DEVELOPMENT OF ON-BOARD SOFTWARE FOR COMS GEOSTATIONARY OCEAN COLOR IMAGER

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ABSTRACT

The Communication Ocean Meteorological Satellite (COMS) is a geostationary satellite being developed by Korea Aerospace Research Institute. Geostationary Ocean Color Imager (GOCI) is one of the payloads embarked on the COMS satellite. It acquires ocean images around Korea in 8 visible spectral bands with a spatial resolution of about 500 m. The acquired data are used to provide forecasting and now casting of the ocean state. The GOCI operations are controlled by the satellite embedded software, i.e. on-board software. This paper introduces the GOCI payload of the COMS satellite and describes the control software for the GOCI.

KEY WORDS: On-Board Software, COMS, Geostationary Ocean Color Imager

1. INTRODUCTION

Korea Aerospace Research Institute (KARI) started the development program of Communication, Ocean and Meteorological Satellite (COMS) as a part of the Korean national space development plan. The COMS contract to develop the COMS satellite and to provide support for system activities has been awarded by KARI to ASTRIUM France. The COMS joint project group is composed of KARI and ASTRIUM engineers. A topmost manufacturer of geostationary satellite in Europe, ASTRIUM offers KARI to benefit from an outstanding heritage for the development of the COMS. The COMS satellite is based on ASTRIUM's flight-qualified model, Eurostar E3000 platform.

The COMS is a geostationary satellite deployed at 116° and 138° East longitude. It is planned to launch in 2008 and designed for 7 years mission life. The basic mission of the COMS is:

- to improve the accuracy of domestic weather forecast, so as to allow in particular a rapid and efficient reaction in case of natural disasters,
- to preserve the sea environment and manage sea resources,
- and to validate new communication technologies in order to face the foreseen increase of the demand for communication services.

The Geostationary Ocean Color Imager (GOCI) is one of the three payloads on the COMS satellite. Several sensors aiming at Ocean Color monitoring have been developed during the last decade in the US and Europe, but the GOCI will be the first one to be operational from the geostationary orbit.

Since the GOCI payload does not have its own computer system, the GOCI operations shall be controlled by the satellite embedded software, i.e. On-Board Software (OBS). This paper introduces the GOCI payload and describes the GOCI control functions of the COMS OBS.

2. GEOSTATIONARY OCEAN COLOR IMAGER

2.1 Major requirements of GOCI

One of the COMS payloads, GOCI, is an ocean color imager to be operational from the geostationary orbit. Figure 1 illustrates the GOCI payload in the COMS configuration, which is based on the Eurostar E3000 platform.

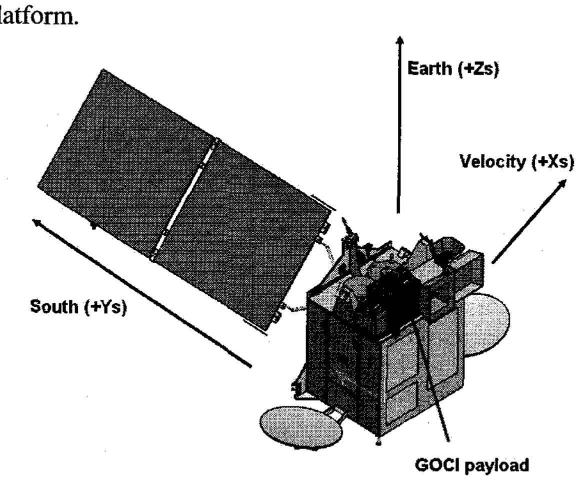

Figure 1. COMS configuration

The ocean monitoring mission aims at monitoring of marine environments around Korean peninsula, producing of fishery information (chlorophyll, etc.), and monitoring of long-term/short-term change of marine ecosystem. Table 1 shows the major requirements for the mission of the GOCI.

