

Prepared by KMA,
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Discussed in Plenary

KMA REPORT ON THE STATUS OF CURRENT AND FUTURE SATELLITE SYSTEMS

In response to CGMS action/recommendation

This document is the current status of Communication, Ocean and Meteorological Satellite (COMS) which has been operating at a longitude of 128.2°E since April 1st, 2011.

COMS meteorological mission is performed by MI (Meteorological Imager) with one visible channel and four infrared channels. Korea Meteorological Administration (KMA) has the competence for MI operation and data distribution. For the ocean observation, Korea Ocean Satellite Center (KOSC) has the competence for GOCI (Geostationary Ocean Colour Imager) Data Processing (GDPS) and data distribution. GOCI data can be accessed on website and the data policy is free costs for public/research purposes.

This document reports on tentative plans for COMS follow-on, GEO-KOMPSAT-2A (meteorological mission) and -2B (ocean and environmental mission) which are scheduled to be launched in 2017 and 2018, respectively. For the AMI (Advanced Meteorological Imager) of GEO-KOMPSAT-2A for meteorological mission is comparable to the Advanced Baseline Imager (ABI) or the Flexible Combined Imager (FCI).

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), Geost. 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).

We have tuned radiometric and geometric parameters during the In-Orbit Test and all the radiometric and geometric performances are satisfied with the specification of URD. 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. And some MI meteorological level 2 products such as cloud detection, sea surface temperature, fog, dust detection also are available on the website and more level 2 data service will be posted in near future.

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 (μm)	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 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

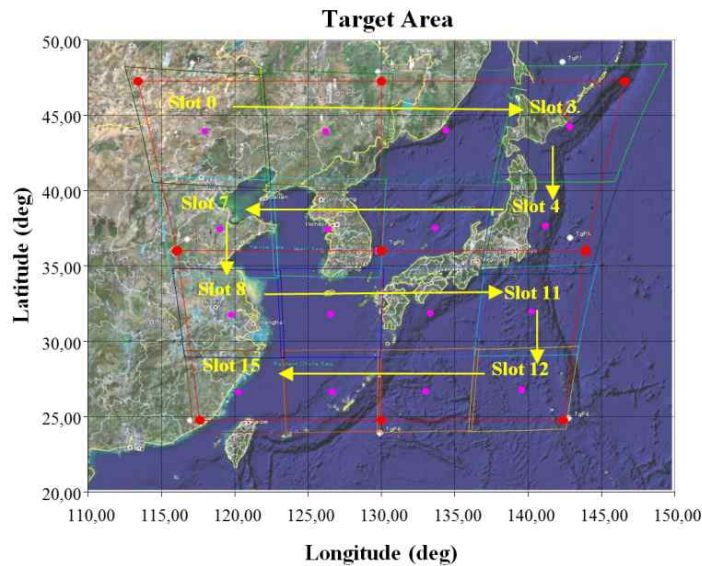


Figure 2.1: The target area of GOCI

2.1.2 Status of spacecraft

Since April 2011, the COMS mission is under the normal operation 24 hours a day 365 days 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. For the Earth observation missions of the meteorological observation and the ocean monitoring, the COMS requires daily mission commands from the satellite control ground station. Daily and weekly operations are also performed for the satellite attitude and orbit control. And monthly, seasonal, and yearly operations are carried out for the spacecraft maintenance.

The mission planning subsystem (MPS) of the SGCS synthesizes the mission requests for 'meteorological observation and ocean monitoring' from the users and the mission requests for satellite orbit and attitude control from the Flight Dynamic Subsystem (FDS) of the SGCS and resolves conflicts among missions to establish daily mission schedule of the Earth observation and the satellite control. Daily mission schedule is transmitted to the spacecraft by the Real-Time Operation Subsystem (ROS) of the SGCS. 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

Not applicable

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 analyzed the success rate from April 1, 2011 to August 31, 2012. 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 ~ 08.31. 2012 (17 months)
 - H/LRIT (disseminated/planned): 42,014/43,647(* 99.76 %)
- *The broadcasts by backup site antenna are included

The broadcast failure cases were caused by ground system anomaly such as antenna and pre-processing system faults. But the success rate of H/LRIT broadcast has been higher than we targeted as a starter of meteorological satellite operation.

