KOMPSAT Data Processing System: Preliminary Acceptance Test Results

Yongseung Kim, Youn-Soo Kim, Hyo-Suk Lim, Dong-Han Lee, Chi-Ho Kang
Satellite Division, Korea Aerospace Research Institute
52 Eoeun-Dong, Yusung, Taejon 305-333, Korea
Tel: +82-42-860-2476, Fax: +82-42-860-2605, E-mail: yskim@viva.kari.re.kr

Abstract

The optical sensors of Electro-Optical Camera (EOC) and Ocean Scanning Multi-spectral Imager (OSMI) aboard the KOrea Multi-Purpose SATellite (KOMPSAT) will be placed in a sun synchronous orbit in 1999. The EOC and OSMI sensors are expected to produce the land mapping imagery of Korean territory and the ocean color imagery of world oceans, respectively. Utilization of the EOC and OSMI data would encompass the various fields of science and technology such as land mapping, land use and development, flood monitoring, biological oceanography, fishery, and environmental monitoring. Readiness of data support for user community is thus essential to the success of the KOMPSAT program. As part of testing such readiness prior to the KOMPSAT launch, we have performed the preliminary acceptance test for the KOMPSAT data processing system using the simulated EOC and OSMI data sets. The purpose of this paper is to demonstrate the readiness of the KOMPSAT data processing system, and to help data users understand how the KOMPSAT EOC and OSMI data are processed and archived. Test results demonstrate that all requirements described in the data processing specification have been met, and that the image integrity is maintained for all products. It is however noted that since the product accuracy is limited by the simulated sensor data, any quantitative assessment of image products can not be made until actual KOMPSAT images will be acquired.

1. Introduction

As part of the KOrea Multi-Purpose SATellite (KOMPSAT) program, the Korea Aerospace Research Institute (KARI) has undertaken the development, installation and operation of the KOMPSAT receiving and processing system (KRPS) since 1995. The main mission of the KRPS is to acquire, process, store, and distribute the data from KOMPSAT payload instruments: an Electro-Optical Camera (EOC), an Ocean Scanning Multi-spectral Imager (OSMI), an Ionosphere Measurement Sensor (IMS), and a High Energy Particle Detector (HEPD).

The KRPS major subsystems as shown in Fig. 1 are the Data Acquisition Facility (DAF), the Direct Ingest System (DIS), the Data Processing Facility (DPF), and the Value-Added Subsystem (VAS). The DAF subsystem tracks the KOMPSAT satellite and captures the X-band downlinked telemetry stream. The DIS ingests these real-time data stream, formats the data, and stores the data on a Redundant Array of

