ANALYSIS ON PROCESSING PERFORMANCE OF COMS LHGS

Hee Jin Bae[1], Sang-il Ahn[2]

Ground System Development Department, Satellite Operations & Applications Division,
Space Application Center, Korea Aerospace Research Institute (KARI)
chelry@kari.re.kr[1], siahn@kari.re.kr[2]

ABSTRACT: The COMS LRIT/HRIT broadcast service should satisfy the 15 minutes timeliness requirement. The timeliness requirement is an important enough to impact on the overall performance of LHGS. Therefore, the simulation for the LHGS processing was performed with the LHGS prototype in this paper. First, processing time is measured for each process (per modules) of the LHGS without I/O time. Then, the LHGS processing is performed with worst scenario and the processing time is measured. Finally, analyses for processing time and time constraint are performed.

KEY WORDS: COMS, LHGS, INRSM, PROCESSING TIME, LRIT, HRIT

1. INTRODUCTION

The COMS (Communication, Ocean, and Meteorological Satellite) to be launched in year 2009 will be the first Korean multi-purpose geostationary satellite aiming at service for LRIT/HRIT (Low Rate Information Transmission/ High Rate Information Transmission). The LHGS (LRIT/HRIT Generation Subsystem) is subsystem of the IDACS (Image Data Acquisition and Control System Specification) and services LRIT/HRIT using INRSM (Image Navigation and Registration Software Module) output received from the INRSM. The COMS RIT/HRIT broadcast service should satisfy the 15 minutes timeliness requirement. If the requirement is not satisfied, the COMS mission will be failed totally. That is, timeliness requirement is an important factor for the LHGS performance. To satisfy 15 minutes requirement, 650 seconds is allocated to the LHGS timeliness. This means that the processing should be within 650 seconds from first block receiving of INRSM output to last block transmission to the DATS (Data Acquisition and Transmission Subsystem).

The LHGS provides LRIT/HRIT service. HRIT is only image data but LRIT is both image data originated from the INRSM and ancillary data. In case of image data, HRIT FD (Full Disk) image data is the largest size. Therefore, if the COMS LHGS performs processing within 650 seconds only for HRIT FD, other data satisfy the time requirement.

The LHGS is under development. The objective of this paper is to test to satisfy the timeliness requirement in stage of the LHGS development.

2. MAIN BODY OF TEXT

2.1 Data Unit for Processing

Processing data unit is different for the LHGS and the INRSM. The INRSM uses block unit containing some scan line and the LHGS does segment for processing. Generally, block unit of the INRSM is smaller than segment unit of the LHGS.

Just like saying previously, processing data unit of the LHGS is segment. The LHGS starts processing as soon as needed data for one segment — some INRSM output block from the INRSM — is received. Then, if processing is ended, processed data transmission starts. Specially, if INRSM output blocks corresponding to next segment are received, the LHGS performs transmission for first segment and processing for second segment simultaneously. Though first segment processing is not ended, it should be considered that INRSM output blocks corresponding to second segment are received. In that case, the LHGS processing for next segment should be waited until the LHGS processing is ended for first segment.

Image data received from the INRSM is data for 1 visible channel and 4 infrared channels. Visible channel is named VIS, 4 infrared channels are named SWIR, WV, IR1, IR2.

2.2 LHGS Functions

The LHGS performs data pre-processing like as segmentation, sub-sampling, geolocation, registration and map projection. And the LHGS generates LRIT/HRIT file with pre-processed data or LRIT/HRIT additional data, performs encryption, compression and transmits LRIT/HRIT CADU to the DATS.

The LHGS is divided into product generation function and product dissemination function roughly in a point of function.

Product generation function performs data pre-processing, LRIT/HRIT file generation and transfers LRIT/HRIT file to module for product dissemination. Product generation subsystem performs processing of application layer and presentation layer of OSI (open systems interconnection) 7 layer.

Product dissemination function performs compression, encryption, CCSDS (Consultative Committee for Space Data Systems) processing. Product dissemination function performs processing from session layer to data link layer with LRIT/HRIT files received from product generation subsystem. The LHGS uses JPEG (Joint

Photographic Coding Experts Group) for compression and DES (Data Encryption Standard) algorithm for encryption.

2.3 LHGS Transmission

The LHGS transmits LRIT/HRIT CADU to the DATS for user dissemination. Since maximum data rate is 3Mbps for COMS HRIT and 128kbps for COMS LRIT, transmission time to the DATS is able to be calculated using size of COMS LRIT/HRIT. That is, the maximum transmission is not simulated but calculated.