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 1.2: Concept of MI H/LRIT direct broadcasting

Currently, H/LRIT include the FD and ENH images and level 2 meteorological products images such as cloud detection (CT), cloud top height (CTH), cloud top temperature (CTT) and GOCI images are broadcast in only LRIT. KMA has a plan to add more contents such as sea surface temperature, fog, numerical weather prediction and typhoon information to LRIT service. Figure 2.3 shows a sample of H/LRIT dissemination schedule. The dissemination has started 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 Numerical weather prediction data (planned) Typhoon information (planned)
Image mode	FD, ENH	FD, ENH
User Station	MDUS	SDUS

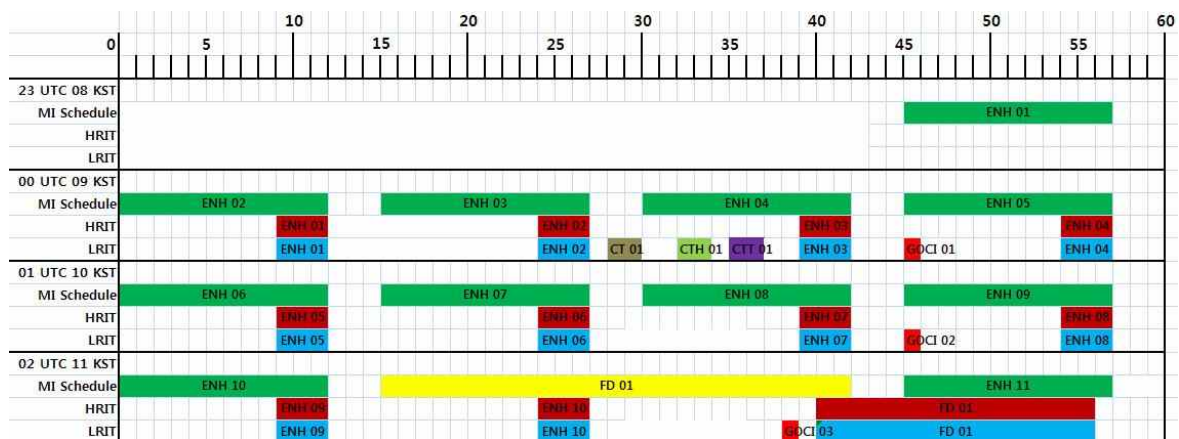


Figure 2.2: Sample of COMS MI H/LRIT dissemination schedule

The MLTM 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 MLTM 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.kordi.re.kr>) 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. Recently, Some of GOCI level 2 data (Chl, TSS, CDOM, Lw, nLw) are available from 01 September 2011. Also, 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://nmisc.kma.go.kr/jsp/eng/contents/main/main.jsp>). All registered members of the website can log on, search, and download COMS data once the formal request is approved. 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.	10 Feb. 2012
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.	
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

NMSC is working on modifying the data service related rules with KMA Headquarters for expanding data service to more users

2.1.7 User statistics

(1) Domestic

NMSC provides COMS data to 21 domestic KMA-related organizations via FTP in real time such as the military, broadcasting companies, disaster prevention centers, and local governments. To receive COMS L/HRIT data, 3 MDUSs and 3 SDUSs have been installing at six organizations: Air Force, Korea Meteorological Industry Promotion Agency and National Science Center since 2011. To get COMS data via Internet, 112 members are registered on NMSC website until end of July 2012.

(2) International

KMA accomplished a project successfully to support COMS receiving, processing systems and education program for the Sri-Lanka with KOICA (Korea International Cooperation Agency) and is planning to extend this project to any other Asian user countries.

2.2 Status of current LEO satellite systems

Not applicable

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	KMA	116.2°E or 128.2°E	2017		Advanced Meteorological Imager (AMI), Space Environmental monitoring payload Direct broadcast via HRIT/LRIT
	GEO-KOMPSAT-2B	MLTM(Ministry of Land, Transport and Maritime Affairs), ME(Ministry of Environment)	116.2°E or 128.2°E	2018		Advanced Geostationary Ocean Colour Imager(GOCI-II), Geostationary Environmental Monitoring Spectrometer(GEMS)

3.1 Status of future GEO satellite systems

KMA is planning for the follow-on geostationary meteorological satellite (GEO-KOMPSAT-2) to continue the COMS’s meteorological and oceanographic mission. From 2009, KMA has prepared a feasibility study for GEO-KOMPSAT-2 program under the cooperation with Ministry of Education, Science and Technology (MEST), Ministry of Land, Transport and Maritime Affairs (MLTM), and Ministry of Environment (ME) of Korean government. The GEO-KOMPSAT-2 program had been approved in September 2010, but 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 mission-only. The other (GEO-KOMPSAT-2B) is for ocean and environmental missions. Ocean mission is to monitor the ocean colour using an advanced GOCI (Geostationary Ocean Colour Imager) 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 2017 and 2018, respectively.

