (MDUS/SDUSs) after being converted into HRIT (High Rate Information Transmission) and LRIT (Low Rate Information Transmission) formats (Table 2.3). We provide the H/LRIT services free of charge and transmit encrypted data to identify the users of H/LRIT. The domestic and foreign MDUS/SDUSs that wish to use our services should make a formal application using the procedures outlined on the website of the National Meteorological Satellite Center (http://nmsc.kma.go.kr/jsp/homepage/eng/contents/etc/member.jsp). The technical documentations to learn about the application procedures for becoming a user station and the means to decrypt the encrypted data are posted on the website.

Figure 2.2: Concept of MI H/LRIT direct broadcasting

Currently, the FD and ENH images are broadcasted in both H/LRIT and three kinds of level 2 meteorological products images (cloud top temperature (CTT), cloud top pressure (CTP), cloud top height (CTH)) and GOCI images are broadcast in only LRIT. Figure 2.3 shows H/LRIT dissemination schedule which has officially carried out since April 1st, 2011.

Table 2.3: Classification of H/LRIT

Classification	HRIT	LRIT
Data Transmission Rate	3 Mbps	512 kbps

Data Types	MI image Alpha numeric text Encryption key message	MI image Alpha numeric text Encryption key message GOCI image Satellite meteorological products(Cloud Top Temperature, Cloud Top Pressure, Cloud Top Height)
Image mode	FD, ENH	FD, ENH
User Station	MDUS	SDUS

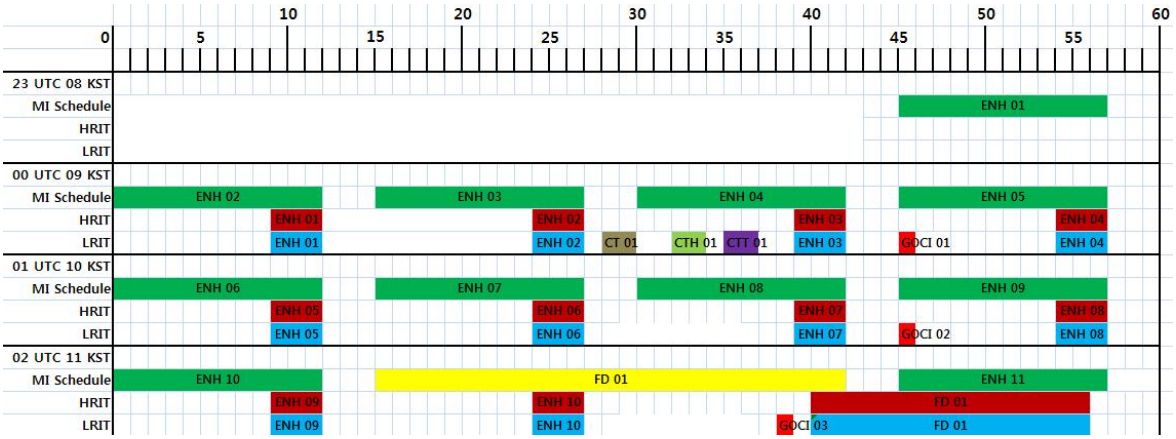


Figure 2.3: Sample of COMS MI H/LRIT dissemination schedule

The MOF issued the GOCI data distribution policy as the Minister's instruction. In the instruction, GOCI data can be distributed free of charge only for public/research purposes. But it takes payments for special request and commercial use. The intellectual property of both GOCI and GOCI data is belonged to the MOF and the re-distribution to third parties of distributed data is limited. The standard products passed the calibration and validation is only distributable on website or on the file transfer service. A distribution is based on this instruction.

The GOCI data has been provided as HDF-EOS5 (He5) format using the orthographic map projection. For a stable distribution service of GOCI data, various systems were installed in KOSC. KOSC developed GOCI Data Distribution System (GDDS) and a website (http://kosc.kiost.ac) to distribute geo-corrected satellite data and browsing image. GDDS has been distributed GOCI data to the users since April 2011 on this website restrictively. Some of GOCI level 2 data (Chl, TSS, CDOM, Lw, nLw) are available and GDPS for user can be downloaded in the web site.

