Conceptual Design of the Meteorological Data Service for COMS

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Abstract: COMS(Communication, Ocean and Meteorological Satellite), planned for launch in 2008, will be the first Korean ocean-meteorological geostationary satellite to provide capabilities for monitoring weather and ocean. Under the direction of Korean government, KARI(Korea Aerospace Research Institute) has the overall responsibility of COMS development project. The main development project was started in September 2003. In this paper, the overview of COMS development project and the conceptual design of the meteorological data service are introduced.

Keywords: COMS, meteorological service, dissemination format, channel characteristics.

1. Introduction

As increasing damage caused by severe weather such as typhoon and heavy rains, more frequent and comprehensive meteorological data are needed. Also, it is expected that the commercial markets using meteorological data will bring enormous economic benefits. The importance of meteorological data has arisen. To keep the pace with, the first Korean ocean-meteorological geostationary satellite, COMS has been developed.

Its development project is progressed under the corporation and support of several related governmental agencies. COMS is a multi functional geostationary satellite for three main missions, i.e., meteorological mission conducted by KMA(Korea Meteorological Administration), oceanographical mission conducted by MOMAF(Ministry of Maritime Affairs and Fisheries), and communication broadcasting mission conducted by MIC(Ministry of Information and Communication). To maximize the development efficiency, supervision governmental agencies are responsible for each related part of the project. Under the direction of Korean government, KARI has the overall responsibility of COMS development project. The main development project was started in September 2003 for the purpose of launch in 2008. This paper will describe the meteorological mission of COMS in the main.

In section 2, we describe the total plan of COMS development. The conceptual design of COMS, the resultant of the *preliminary analysis*, will be explained in section 3. In section 4, we provide a summary and conclude this paper.

2. Overview of COMS Development Plan

Total development plan and milestone of COMS project are shown in Fig. 1. The *feasibility study* for user requirements, mission establishments, and the *preliminary analysis* for conceptual designs and analysis of user requirements were finished. As already mentioned, the main part of COMS development project has been just started. In this phase, the overseas collaboration company will be selected via evaluation of the proposal against RFP(Request for Proposal). From 2004 to 2006, the main development projection will be progressed with designs, assembly and performance tests in order to launch in 2008. After IOT(In-Orbit Test), COMS is planned to come into services in 2009.

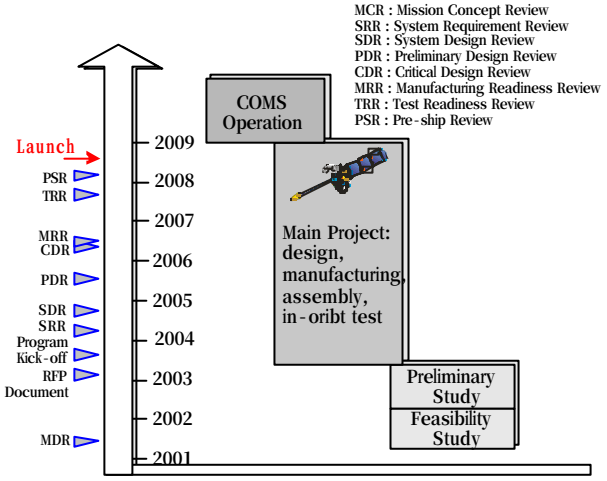

Fig. 1. COMS development project plan.

3. Conceptual Design of COMS System

In this section, we describe the conceptual design of COMS in detail. Firstly we explain the outline of COMS service plan. After that, projection type, data distribution schedule, channel characteristics for links between COMS' satellite and the ground segment, the dissemination data format for users, and the ground system design for COMS are explained in order.

1) Outline of COMS service plan

The incipient COMS service plan is as follows. COMS is a three-axis stabilized geostationary satellite at 116° East longitude. Current plans include new 10-channel imager and 8-channel ocean color sensor for 10 spectral channels (VIS 3, SWIR 1, IR 6). All the sensors may require a combined raw data downlink of as much as 7 Mbps, and the dissemination data (LRIT/HRIT) rate to the users after ground processing may be around 3 Mbps. The spatial resolution will be 1 km for the VIS channel and 2 km for the IR channel. The quantization level of image data is 10 bits in both VIS and IR channels. Table 1 shows the comparison of COMS with MTSAT-1R and MSG, which provides similar functionality with COMS.