3.1.1 Mission objectives, spacecraft, payload/instruments, products

Observation mission

The KMA is considering a Advanced Meteorological Imager (AMI) comparable to the meteorological payload of ABI (GOES-R) or FCI (MTG) as follows:

- Multi-channel capacity: 16 channels (including 2~3 visible channels)
- High spatial resolution: 0.5-1.0 km for visible and 1-2 km for infrared channels
- Fast imaging: within 10 minutes for Full Disk observation
- Flexibility for the regional area selection and scheduling

The draft specifications suggested from the feasibility study are summarized in Table 3.1.

Table 3.1: Draft specifications of the AMI for the GEO-KOMPSAT-2A satellite

Channels		
	Spatial resolution	Number of observational bands
VIS (<0.7 micron)	0.5 km - 1.0 km	2~3
NIR (0.7-3 micron)	1km - 2 km	2~3
IR (>3 micron)	2 km	9~11
Total Number of Channels		16
Observation Capability		
Imaging Rate	< 10 min	(Full Disk)
Scan Capability	Full Disk: normal operation Area: flexible schedule and location definition	
Lifetime of meteorological mission		
10 years (TBD)		

In addition to meteorological mission, GEO-KOMPSAT-2A satellite will carry on payload for space weather observation depending on specifications of meteorological imager which will be decided in 2012, such as weight, power and so on.

The preliminary studies for ground segment and meteorological data processing system have been carrying out from 2011 to 2012, and the development will be kicked off in 2013.

In addition to AMI in GEO-KOMPSAT-2A, Geostationary Ocean Colour Imager-II (hereinafter “GOCI-II”) is another payload under the GEO-KOMPSAT-2 program. Korea Institute of Ocean Science & Technology (hereinafter “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 largely 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.

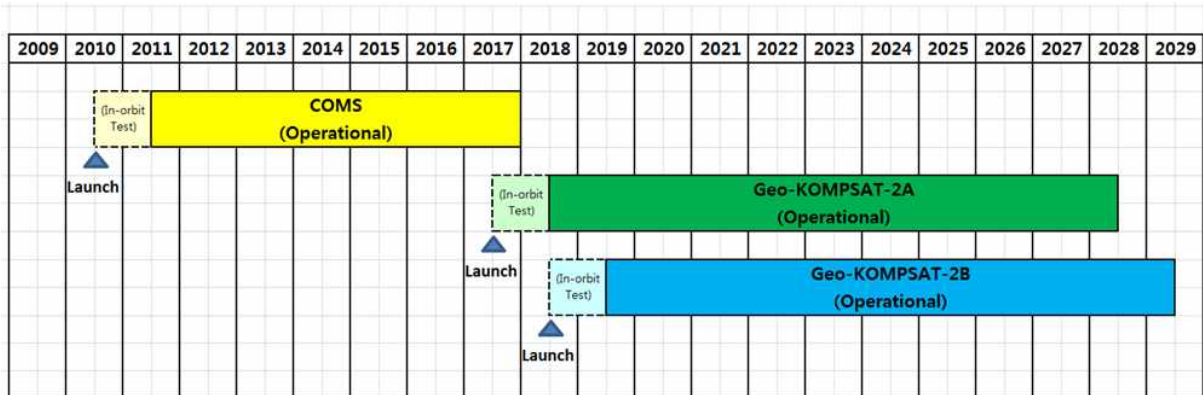
Table 3.2: Spectral Bands and Radiance Performance of GOCI-II (Baseline)