All what users to do is to access to web server for the data searching. User can search data as specified date and sensor. Basic selected options are including sensor name, time, date1, date2 and amount of clouds, searching area and each products of each sensor in advanced selections. The function of cart and saving condition is added for user's convenience. User can download the searched/requested data from the data server through download component.

Data distribution for dedicated institution is performed by FTP push method. There are 16 domestic institutions which are getting the GOCI data through the FTP service

from KOSC. Interested in using the FTP service, an institution, who wants to receive the satellite data in near-real time, can fill out an application and send it to KOSC. But the institution should prepare the FTP system for receiving the data. It is just to minimize inconvenience of users by avoiding overloading the KOSC system. If there is no problem on the application through the review, KOSC will announce the start date to you by e-mail. Then the data will be sent from KOSC FTP to your system and the report on the transmission also sent you every day by e-mail. The report includes the result and information of the provided data. If there is any missed data, re-transmission can be required.

2.1.6 Projects, services

(1) Service via Satellite

Please refer to 2.1.5.

(2) Service via Landline

The NMSC provides COMS level 1B data of all five channels and level 2 products to users by posting the processed data on NMSC website (http://nmsc.kma.go.kr/jsp/eng/contents/main/main.jsp). All registered members of the website can log on, search, and download those data up to 3GB and 500 files for one time request. Here is the list of COMS meteorological products open to users.

Table 2.4: The list of COMS MI products

No.	Products	Resolution	Period	Start Date of Service
1	Cloud analysis (cloud type, phase and amount)	4 km	15 min.	1 Apr. 2011
2	Cloud top pressure/temperature/height	4 km	15 min.	
3	Atmospheric Motion Vector (AMV)	64 km	1 hour	
4	Cloud detection	4 km	15 min.	
5	Fog	4 km	15 min.	
6	Aerosol index (AI)	4 km	15 min.	
7	Sea surface temperature (SST)	4 km	1-, 5-, 10-day composition	10 Aug. 2011
8	Rain intensity (RI)	4 km	15 min.	
9	Outgoing longwave radiation (OLR)	4 km	1 day	
10	Upper tropospheric humidity (UTH)	36 km	15 min.	
11	Land Surface Temperature	4 km	15 min.	10 Feb. 2012
12	Snow and Sea Ice	4 km	1 day/8 day	
13	Total Precipitation	4 km	15 min.	
14	Clear Sky Radiance	28 km	15 min.	

Currently near real-time FTP service of COMS HRIT data is only open to organizations which has MOU conclusion for data exchange with NMSC such as NESDIS, EUMETSAT. Last seven days of COMS HRIT data are stored in FTP disk, so the authorised organization can get those data via land-based network once they get FTP account of it.

Contact information for request FTP account: kmasod@korea.kr

(3) DCPC-NMSC

As a part of WIS DCPC project lead by WMO, NMSC accomplished the construction of DCPC-NMSC and started normal operation on 29th March 2013 for providing COMS meteorological data as below list.

- All five channels level 1B in binary and graphic file format
- Eleven level 2 products in binary and graphic file format as below:
  (1) Cloud detection
  (2) Land surface temperature
  (3) Total precipitable water
  (4) Cloud analysis (cloud top temperature/pressure/height, cloud type, cloud amount, cloud phase, cloud optical thickness)
  (5) Fog
  (6) Rainfall Intensity
  (7) Atmospheric motion vector
  (8) Sea surface temperature
  (9) Sea ice/snow cover detection
  (10) Outgoing longwave radiance
  (11) Clear Sky Radiance

The registered user can search, access, download the COMS meteorological data on this user portal web address : http://dcpc.nmsc.kma.go.kr

Figure 2.4: Main page of DCPC-NMSC website

2.1.7 User statistics

(1) Domestic

NMSC provides COMS data to 19 domestic KMA-related via FTP in real time such as the military, broadcasting companies, disaster prevention centers, and local governments. To receive COMS L/HRIT data, 12 MDUSs and 6 have been installing at 13 organizations: Air Force, National Fisheries Research and Develop Institute, Korea Meteorological Industry Promotion Agency, Seoul Emergency Management Center, National Science Museum and so on since 2011. To get COMS data via Internet, around 1,100 members are registered on NMSC website until end of May2017.