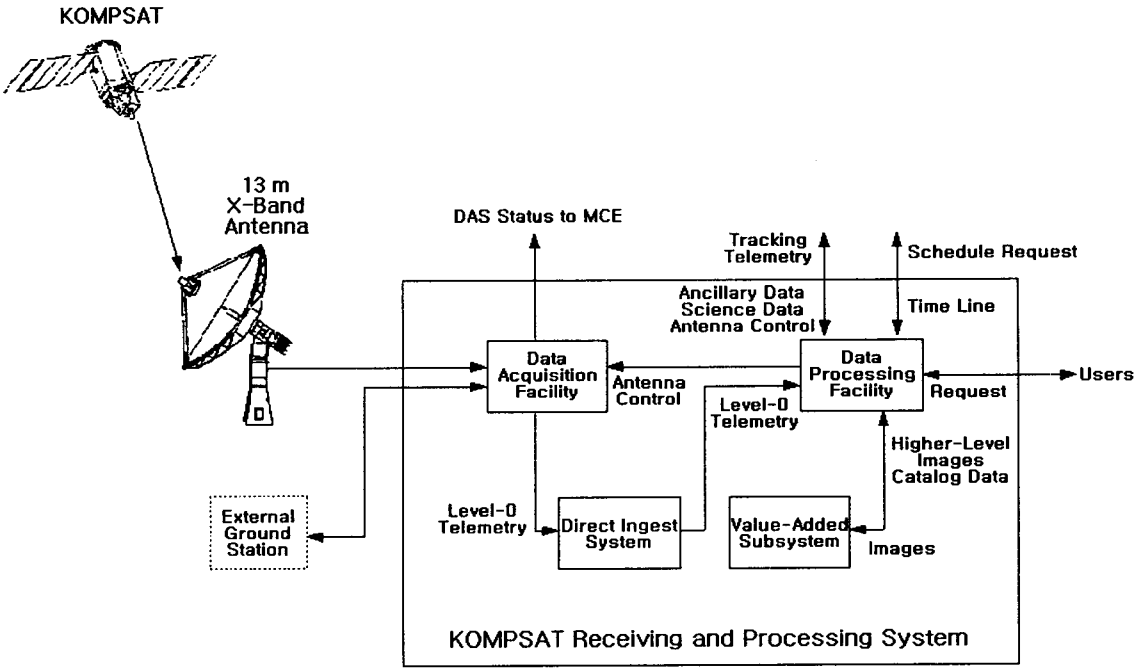


Fig. 1. KOMPSAT Receiving and Processing System

Inexpensive Disks (RAID). The data can then be archived or processed immediately by the DPF where standard image products are generated. The VAS using PCI software completes the processing through the generation of end-user products (Level-4). A 100 Mbps Ethernet performs the data transfer between subsystems.

In this paper, we are primarily concerned with testing the ability of the KRPS to process the EOC and OSMI data. Since the actual EOC and OSMI data are not available for this test, we have employed the simulated EOC and OSMI data as will be discussed next.

2. Simulated Sensor Data

The timely provision of the reliable simulated EOC and OSMI data has been considered important for the KRPS project in terms of validating the KRPS development software, and hence these tasks have been procured by the experienced organizations. In principle, the usefulness of the simulated sensor data depends upon the thoroughness with which the data are prepared, the adherence to format/content specifications, and the realism of the data (Gregg *et al.* 1997). The efforts to adhere such a principle have been made in the development of the simulated EOC and OSMI data. The KOMPSAT specific parameters of spacecraft, orbit, sensor, and data format were incorporated in the simulated EOC and OSMI data. Along with these simulated sensor data, we have generated the corresponding ancillary data necessary for generating standard image products.

The Colorado Front orthorectified imagery (1 meter resolution) and its associated Digital Elevation

Model (DEM) map (20 meter posting) were used to generate stereo pairs of the simulated EOC image. The process consists of the DEM data processing, the platform ephemeris and line-of-sight (LOS) generation, the surface back projection and processing of the detector array for a single time sample, and the EOC sensor modeling. The radiation model code MODTRAN was used to calculate the transmittance of the atmosphere and path radiance in the EOC sensor model. We avoid the detailed description of the process involved in the simulated EOC image generation because of the scope of this study.

The SeaWiFS sensor data were used as source data to produce the simulated OSMI data. A total of 12 scenes including the coastal and open ocean environments were generated for the various sea states and cloud cover. The raw SeaWiFS data were radiometrically corrected using sensor gains and offsets, and converted into at-satellite spectral radiances. The resulting pixel values were projected onto the Earth's surface. A sensor-Earth viewing model incorporates the OSMI viewing geometry and was used to produce at-satellite radiance as a function of frame number, along-track pixel, and spectral band. These at-satellite radiances were then converted into digital counts and formatted into Science Data Format (SDF) for the KRPS test.

3. Product Processing

As shown in Fig. 1, the DPF retrieves the level-0 telemetry from the DIS, merges with ancillary data, and produces the standard products of EOC and OSMI. The level definitions of the EOC and OSMI data products are given in Table 1. The EOC product processing is performed by the OPEN 2000 software which basically consists of six software modules: Catalog Browse Module (CBM), External Browse Module (EBM), Geometric Correction Module (GCM), Product Control Module (PCM), Product Tracking Module (PTM), and Satellite Programming Module (SPM). Figure 2 illustrates the EOC product processing flow from the data collection planning to the generation of a orthorectified map.

The OSMI product processing is however done through the OSMI data analysis system (OSMIDAS) with a product search function embedded in the PTM. The OSMIDAS is developed based upon the NASA SeaWiFS data analysis system (SeaDAS) and capable of processing, display, and analysis of all OSMI data products from Level 0 to standard map images. Figure 3 shows the OSMI product processing flow with the relevant input specification. Level 3 processing not shown in Fig. 3 is identical to the SeaWiFS algorithms.