Band	Band Center	Bandwidth	Nominal Radiance	Maximum Ocean Radiance	Saturation 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	152	601.6	1050
3	443 nm	20 nm	92.5	145.8	148	679.1	1145
4	490 nm	20 nm	72.2	115.5	116	682.1	1228
5	555 nm	20 nm	55.3	85.2	87	649.7	1124
6	590 nm	20 nm	53.3	64.1	65.5	629.5	1102
7	660 nm	20 nm	32	58.3	61	589	1060
8	680 nm	10 nm	27.1	46.2	47	549.3	914
9	709 nm	10 nm	27.7	50.6	51.5	450	914
10	745 nm	20 nm	17.7	33	33	429.8	903
11	865 nm	40 nm	12	23.4	24	343.8	788
12	1040 nm	40 nm	8.4	-	17	203	525
13	1240 nm	40 nm	5.7	-	12	138	472

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

The schedule for GEO-KOMPSAT-2A and 2B program is shown in Figure 3.1.

Figure 3.1: Schedule for the GEO-KOMPSAT-2



3.1.2 Ground segment matters

Through the preliminary studies for ground segment and meteorological data processing system development of GeoKOMPSAT-2A, tentative ground system configuration was derived. This configuration will be updated after the GEO-KOMPSAT-2A operation frequencies for sensor data up/downlink, satellite telecommanding and broadcast are resolved.

3.1.3 Data transmission

The baseline of data broadcast policy for GeoKOMPSAT-2A is to disseminate all channels data of meteorological observations and to maintain L/HRIT broadcast corresponding to COMS five channels. This is dependent on the bandwidth of broadcast frequencies which will be determined after satellite system design review.

3.2 Status of future LEO satellite systems

3.2.1 KOMPSAT-5 program

The KOMPSAT (Korean Multi-Purpose SATellite) program is a government funded space program which was started in the mid 90's. The first satellite of the KOMPSAT program was launched in 1999 and the second satellite was launched in 2006. Currently, KOMPSAT-5 (Figure 1) will be launch in December 2012.

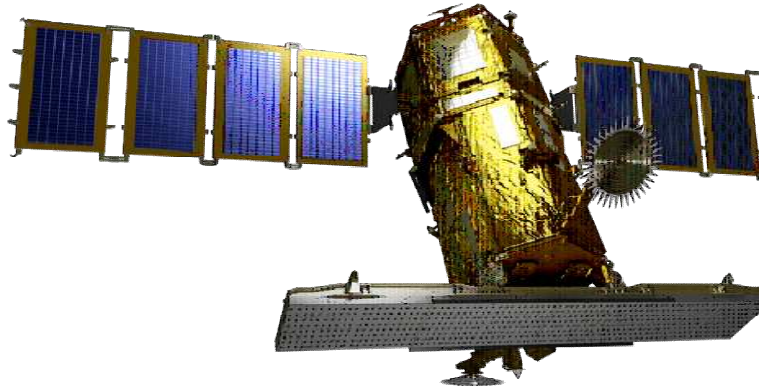


Figure 3.2: KOMPSAT-5

The main mission of KOMPSAT-5 is the Earth Observation by using a Synthetic Aperture Radar (SAR). In Figure 2, the KOMPSAT-5 program architecture is described. 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 (LRRR).

Figure 3.3 shows the KOMPSAT-5 dual frequency GPS receiver and LRRR. A dual frequency GPS receiver will be used for generation of POD (Precision Orbit Determination) data and GPS Radio Occultation (RO) science data. The LRRR is used for POD validation of KOMPSAT-5.

Currently RO products became one of the key observation data for space environment, atmospheric science, and meteorological applications. Since 2007, many national meteorology agencies have assimilated the RO data to the operational weather forecasting. KOMPSAT-5 RO data are expected to contribute a global RO sounding coverage and international user community.