(2) International

Currently, 15 MDUSs and 10 SDUSs have been installed at 25 foreign organizations since 2011 including Air Force weather Agency of US(Guam and Okinawa), Department of Meteorology of Sri Lanka, Hongkong Observatory, Laos Department of Meteorology and Hydrology, Central Weather Bureau of Taiwan, Japan Agency Marine-Earth Sciences and Technology, Chulalongkorn University in Thailand, Vietnamese Air Force and Air Defence and so on.

For ODA (Official Development Assistance) activities, KMA had supported COMS receiving, processing systems and education program for the Philippines being managed by KOICA (Korea International Cooperation Agency) for two years from 2014 as a follow-up project for Sri Lanka which was accomplished in 2012. Now KMA is preparing to extend this kind of project to Asian user countries for GEO-KOMPSAT-2A.

2.2 Status of current LEO satellite systems

2.2.1 KOMPSAT-5 program

The KOMPSAT-5 (KOrean Multi-Purpose SATellite), launched in August 22nd 2013, has the mission orbit of a sun-synchronous dawn-dusk circular orbit with an average altitude of 550 Km which provides about 15 revolutions per day. The KOMPSAT-5 orbital elements are listed in Table 2.5. KARI (Korea Aerospace Research Institute) is a primary contractor of KOMPSAT-5 development and SAR Payload operation. KASI (Korea Astronomy and Space Science Institute) is in charge of the development of Atmosphere Occultation and Precision Orbit Determination (AOPOD) secondary payload which includes a dual frequency GPS receiver and a laser retro reflector Array (LRRA).

Table 2.5: Mission Orbit of KOMPSAT-5

Orbital Elements	Mean Values
Semi-Major Axis (km)	6928.137
Altitude (km)	550
Eccentricity	0.0012
Inclination (deg)	97.6
Mean Local Time of Ascending Node	06:00 A.M.
Argument of Perigee (deg)	90.0

For the occultation mission as a secondary mission, the KOMPSAT-5 has two occultation antennas for observation of a rising and setting occultation. The data from two POD antennas are utilized together with occultation data. The observed occultation data, approximately 500 events/day (maximum), are stored in the Solid State Recorder (SSR) and collected by the spacecraft's 1553B bus interface. The Data downlink to the ground station is via S-band telemetry.

2.2.2 Ground segment matters

KOMPSAT-5 program operates one ground station located in Daejeon. The baseline period of data publication is twice a day when KOMPSAT-5 contacts the Daejeon ground station.

2.2.3 Data transmission

KOMPSAT-5 AOPOD system is now optimized including receiver's firmware update and its GNSS-RO data is also validating for operational use by KASI in cooperation with UCAR (University cooperation for atmospheric Research)/COSMIC group.

2.2.4 Timeliness problem for utilization

KMA has been receiving KOMPSAT-5 radio occultation data from UCAR via landline (FTP) with latency of several hours mostly 12 hours or later because of time consumption for data processing and data transmission delay. This issue makes

KMA be not able to utilize the KOMPSAT-5 radio occultation data in real-time into the NWP system yet.