Table 1. Comparison of COMS with MTSAT-1R and MSG.

	MTSAT-1R	MSG	COMS
Attitude Control	Three-axis stabilized	Spin-stabilized	Three-axis stabilized
Location	140 ° E	10 ° E	116 ° E
Channels	5 (VIS:1, IR:4)	12 (VIS:4, WV:2, IR:6)	10 (VIS:3, SWIR:1,IR: 6)
Qualization level	VIS(6bits in HiRID, 10bits in HRIT)	VIS(10bits)	VIS(10bits)
	IR(10bits)	IR(10bits)	IR(10bits)
Spatial Resolution	VIS(1.25km in HiRID, 1km in HRIT)	HRV(1km)	VIS(1km)
	IR(5km in WEFAX, 4km in LRIT)	Others(3km)	IR,SWIR(2km)
Sensors	JAMI	SEVIRI	Imager
		GERB	Ocean color sensor

2) Projection type(Observation mode)

To disseminate frequent and high quality imaging, following projection types for image data are needed:

1.Full disk projection type
2.Regional disk projection type
3.Local disk projection type

The full disk image data is full Earth's disk image and the regional disk covers Korean peninsula. The local disk covers the specific area and will be provided only in severe weather.

3) Data distribution schedule

To improve the accuracy of short-period weather forecasts, observations are made and processed image data are disseminated within a baseline cycle of 30 minutes. Schedules of raw data observation and processed data dissemination are shown in Fig.2.

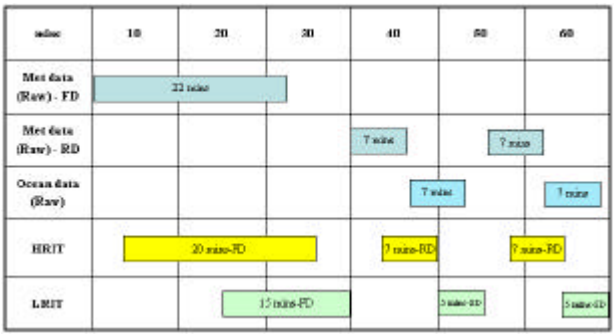

Fig. 2. COMS data distribution schedule.

4) Channel characteristics

For transmission of meteorological data, following channels shown in Fig. 3 are needed between COMS' satellite and the ground segment. The ground segment is composed of SOC(Satellite Operation Center), SDPC(Satellite Data Processing Center), MDAC(Meteorological Data Application Center) of KMA, and user receiving stations. In SOC, CMD(Command) and TLM(Telemetry) channels are needed for the operation of satellite. SDPC needs channels for receiving raw data from COMS and disseminating the processed data, LRIT and HRIT to users. MDAC receives the HRIT and generates meteorological products. Then they are formatted into LRIT and disseminated via COMS. As a backup link, MDAC can receive the raw data from COMS directly. The image data with high resolution and diverse meteorological information can lead to the large amount of bandwidth. To assure bandwidth and frequencies needed for COMS and not to influence adjacent satellites, the appropriate compression methods will be needed. COMS needs 7 Mbps channel for transmitting raw data and around 3 Mbps for LRIT/HRIT. Table 2 shows the details of channel characteristics used for COMS.

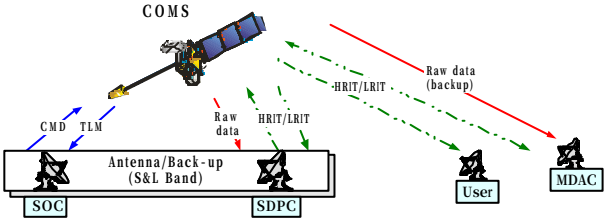

Fig. 3. Channels for data transmission of COMS.

Table 2. COMS channel characteristics.