2.4 LHGS Time Requirement

FD image data consists of 56 INRSM output blocks. And the HRIT FD image data in the LHGS is segmented as 10 files. If the size of INRSM output block is identical, one segment in the LHGS corresponds to 5.6 INRSM output blocks.

The COMS LHGS should satisfy the 15minutes timeliness requirement. That is, the LHGS processing should be ended within 650 seconds from 1st block receiving of INRSM output to 56th block transmission to the DATS after LHGS processing.

The LHGS for 1st segment is not able to start data generation until 6th INRSM output block is received. Similarly, the LHGS for 10th segment is not able to start data generation until 56th INRSM output block is received. Transmission of 56th INRSM output block should be ended 60 seconds before user dissemination end. That is, HRIT generation and transmission for 10th segment should be ended within 60 seconds.

3. SIMULATION

The simulation was performed by the LHGS prototype under LHGS development.

Since the HRIT FD (Full Disk) image data is the largest size of generated data by the LHGS, the LHGS should perform processing within 650 seconds for HRIT FD. The satisfaction of time requirement for HRIT FD is necessary condition for other data of the LHGS. Therefore, this simulation is performed only for HRIT FD.

3.1 Test Environments

CPU: Intel Pentium(R) D 2.80GHz
Memory: 2.00GB
OS: Windows XP pro

This test is performed to generate HRIT FD image (VIS: 11000 X 11000, IR: 2750 X 2750) according to COMS HRIT Specification. Used data for simulation of HRIT image data generation is MTSAT-1R HRIT (20051107 ~ 20051117).

The test includes segmentation, HRIT file generation, lossless JPEG processing, DES algorithm, CADU generation. Figure 1 describes test configuration for HRIT image data simulation. The test performed to measure time from MTSAT-1R receiving to CADU generation.

The test was performed 10 iterations per each pass for accuracy of the simulation.

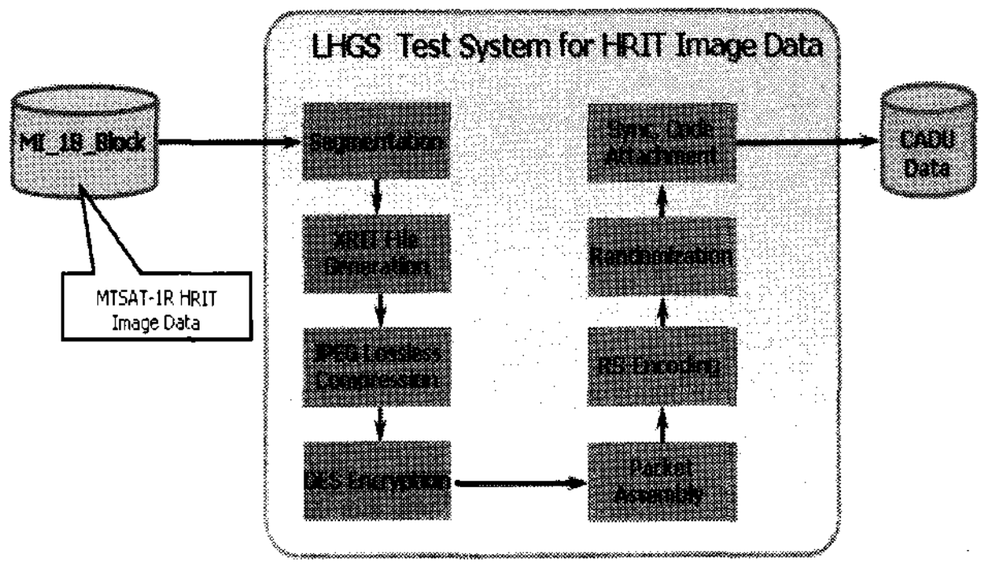

Figure 1. Test Configuration for HRIT Image Data Simulation

3.2 Results

The simulation is performed for each pass. One pass contains all channels like as VIS, SWIR, WV, IR1 and IR2.

Figure 2 is processing time for each observation for 10 days. Maximum processing time is 131.168 seconds, minimum processing time is 56.831 seconds and average processing time is 84.889 seconds. Since compression ratio is higher for image of visible channel at night, the processing time is shorter as compared to that in daytime.