2.3 Status of current HEO [or other] satellite systems

Not applicable

2.4 Status of current R&D satellite systems

Not applicable

3 FUTURE SATELLITE SYSTEMS

Sector	Satellite in Orbit P=pre-operational Op=operational B=back-up L=limited availability	Operator	Location	Launch date	Details on near real time access to L0/L1 data (Link)	Environmental payload and status
West Pacific	GEO-KOMPSAT-2A(P)	KMA	128.2°E	November, 2018		Advanced Meteorological Imager (AMI), Space Environmental monitoring payload Direct broadcast via UHRIT/HRIT/LRIT
	GEO-KOMPSAT-2B(P)	MOF(Ministry of Oceans and Fisheries), ME(Ministry of Environment)	128.2°E	2nd Half, 2019		Advanced Geostationary Ocean Colour Imager(GOCI-II), Geostationary Environmental Monitoring Spectrometer(GEMS)

3.1 Status of future GEO satellite systems

GEO-KOMPSAT-2 program had been started under the cooperation with Ministry of Science, ICT and Future Planning (MSIP), Ministry of Oceans and Fisheries (MOF), and Ministry of Environment (ME) of Korean government, and kicked off in the middle of 2012.

The GEO-KOMPSAT-2 consists of a pair of satellites for multi-purpose. One (GEO-KOMPSAT-2A) is for meteorological dedicated satellite with the space weather as a piggyback mission. The other (GEO-KOMPSAT-2B) is for ocean and environmental missions. Ocean mission is to monitor the ocean colour using an advanced Geostationary Ocean Colour Imager (GOCI) continuously. The environmental mission is to monitor atmospheric environments globally with the first payload carried on the geostationary satellite. The GEO-KOMPSAT-2A and -2B satellites will be launched in November 2018, and 2nd half of 2019, respectively.

3.1.1 Mission objectives, spacecraft, payload/instruments, products

Observation mission

The Advanced Meteorological Imager, the payload for meteorological mission of GEO-KOMPSAT-2A, is comparable to those of the ABI and AHI imager on board Himawari-8/9 and GOES-R. The detailed specification of AMI is as follows:

- Multi-channel capacity: 16 channels (4 visible, 2 near-infrared and 10 infrared channels)
- High spatial resolution: 0.5-1.0 km for visible and 2 km for infrared channels
- Fast imaging: within 10 minutes for Full Disk observation
- Flexibility for the regional area selection and scheduling

The channel characterizations of the AMI are summarized in Table 3.1.

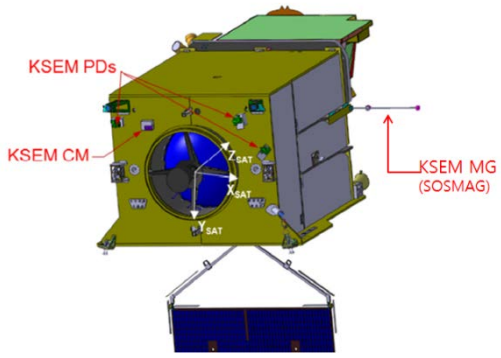
Table 3.1: Channel characterizations of the AMI for the GEO-KOMPSAT-2A satellite

Bands		Center Wavelength (measured, um)	Band Width (Measured, um)	Resolution (km)	SNR	NEdT(K) (240/300K)	Radiometric Accuracy
VNIR	VIS0.4	0.4702	0.0408	1	250		5%
	VIS0.5	0.5086	0.0291	1	250		5%
	VIS0.6	0.6394	0.0808	0.5	120		5%
	VIS0.8	0.8630	0.0344	1	210		5%
	NIR1.3	1.3740	0.0155	2	300		5%
	NIR1.6	1.6092	0.0410	2	300		5%
MWIR	IR3.8	3.8316	0.1912	2		3/0.2	1K
	IR6.3	6.2104	0.8397	2		0.4/0.1	1K
	IR6.9	6.9413	0.4004	2		0.37/0.1	1K
	IR7.3	7.3266	0.1823	2		0.35/0.12	1K
	IR8.7	8.5881	0.3552	2		0.27/0.1	1K
LWIR	IR9.6	9.6210	0.3789	2		0.35/0.15	1K
	IR10.5	10.3539	0.4683	2		0.4/0.2	1K