4. Test Procedures and Results

The preliminary acceptance test for the KRPS has been conducted at KARI to qualify the DIS, DPF, and VAS hardware and software, with emphasis on the image processing for the EOC and OSMI sensors. The test procedure for image processing consists of the following: data ingestion, data retrieval, inventory/catalog order, product search, product order, product generation, and product archival (Frost, 1999; Ringwald, 1999). The EOC product generation was tested for the Level 1R, Level 1GR, Level

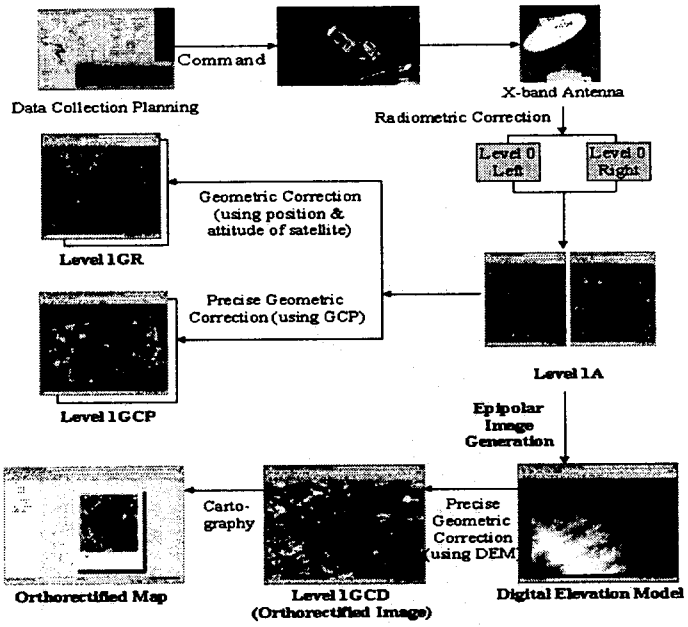


Fig. 2. EOC product processing flow

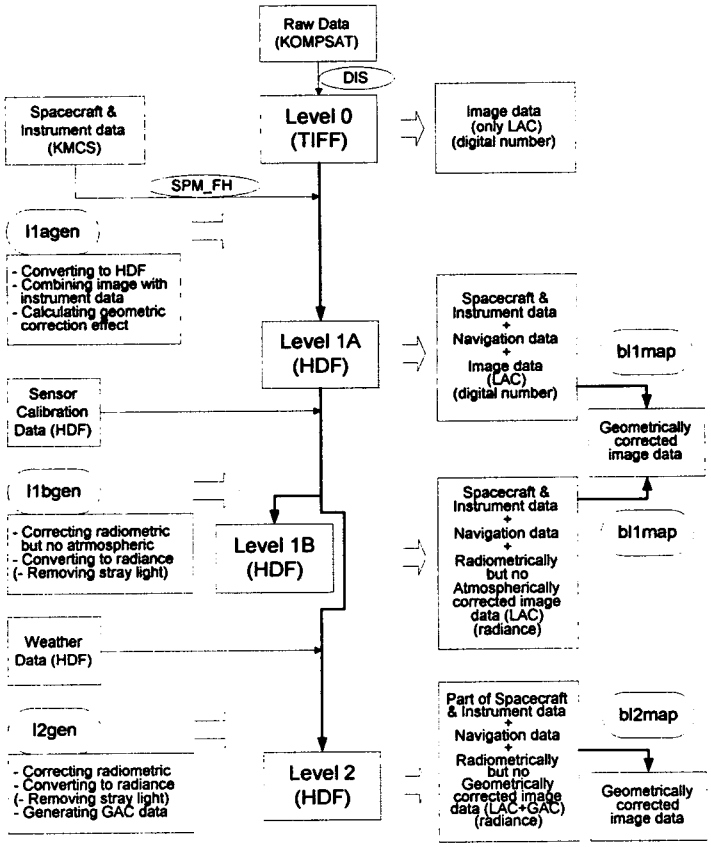


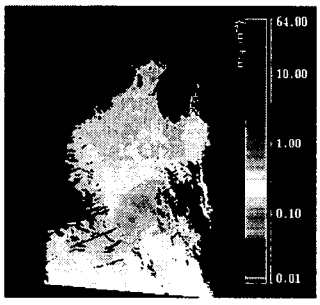
Fig. 3. OSMI product processing flow

Table 1. Data product level definitions

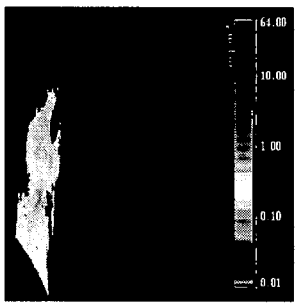
	Product Level	Description
E O C	Level 0	Frame formatted, unprocessed instrument/payload data at full resolution; any and all communications artifacts (e.g., synchronization frames, communications headers) removed
	Level 1A	Unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters (i.e., platform ephemeris) computed and appended, but not applied, to the Level 0 data
	Level 1R	Level 1A data that have been radiometrically corrected
	Level 1GR	Level 1R data that have been geometrically corrected and geo-referenced
	Level 1GC	Level 1R data that have been geometrically corrected and geo-coded Note: Level 1GC may be further processed with the following options: (Level 1GC)_P: Precise geometric correction with GCP (Level 1GC)_D: Geometric correction with DEM
	Level 4	Value added EOC products such as mosaic, DTM and maps
O S M I	Level 0	Frame formatted, unprocessed instrument/payload data at full resolution; any and all communications artifacts (e.g., synchronization frames, communications headers) removed
	Level 1A	Unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters (i.e., platform ephemeris) computed and appended, but not applied, to the Level 0 data
	Level 1B	Radiometrically corrected level 1A data that have been converted to at-satellite radiances
	Level 2	Derived geophysical variables at the same resolution and location as the Level 1A data
	Level 3	Geophysical variables mapped on uniform space/time grid scales
	Level 4	Value added OSMI products

Level 1A (555 nm)

bl1map (555 nm)



Level 2 (Chlorophyll a)



Level 3 (Chlorophyll a)