Table 1. Major requirements of GOCI

No of bands	8
Spatial resolution	500 m x 500 m (pixel size)
Coverage (FOV)	2500 km x 2500 km (fixed target area covering the Korean seas and surrounding oceans)
Spectral coverage	400-900 nm (for 8 bands)
Duty cycle	8 images during day time and 2 images during night time

During the nominal on station lifetime, the GOCI is expected to perform about 10 images per day. It acquires image data in 8 visible spectral bands with a spatial resolution of about 500 m over the Korean sea. The required target area is an area of at least 2500 km x 2500 km. Figure 2 shows the Field of View (FOV) of the GOCI.

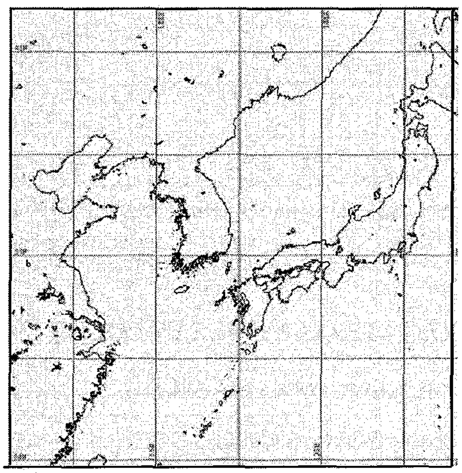

Figure 2. FOV of GOCI

2.2 GOCI mechanisms

In order to cover the complete required scene, images are nominally split into 16 slots. The global image is reconstructed by ground processing.

For an image acquisition, the GOCI drives four mechanisms: 2-axes pointing mechanism, filter wheel mechanism, and shutter/calibration mechanism. A 2-axes pointing mechanism allows the GOCI covering the 16 slots. On each slot, 10 images are acquired, 8 in the 8 required spectral bands and 2 in dark position for post processing purpose. These 10 positions are obtained by moving a filter wheel with 8 color filters and a dark position. Furthermore, a part of the nominal image acquisition mode, 2 calibration modes are available to re-calibrate the GOCI during the life of the satellite. A calibration/shutter mechanism allows 4 positions: closed position (to protect the instrument when not used), open position, diffuser calibration position and direct calibration position.

The Instrument Electronic Unit (IEU) is an electronic box making up of the GOCI. The GOCI mechanisms are driven by the GOCI IEU. The IEU controls a slot acquisition sequence and transfers the acquired image to the dedicated subsystem, as well. The IEU itself, however, is controlled and monitored by the satellite commands. All operations of the GOCI payload are controlled by the satellite-embedded software, i.e. On-Board Software (OBS). The next section explains the general functions of the OBS and the specific functions for the GOCI SW.

3. COMS ON-BOARD SOFTWARE

The OBS is located in Spacecraft Computer Unit (SCU) and interacts with its environments through the interfaces provided by the SCU. The environments of the OBS mean ground, platform and payloads. Generally, the OBS receives the telecommand bit stream coming from the ground, emits data collected throughout the spacecraft toward ground, manages and observes both payloads and platform equipments through command and acquisition interfaces. Figure 3 shows the interaction of OBS with its environments.

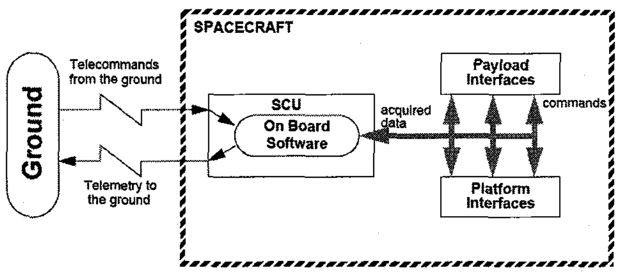

Figure 3. Interaction of OBS with its environments

In COMS platform, the SCU is connected to the GOCI IEU through the Modular Payload Interface Unit (MPIU), which interfaces SCU with payloads. Figure 4 shows the MPIU interface between SCU and the GOCI IEU. The MPIU is connected to the SCU via the system bus, 1553 bus. The MPIU provides the Low Speed Serial Bus (LSSB) to manage payload operations. In order to send commands towards the GOCI and to acquire data from the GOCI, the GOCI SW shall use the MPIU and the LSSB bus. Section 3.1 explains major requirements of the GOCI SW.