	IR11.2	11.2285	0.6636	2		0.19/0.1	1K
	IR12.3	12.3651	1.1072	2		0.35/0.2	1.1K
	IR13.3	13.2870	0.5566	2		0.48/0.3	1.1K

※ SNR@100% albedo, NEdT@240/300K, calibration accuracy@100% albedo/300K

KMA in coordination with KARI and KHU (KyungHee University) completed two major milestones of KSEM by successfully completing Critical Design Review (CDR) on October 2015, respectively. KSEM will be in operation over local time of the Korean Peninsular from 2018 and consists of particle detector (PD), a set of dual magnetometers (MAG), and a spacecraft charging monitor (CM). The energetic particle detectors simultaneously measure the population of charged particles in the energy range of at least 100 keV ~ 2 MeV for electrons and 100 keV ~ 20 MeV for protons, respectively, over the six viewing angles. The dual magnetometer samples variations of low frequency magnetic fields at two different locations on a deployable boom to accurately measure the Earth's magnetic fields by separating the spacecraft contribution. The spacecraft charging monitor measures integrated fluxes of electrons above ~ 1 MeV that is crucial for the satellite operation. KSEM specification is as follows:



Sensor	Requirements	Application Field
Particle Detector	- Electron energy range : ~100keV ~ 2 MeV - Angular Resolution (pitch angle): 60° at least	Global Electron Distribution Particles distribution on geostationary
Magnetometer	- Measurement range : ± 64,000nT (in 3 axes) - Field resolution : 1nT at least (on orbit)	Prediction for Dst and Kp Index
Satellite Charging Monitor	- Current range: ± 3pA/cm^2 - Measurement resolution : 0.001pA/cm^2	Satellite Charging Index

In addition to AMI in GEO-KOMPSAT-2A, Geostationary Ocean Colour Imager-II (GOCI-II) is another payload under the GEO-KOMPSAT-2 program. Korea Institute of Ocean Science & Technology (KIOST), independent national institute established by dedicated law, is responsible for the definition of mission and user requirements, and for the operation of GOCI-II.

GOCI-II is a next generation of GOCI, one of the major payloads in COMS, which is the 1st ocean colour imager in the world operating on the geostationary orbit. GOCI has been developed to provide a monitoring of ocean colour around the Korean Peninsula to detect, monitor, quantify, and predict short term changes of coastal ocean environment for marine science research and application purpose. GOCI-II is expected to have highly enhanced radiometric/geometric performance in comparison with GOCI.

Table 3.2 shows the spectral bands and radiance performance of GOCI-II including the new spectral bands. Additional spectral bands will be expected to perform specific coastal monitoring and application researches as well as more accurate atmospheric correction will be possible in this research area.

Table 3.2: Spectral Bands and Radiance Performance of GOCI-II

Band	Band Center	Band-width	Nominal Radiance	Maximum Ocean Radiance	Threshold Radiance	Maximum Cloud Radiance	SNR @ nominal radiance
1	380 nm	20 nm	93	139.5	143.1	634.4	998
2	412 nm	20 nm	100	150.0	152.0	601.6	1,050
3	443 nm	20 nm	92.5	145.8	148.0	679.1	1,145
4	490 nm	20 nm	72.2	115.5	116.0	682.1	1,228
5	510 nm	20 nm	64.9	108.5	122.0	665.3	1,180
6	555 nm	20 nm	55.3	85.2	87.0	649.7	1,124
7	620 nm	20 nm	53.3	64.1	65.5	629.5	1,102
8	660 nm	20 nm	32.0	58.3	61.0	589.0	1,060
9	680 nm	10 nm	27.1	46.2	47.0	549.3	914
10	709 nm	10 nm	27.7	50.6	51.5	450.0	914
11	745 nm	20 nm	17.7	33.0	33.0	429.8	903
12	865 nm	40 nm	12.0	23.4	24.0	343.8	788
13	Wideband		-	-	-	-	-

※ Spectral radiances values are in $Wm^{-2}\mu m^{-1}sr^{-1}$

GEMS will contribute to the understanding of the globalization of pollution events, source/sink identification, and long-range transport of pollutants and short-lived climate forcers (SLCFs), as a part of the activities of Atmospheric Composition Constellation under the Committee on Earth Observation Satellites (CEOS). This Constellation coordination activity is focused on collaboration to improve and extend data utilization from the planned missions. The missions now funded are: Korea (GEMS), Europe (Sentinel-4), and the US (TEMPO) will enable the “baseline” constellation data products.