	Raw Data	LRIT		HRIT	
	Down	Up	Down	Up	Down
Frequency [MHz]	1695	2033.5	1671.0	2032.0	1690.0
Bandwidth [MHz]	7.0	0.08	0.08	3.0	3.0
Data Rate [Mbps]	7.0	0.04	0.04	3.0	3.0
Modulation	PCM /QPSK	PCM /BPSK	PCM /BPSK	PCM /QPSK	PCM /QPSK

5) Dissemination Format

The raw data received from COMS is pre-processed in the ground system to remove radiometric and geometric errors. To disseminate processed image data and meteorological products to users, the new dissemination data format will be introduced: LRIT(Low Rate Information Transmission), HRIT(High Rate Information Transmission).

As LRIT and HRIT data format are coordinated and agreed by CGMS(Coordination Group for Meteorological Satellites) members, the existing dissemination data format is changed into LRIT/HRIT data format on many meteorological satellite systems. MTSAT-1R is planned to change the existing format WEFAX into LRIT in 2004 and HiRID into HRIT 2005. MSG dissemination trials of LRIT/HRIT are underway and routine operation services are planned to begin by end of 2003.

HRIT contains the full volume of the real-time processed image data from all channels. The reduced image data and meteorological products will be delivered to users in near real-time via LRIT. Both of LRIT and HRIT will be archived in SDPC, it can be retransmitted to users by their requests.

In order to maximize the amount of information to be transmitted, the compression scheme is required. The lossless compression method such as JPEG- or Wavelet compression is applied to HRIT and lossy compression method is applied to LRIT. Different levels of access to HRIT and LRIT will be provided to different groups of users through encryption schemes in accordance with the data policy. The contents of LRIT/HRIT and details of data policy are under consideration.

It is necessary for users to install new receiving systems or change the receiver hardware and the data processing software of the existing system to receive images transmitted with new methods. The receiving station of HRIT is called as MDUS(Medium-scale Data Utilization Station) and that of LRIT is called as SDUS(Small-scale Data Utilization Station).

6) Ground System

The ground system for the operation of COMS is composed of SOC and SDPC. SOC provides the functionality to operate COMS by receiving telemetry and transmitting commands to COMS. SDPC converts received raw data from COMS into corrected data and disseminates them to users via COMS. TT&C system of SOC is being developed by ETRI(Electronics and Telecommunication Research Institute) and KARI is implementing related systems of SDPC. SDPC should guarantee the high performance reliability afforded by redundancy configurations. The primary part of SDPC seems to be located in KARI where the SOC will be also located. But where the primary part of SDPC will be located is still under negotiation.

The image pre-processing facility of SDPC corrects the radiometric and geometrical errors of raw data. The pre-processed data, Level 1B, is transmitted to MDAC of KMA and ODAC(Ocean Data Application Center) of MOMAF via the terrestrial line.

The Level 1B data is formatted into HRIT to disseminate the corrected image data to users. The HRIT is transmitted via COMS for MDUS users. The LRIT is generated on MDAC of KMA. This is not fixed yet but seems that KMA has advantage over KARI in generating LRIT, because KMA has wide range of experiences and predominant technologies on the production of meteorological data. Moreover in case of MTSAT, Japanese meteorological satellite, JMA(Japan Meteorological Agency) provides functionality of LRIT generation. Up to now, it is assumed that the MDAC of KMA receives Level 1B data, and produces meteorological products such as numerical weather prediction data. The meteorological data and high-resolution satellite image data are formatted into LRIT format and disseminated via COMS to SDUS users.

4. Conclusions

The COMS development plan and the progress status up to now were overviewed. The current conceptual design of meteorological service for COMS was also explained. Especially the new dissemination method of high quality image data and meteorological data via HRIT and LRIT are expected to bring significant improvement on the meteorological data utilization. As the early stage of project, details of channel characteristics and the dissemination schedule are still under consideration and above-mentioned details can be adjusted hereafter or altered. To start services in 2009, COMS development project has been progressing under the cooperative effort of governmental agencies and research institutes.

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