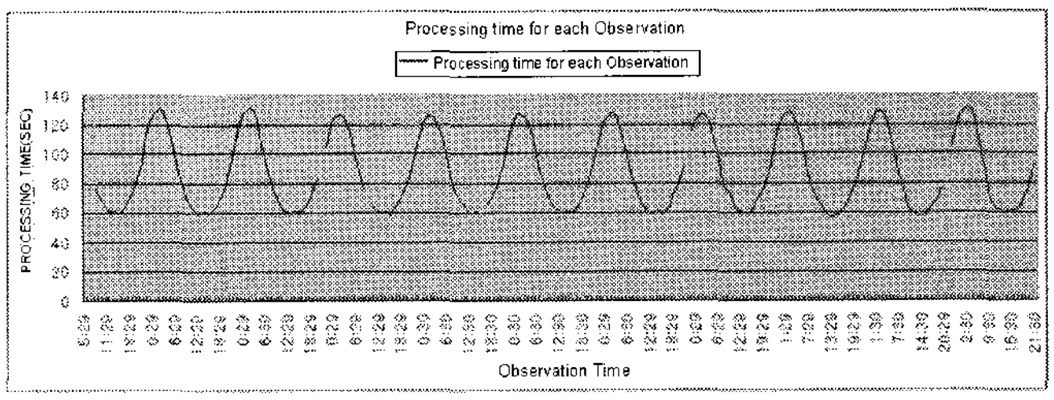

Figure 2. Processing time for Each Observatioin

Figure 3 is size for each pass for 10 days. Maximum size is 95.37 Mbytes, minimum size is 35.21 Mbytes and average size is 60.68 Mbytes. Since compression ratio is high for image of visible channel at night, image size is smaller as compared to that in daytime.

The bigger size of image is, the longer processing time. That's why Figure 2 and Figure 3 are shown in similar pattern.

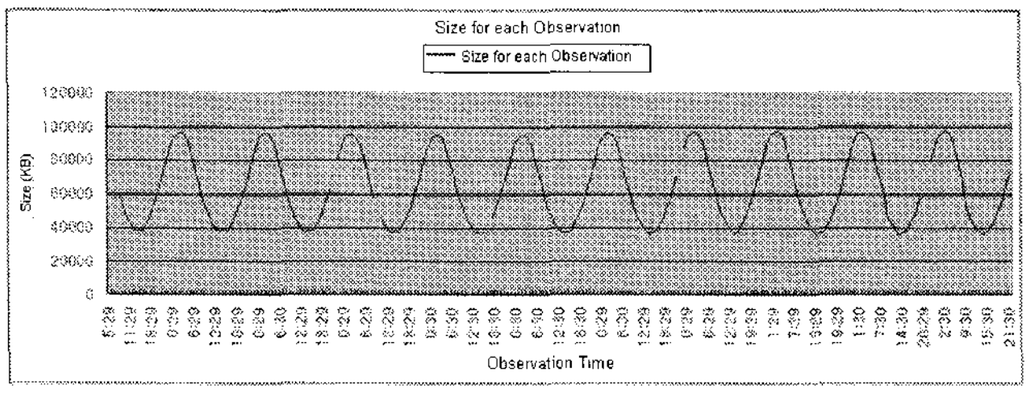

Figure 3. Size for Each Pass

Since I/O time was not considered in the simulation, maximum generation time and transmission time are used for analysis.

Table 1 shows maximum generation time for each segment for each channel.

Table 1. LHGS Generation Time [unit: second]

Segment	VIS	SWIR	WV	IR1	IR2	Total
1	7.25	0.56	0.54	0.51	0.53	9.40
2	12.38	0.66	0.66	0.56	0.67	14.93
3	15.14	0.68	0.68	0.62	0.69	17.81
4	15.79	0.68	0.69	0.63	0.69	18.49
5	15.73	0.70	0.70	0.64	0.70	18.48
6	16.45	0.71	0.70	0.65	0.71	19.22
7	16.83	0.69	0.68	0.63	0.70	19.53
8	15.74	0.68	0.67	0.60	0.68	18.37
9	13.73	0.65	0.66	0.58	0.67	16.28
10	8.44	0.54	0.55	0.51	0.54	10.59

LHGS transmission time is shown in Table 2. This is calculated value using size of HRIT CADU and data rate.