GEMS is expected to contribute monitoring air quality and SLCFs including ozone and aerosols in Asia in high temporal and spatial resolution. Using a scanning UV-Visible spectrometer, its observations can contribute to provide a set of tropospheric column products over the Asia-Pacific region at spatial resolution of ~8 km and temporal resolution of 1 hour. Other products include NO2, HCHO, SO2, and aerosol optical depth.

Table 3.3 shows GEMS requirements for mission success.

Table 3.3: Payload Requirement of GEMS

Item	**Requirement**
Lifetime	> 10 years after IOT
Reliability	> 0.85 @ 7 years
Field of regard	> 5,000 km(N/S) × 5,000 km(E/W) N/S: 45°N ~ 5°S, E/W: Selectable between 75°E ~ 145°E

Duty cycle/Imaging time	8 images during daytime (30 min imaging + 30 min rest) × 8 times/day
Ground sampling distance	< 7 km(N/S) at Seoul GSD area < 56km^2 at Seoul(Aspect ratio shall be less than 1:3)
Spectral range	300 nm to 500 nm
Spectral resolution	< 0.6 nm
Spectral sampling	< 0.2 nm
Signal-to-noise ratio	> 720 @ 320 nm > 1500 @ 430 nm
Data quantization	≥ 12 bits
MTF (Instrument level)	> 0.3 in N/S direction @ Nyquist frequency > 0.3 in E/W direction @ Nyquist frequency
Radiometric calibration accuracy	< 4%
Spectral calibration accuracy	< 0.02 nm
Polarization factor	< 2% (310-500 nm) No inflection point within 20nm for all wavelength range

The schedule for GEO-KOMPSAT-2A and 2B program is shown in Figure 3.2.

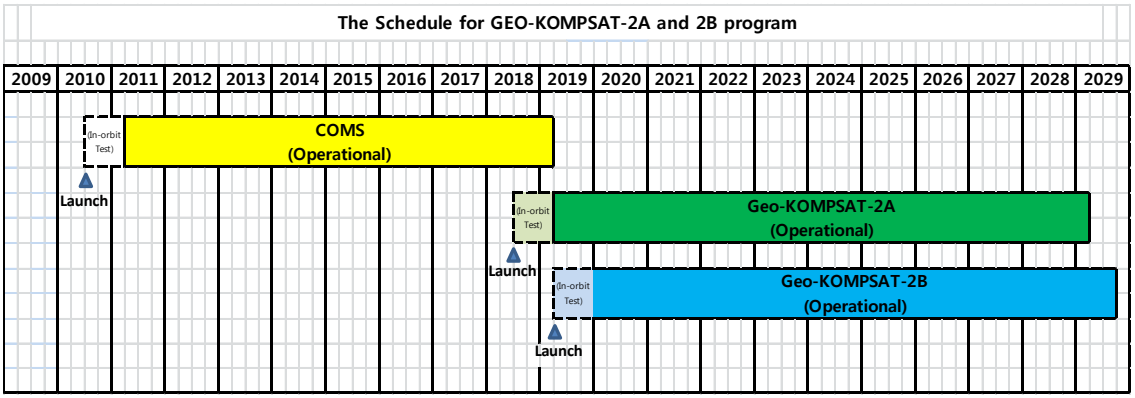


Figure 3.2: Schedule for the GEO-KOMPSAT-2

3.1.2 Ground segment matters

In July 2014, NMSC/KMA kicked off the project of ground segment development that will receive data from Geo-KOMPSAT-2A spacecraft, generate real-time Geo-KOMPSAT-2A meteorological/space weather products and disseminate data via Geo-KOMPSAT-2A broadcasting. The top-notch Information & Communication Technologies and scientific capabilities will be applied to handle the vast volume of Geo-KOMPSAT-2A data in real-time manner consistent with user requirements.