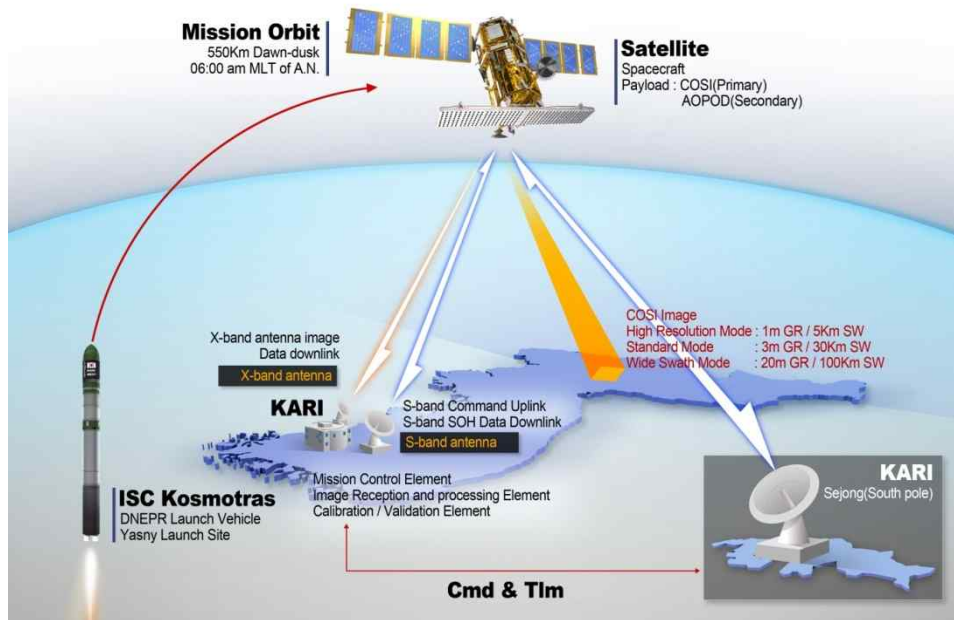


Figure 3.3: KOMPSAT-5 Program Architecture

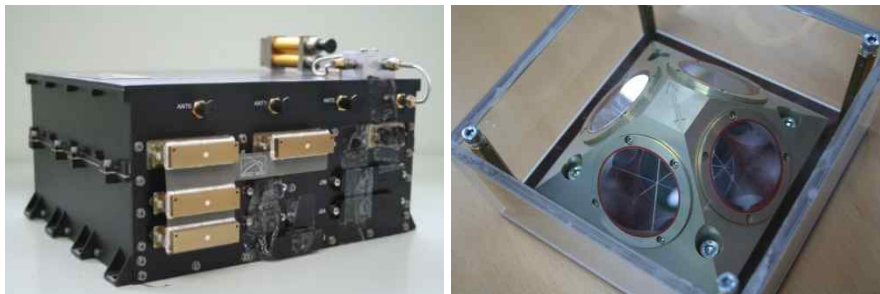


Figure 3.4: Spaceborne GPS Receiver and LRR

3.2.1.1 Mission objectives, payload/instruments, products

The mission orbit of KOMPSAT-5 is a sun-synchronous dawn-dusk circular orbit with an average altitude of 550 Km which provides about 15 revolutions per day. In Table 3.3, the KOMPSAT-5 orbital elements are listed.

Table 3.3: Mission Orbit of KOMPSAT-5

Orbital Elements	Mean Values
Semi-Major Axis (km)	6928.114
Eccentricity	0.00107
Inclination (deg)	97.60
R.A of Ascending Node (deg)	339.73
Argument of Perigee (deg)	90.0
Mean Anomaly	270.0

For KOMPSAT-5, the occultation mission is 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 600 events/day, will be 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.

3.2.2 Ground segment matters

KOMPSAT-5 program operates one ground station located in Daejeon. The baseline period of data publication is twice a day since KOMPSAT-5 contacts the Daejeon ground station twice a day. In addition to the baseline policy, KARI and KASI are building up cooperation with NOAA (National Ocean and Atmosphere Administration, US) for a utilization of NOAA's polar ground station. Since the ground station of NOAA may contact KOMPSAT-5 in every orbit, the latency of data publication will be reduced to less than 3 hours.

3.2.3 Data transmission

The RO data of KOMPSAT-5 will be released to public users. KASI plans to release raw data and processed products. KASI has been developed KROPS (KASI Radio Occultation Processing System) for processing the GPS radio occultation data and generating atmospheric profiles. Currently KASI and UCAR (University cooperation for atmospheric Research) are developing the near-real time data processing system for the KOMPSAT-5 data from NOAA's ground station. The data and processed products by KASI and UCAR will be stored and released to public users from KASI data center and UCAR data center. The data flow between KOMPSAT-5, KOMPSAT-5 ground station, NOAA ground station, KARI, and KASI is currently under construction.

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