Fig. 4. OSMI image products derived from the simulated data over the eastern coast of Canada

1GC_P, DEM, DEM mosaic, Level 1GC_D, and EOC orthoimage map. The OSMI product generation includes the Level 1A, Level 1B, Level 2, Level 3, and standard map images. Fig. 2 and Fig. 4 show some product images of the EOC and OSMI data processing, respectively, for which the corresponding simulated data are used. It is apparent that image integrity remains in each product image. Test results also demonstrated that all requirements for the data processing (e.g., 1:25,000 scale orthoimage map generation, DEM with 20 meter vertical accuracy) have been met. Nevertheless, it is cautioned that because of the limits of the simulated sensor data the detailed quantitative assessment with respect to image fidelity must be deferred until after the KOMPSAT launch.

5. Online Data Services

Anyone in the user community can have access to the online catalog database of the EOC and OSMI imagery via the World Wide Web (WWW). The URL of the KRPS web site is http://krps.kari.re.kr. The catalog database maintained by the EBM server includes the EOC and OSMI browse image and the related information such as date, time, geographical location, cloud cover, and so forth. The user can log in to the EBM server either as a registrant or as a guest. Once the user is logged in successfully, a graphical map query will be displayed to allow selection of a specific sensor (EOC or OSMI) and a geographical search area. After the user has entered the search criteria, the scene list with identification data will be presented to the user. The user may then choose any of the items on the list for viewing and click on the add button to order images.

Acknowledgments

This study was supported by the ministry of science and technology of Korea through the project entitled "The KOMPSAT Ground Station: Installation and Operations of Data Receiving Facilities (V)" (grant N99070).

References

Frost, B., 1999: Factory acceptance test procedure, Korea Aerospace Research Institute Receiving & Processing System. Datron/Transco Inc., 161 pp.

Gregg, W. W., F. S. Patt, and R. H. Woodward, 1997: Development of a simulated data set for the SeaWiFS mission. *IEEE Geosci. Remote Sens.*, **35**, 421-435.

Ringwald, R., 1999: Preliminary (site) OSMI acceptance test procedure, Korea Aerospace Research Institute Receiving & Processing System. Datron/Transco Inc., 59 pp.