For non-stop operation and real-time data service, back-up systems will be equipped for all components and the remote data storage concept will be implemented for enhancing data security.

The timeline of Geo-KOMPSAT-2A ground segment development consists of three phases as below:

- Phase 1 (2014~2015) : System Design and Algorithm Development
- Phase 2 (2016~2017) : Implementation and Integration
- Phase 3 (2018~2019) : In-orbit Ground Test and Preparation of Normal Operation

Currently the project is in stage of Phase 2 as scheduled and the Critical design review(CDR) of the project was carried out in December 2016. The Figure 3.3 displays the time schedule of Geo-KOMPSAT-2A ground segment development, which might be modified according to the Geo-KOMPSAT-2A satellite development progress and budgeting for this project.

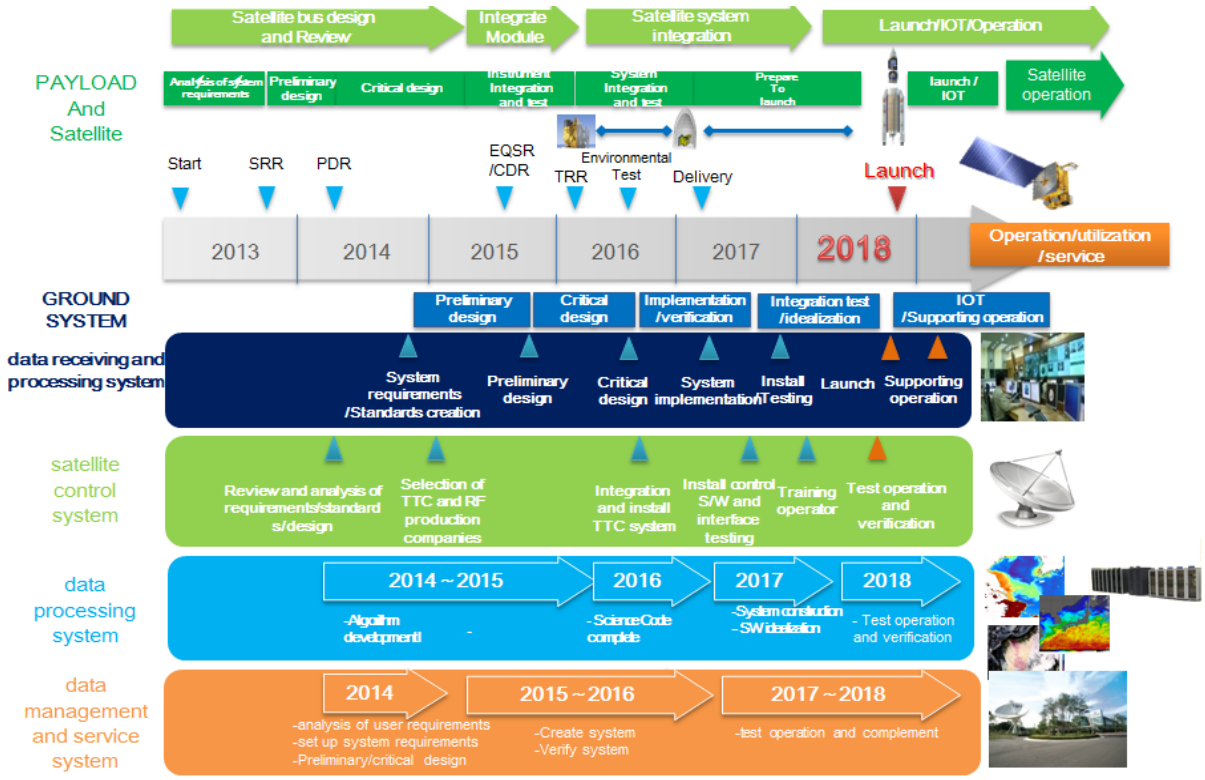


Figure 3.3: Schedule for the space/ground segment development of the GEO-KOMPSAT-2A

