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KOMPSAT-2 Terminal for Polar Station (K2PS) Development by KARI

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Abstract : Recently, KARI developed "KOMPSAT-2 Terminal for Polar Station" which is high performance system newly required for stimulating KOMPSAT-2 application. The KOMPSAT-2 Terminal for Polar Station consists of one receiving system and two processing systems. The receiving system has been installed at Svalbard Satellite Station located at Norwegian Svalbard island, and the two receiving systems have been installed at Kongsberg Satellite Service AS located at Tromso Norway and Spot Image SA located at Toulouse France respectively. In this paper overall items of KOMPSAT-2 Terminal for Polar Station, which includes requirements, designs and operation concepts, are to be addressed with the verification result on its performance.

Key Words : K2PS, KOMPSAT-2, New Tasking Order, Archive Order, DIMAP, Level 1R, Level 1G.

1. Introduction

Recently, KARI developed "KOMPSAT-2 Terminal for Polar Station (K2PS, hereafter)" which is high performance system newly required for stimulating KOMPSAT-2 application under the contract with Kongsberg Satellite Service AS (KSAT, hereafter), Spot Image SA (SISA, hereafter) and European Space Agency (ESA, hereafter).

In fact, the K2PS has been developed on the basis design of the Image Receiving and Processing Element (IRPE, hereafter) which is in working for generating KOMPSAT-2 level products. The K2PS has been designed to have higher performance on processing capability, especially reducing overall processing time considering state-of-the-art technologies and software coding optimization according to the need for commercialization.

The K2PS aims to provide a complete solution to the final customer. The K2PS provides as followings.

- Full functions for receiving RF signal from KOMPSAT-2 satellite, processing and archiving KOMPSAT-2 level products.
- Interfaces with KOMPSAT-2 Mission Control System (MCS, hereafter) through a network
- Web-based catalogue browsing and order ingest for supporting general user.

The K2PS consists of one receiving system and two processing systems physically. The receiving system is installed at Svalsat located in Svalbard of

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the North Pole and processing systems are installed at KSAT in Tromso Norway and SISA in Toulouse France respectively. The receiving system receives the image data from KOMPSAT-2 and transfers the image data to the processing systems through dedicated T3 network at a rate of 45Mbps. The processing system receives image data from the receiving system and generates Level 0 data, Level 1A data, Level 1R and a Level 1G product.

In this paper, overall items of KOMPSAT-2 Terminal for Polar Station, which includes requirements, designs and operation concepts, are to be addressed with the verification result on its performance.

2. Functional Requiremets

Major functional requirements of K2PS are as followings.

- KOMPSAT-2 level product generation: The system processes data to produce level products that meet the KOMPSAT-2 level product specifications.
- Maximum automation: The system is centralized and operated with the minimum operator's interactions or considerations.
- Rapid receiving and processing capability: The system receives image data at a rate of 320 Mbps and generate level products more rapidly compared to the existing IRPE.
- Higher reliability: The system does not fail to achieve system objectives by single point failure and/or trivial mistakes by operators.
- Integrity: Operations and managements of system are integrated in the most efficient manner.
- Security/Accessibility: The system can control the access to the level products, scene by scene, using an access control function and only the authorized user can access to a catalogue data and only the authorized operators can access to the system modules.

According to the classification based on functionalities, 4 functional subsystems which consist of acquisition, processing, archiving and product generation have been designed to meet requirements of K2PS.

The acquisition is responsible for receiving data from KOMPSAT-2 satellite. The processing is to produce Level 0, Level 1A products and catalogue data. The archiving is designed to support backup function for the processing result. Finally, the product generation is to produce Level 1R and Level 1G product. Detailed description on each functional subsystem is addressed in following sections.

1) Acquisition

The K2PS receiving system should contact with KOMPSAT-2 during 10 orbits per day.

The receiving system receives RF signal from KOMPSAT-2 satellite and pre-process earth observation data with imaging duration of 7 minutes per orbit to produce Pre-Level 0 data. The Pre-Level 0 data has been designed to cope with network bandwidth bottleneck (45Mbps) compared to KOMPSAT-2 downlink data rate at 320 Mbps. The Pre-Level 0 data is to be defined as the Level 0 data without decompression. Finally, the Pre-Level 0 data is to be transferred to processing systems located in both Tromso and Toulouse through T3 network at a rate of 45Mbps.

2) Processing

The processing system should complete generation of Level 0, Level 1A and catalogue with Pre-Level 0 from the receiving system before next pass. This means that processing of imaging data with 7 minutes and generation of Level 0, Level 1A and catalogue

should be completed in 98 minutes, which is orbital period of KOMPSAT-2 satellite. During the processing of Pre-Level 0 data with 7 minutes imaging, Level 0 and Level 1A products of about each 100Gbytes are to be produced. Consequently, the high-rated technology such as parallel processing is to be adopted to develop the processing system to meet processing capability of huge amount of data with higher speed.