3.1 Major requirements of GOCI SW

In order to operate the GOCI payload, the ground sends the satellite telecommands including general instructions and the image parameters for the GOCI. General instructions are to switch on/off, reconfigure the GOCI payload, etc. The parameters mean the expected position of the GOCI mechanisms and the time of the next slot acquisition. When the COMS OBS receives the telecommands from the ground, it decodes them and decides which SW is in charge of them. If the telecommands targets the GOCI, the GOCI SW manages the GOCI payload according to the ground request. The GOCI SW formats LSSB commands and sends them to the MPIU via 1553 bus. Once the commands arrive at MPIU, the LSSB bus will transmit the command to its destination, GOCI IEU.

The acquired video data will not be transferred to the satellite. They are transmitted by the IEU to the Meteorological and Ocean Data Communication Subsystem (MODCS) that formats and transfer the data directly to the ground. Figure 4 depicts the video data transmission of the MODCS.

In addition to the orders and data required to manage the operations, some information such as the date and the satellite attitude are necessary for the image post-processing on ground. In order to ensure the consistency between the video data and these satellite data, they will be provided to the GOCI through the LSSB and re-transferred to the ground with the relevant video data.

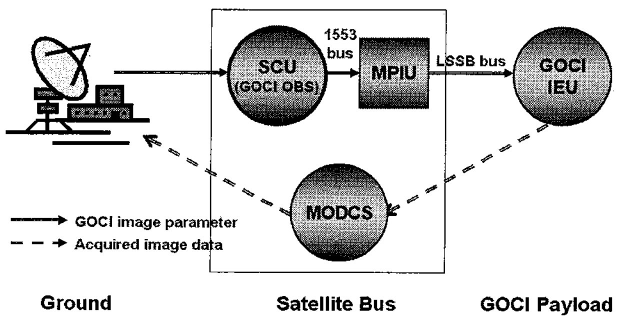

Figure 4. Interface between Ground and GOCI

3.2 Image Acquisition Sequence

In the frame of a standard Image acquisition sequence, the GOCI is operated autonomously by the IEU for each slot acquisition. For each slot, the IEU acquires 8 spectral channels images with 2 dark images by moving the filter wheel according to the image parameters. That means that during slot n acquisition by GOCI, the GOCI SW is expected to transmit asynchronously the relevant parameters and mechanisms consign for slot n+1.

Once the expected duration for each slot is over, the GOCI SW is expected to send to the IEU an "execute" command that will initiate the control of slot n+1 acquisition by IEU. The IEU encompasses a flip-flop memory mechanism that enables commanding the GOCI with the "flip" parameters while loading the flop parameters for the next slot. The duration between two "execute" commands may be driven either by the expected duration of the slot acquisition or by the duration of the transmission of the previous slot image format. Once the OBS commands the IEU to transmit the acquired data to MODCS, the IEU fully controls the transmission of the data to MODCS.

For each slot, the GOCI SW shall therefore send image parameters to the GOCI IEU, "execute" command to start the slot acquisition, and "transfer" command to transmit acquired data to MODCS. At the end of an image acquisition sequence, the OBS shall command the GOCI mechanisms to the reference position.

4. CONCLUSTION

The GOCI payload on the COMS satellite is an ocean imager that acquires ocean images around Korean peninsula from the geostationary orbit. In order to cover the FOV of the GOCI, an image is split into the smaller slots. For each slot, the GOCI operates a sequence of instructions after receiving the sequence description and the relevant parameters from the ground. The SW loaded in the SCU, OBS performs the interaction between the GOCI and the ground through the interface units provided by the SCU.

The COMS OBS receives the image parameters from the ground, formats and sends the parameters to the GOCI electronic box, IEU. The GOCI IEU drives GOCI mechanisms according to the stored image parameter and performs a slot acquisition autonomously. After a slot acquisition, it transmits the acquired video data to the MODCS subsystem that formats and transmits the data to the ground. Since the IEU itself is controlled by the satellite, the GOCI SW shall send the GOCI IEU commands to start a slot acquisition and to transmit the acquired data to the MODCS. In addition, the GOCI SW formats attitude and date information from the satellite and transmits them to the GOCI IEU for the ground image processing.

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