Based on 16 channels measurement of Geo-KOMPSAT-2A, 52 kinds of meteorological products in Table 3.4 will be generated and parts of them will be utilized for operation and released to users.

Table 3.4: List of meteorological products for Geo-KOMPSAT-2A

Scene & Surface Analysis (13)	Cloud & Precipitation (14)	Aerosol & Radiation (14)	Atmospheric condition & Aviation (11)
Cloud detection	**Cloud Top Temperature**	**Aerosol Detection**	**Atmospheric Motion Vector**
Snow Cover	**Cloud Top Pressure**	**Aerosol Optical Depth**	**Vertical Temperature Profile**
Sea Ice Cover	**Cloud Top Height**	**Asian Dust Detection**	**Vertical Moisture Profile**
Fog	Cloud Type	**Asian Dust Optical Depth**	**Stability Index**
Sea Surface Temperature	**Cloud Phase**	Aerosol Particle Size	Total Precipitable Water
Land Surface Temperature	Cloud Amount	**Volcanic Ash Detection and Height**	Tropopause Folding Turbulence
Surface Emissivity	Cloud Optical Depth	Visibility	**Total Ozone**
Surface Albedo	Cloud Effective Radius	**Radiances**	SO_2 Detection
Fire Detection	Cloud Liquid Water Path	Downward SW Radiation (SFC)	**Convective Initiation**
Vegetation Index	Cloud Ice Water Path	Reflected SW Radiation (TOA)	Overshooting Top Detection
Vegetation Green Fraction	Cloud Layer/Height	Absorbed SW Radiation (SFC)	Aircraft Icing
Snow Depth	**Rainfall Rate**	Upward LW Radiation (TOA)	
Current	Rainfall Potential	Downward LW Radiation (SFC)	
	Probability of Rainfall	Upward LW Radiation (SFC)	

3.1.3 Data Service

The baseline of data broadcast policy for Geo-KOMPSAT-2A is to disseminate all 16 channels data of meteorological observations in Ultra HRIT (tentatively named as UHRIT) and to maintain H/LRIT broadcast corresponding to COMS five channels.

Below table is the current status of international registration request of frequency for Geo-KOMPSAT-2A which was submitted to International Telecommunication Union (ITU) on June 4th, 2012. The uplink/downlink frequency domains for Geo-KOMPSAT-2A mission will be determined afterward within the requested bandwidth of each frequency band.

Table 3.5: International frequency registration request for Geo-KOMPSAT-2A.

Category	Uplink (MHz)	Downlink (MHz)
L-Band	-	1670 ~ 1710 (for L/HRIT)
S-Band	2025 ~ 2110 (for UHRIT)	2200 ~ 2290 (for UHRIT)
X-Band	8175 ~ 8215 (for UHRIT)	7450 ~ 7550 (for Sensor Data & UHRIT)
	-	8025 ~ 8400 (for Sensor Data & UHRIT)

For landline service of Geo-KOMPSAT-2A, we are planning two ways to provide the data for domestic and international users in real-time and non-real-time. One way is a real-time service of level 1B similar to Himawaricloud which is being provided by JMA and the other way is a conventional user request based data service via the NMSC website. Those functions will be implemented in timeline scheduled in Figure 3.3.

3.2 Status of future LEO satellite systems

3.3 Status of future HEO [or other] satellite systems

Not applicable

4 ACTIONS AND/OR RECOMMENDATIONS FOR CONSIDERATION BY CGMS PLENARY SESSION

Not applicable

5 CONCLUSIONS