Table 2. LHGS Transmission Time [unit: second]

Segment	VIS	SWIR	WV	IR1	IR2	Total
1	12.60	0.98	0.98	0.58	0.94	16.06
2	23.99	1.67	1.65	0.88	1.76	29.95
3	27.81	1.88	1.82	1.10	2.06	34.67
4	28.43	1.94	1.88	1.21	2.04	35.49
5	28.50	2.14	2.08	1.40	2.08	36.19
6	29.42	2.14	2.08	1.37	2.16	37.18
7	30.15	1.96	1.90	1.15	2.16	37.33
8	28.64	1.91	1.88	0.99	2.10	35.51
9	25.81	1.63	1.59	0.89	1.85	31.76
10	15.71	0.99	0.99	0.59	1.13	19.40

Maximum data rate of HRIT is adapted to calculate LHGS transmission time in Table 2.

4. ANALYSIS & CONCLUSION

4.1 Processing Time

Considering parallel processing for generation and transmission for the LHGS, LHGS processing time is able to be calculated sum of generation time for 1st segment and transmission time from 1st segment to 10th segment.

Figure 4 shows LHGS processing time for each segment

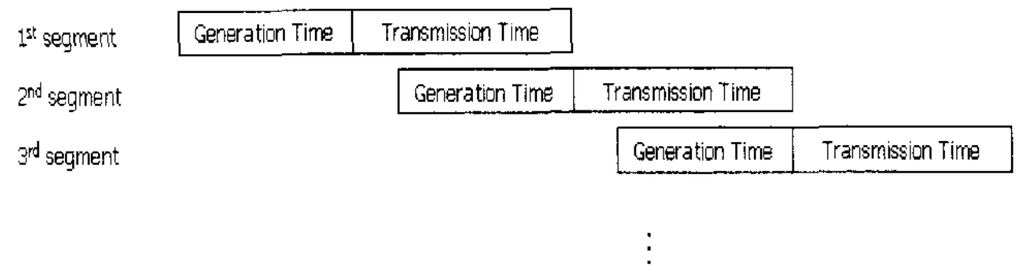

Figure 4. LHGS Processing Time

Minimum needed time for the LHGS
= generation time for 1st segment
+ Transmission time from 1st segment to 9th segment
+ processing time for 10th segment
= 9.4 + 288.5 +60
= 358 [seconds]

Since minimum needed time for the LHGS is 358 seconds, this means that the LHGS is able to perform processing within 650 seconds.

Therefore, the LHGS satisfy the 15 minutes requirement only if INRSM output block is received in time.

4.2 Time Constraint

HRIT FD is divided as 56 INRSM output blocks in the INRSM and is segmented as 10 files in the LHGS. If size of each INRSM output block is identical, one segment for the LHGS is equal to 5.6 blocks for the INRSM. Therefore, the needed INRSM output block for each segment processing of the LHGS can be calculated as below.

HRIT for $k-th$ segment needs from [ceil $(5.6 \times k)$]-th INRSM block to [ceil $(5.6 \times (k+1))$]-th INRSM block.

Table 3. Needed INRSM Output Block & Expected Time vs. LHGS Segment

LHGS Segment #	1	2	3	4	5
Needed INRSM output Block #	1~6	7~12	13~17	18~23	24~28
Expected Time	358	342	315	281	246
LHGS Segment #	**6**	**7**	**8**	**9**	**10**
Needed INRSM output Block #	29~34	35~40	41~45	46~51	52~56
Expected Time	210	174	135	97	60

Considering parallel processing for the LHGS, $E_i(t)$ is needed time for the LHGS of $i-th$ segment. That is, the LHGS expects until the LHGS receive INRSM output for $i-th$ segment at least can be calculated as below.

$$E_i(t) = i-th\ generation\ time$$
$$+ \sum_{k=i}^{9} transmission\ time\ for\ k-th\ segment +$$
$$+ E_{10}(t)$$

The LHGS expects that the INRSM transmit INRSM output to the LHGS containing scan line corresponding to the last line of $i-th$ segment $E_i(t)$ before dissemination end.

The calculated time for LHGS segment is shown in Table 3.

5. REFERENCE

[1] JMA, 2003, JMA HRIT Mission Specific Implementation
[2] KARI, 2007, COMS HRIT Mission Specification
[3] KARI, 2007, COMS LHGS Specification
[4]KARI, 2007, COMS LHGS Detailed Design Description
[5] EADS Astrium, Image Quality Verification Report (SYS-13)