3) Archiving

The K2PS should backup all imaging duration, 7 minutes, Level 0 data of 10 orbits in HDD within 24 hours and complete backup of Level 0 before next contact with KOMPSAT-2.

The Level 0 and Level 1A data will be archived for future use. After the Level 0 and Level 1A processing is finished, the archiving procedure will be started automatically.

The Level 0 file will be removed right after the archiving procedure is completed. However, the Level 1A file will not be removed immediately because the Level 1A data will be used for the production generation. The Level 1A data will be stored at online RAID storage and only if the RAID storage's remaining space is over the limit, the oldest Level 1A data will be removed from the storage.

4) Product Generation

The K2PS processing system should generate 300 Level 1R products and 30 Level 1G products without MTF compensation within 24 hours or 230 Level 1R products and 23 Level 1G products with MTF compensation within 24 hours.

In product generation step, the Level 1A is used for generation of the Level 1R and the Level 1G product. If the required Level 1A product already exists in RAID storage, the system automatically uses the Level 1A product for generation of the Level 1R or Level 1G product. If this is not the case, the system is to ask operator to restore the Level 1A product.

A user can order products through web based ordering interface. The user can select several options with MTF compensation, Level of product, and output media and so on. For example, the user can get level products via FTP transfer or in DVD media by selecting output media option.

The system also provides the function to convert Level 1R and 1G product to the DIMAP format for compatibility with SISA. This leads to the development of the DIMAP Generator. The DIMAP Generator is to be used in converting Level 1R and Level 1G product into those of DIMAP format in a stand-alone manner.

3. System Design

The K2PS has been designed to have one receiving system and two processing systems in a physical sense. The receiving system is determined to be installed at Svalsat located in Svalvard island of Norway Territory. Meanwhile, processing systems are determined to be installed at KSAT in Tromso of Norway and SISA in Toulouse of France respectively. Fig. 1 shows the geographical location of receiving system and processing systems of the K2PS.

Following sections address the design of S/W and H/W for implementing each subsystem.

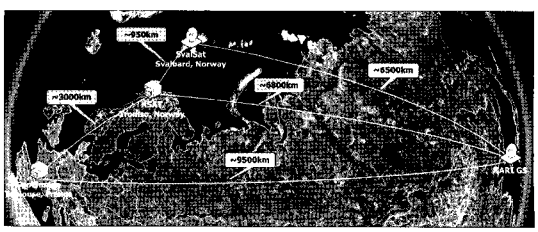

Fig. 1. Geographical location of Receiving System and Processing Systems.

3) Hardware Design

(1) Receiving System

Receiving system performs functions as followings.

- Receiving scheduling based on a mission timeline
- Receiving Image data from KOMPSAT-2 satellite.
- Generation of Pre-Level 0 data.
- Pre-Level 0 data transfer to the processing systems.

Fig. 2 shows the configuration of H/W for receiving system.

The configuration of H/W for receiving system is to be determined in such a way to have receiving card supporting frame synchronization and to guarantee security of system through duplex workstations.

Using frame synchronization card is able to generate Level 0 data in real time. Duplex of workstation for each channel is to minimize chance to loss data for system failure. For example, if there is a failure for receiving bitstream data on Primary-I channel and Backup-Q channel, receiving system selects Backup-I channel and Primary-Q channel data and generates Pre-Level 0 data without any loss of acquisition data.

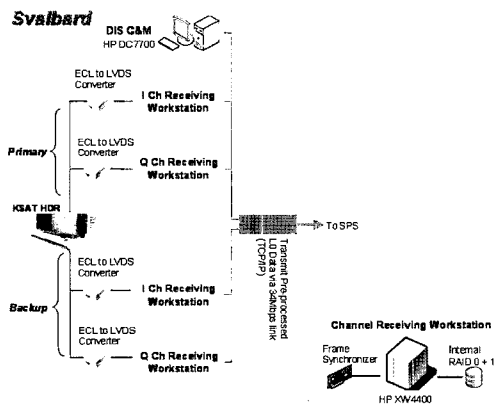

Fig. 2. Configuration of H/W for receiving system [1].

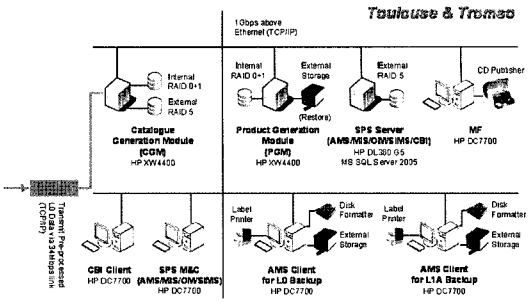

Fig. 3. Configuration of H/W for processing system.

(2) Processing System

Processing system performs following functions.

- Automatic generation of Level 0 and Level 1A products
- Generation of Level 1R and Level 1G products
- HDD back-up of Level 0 and Level 1A products

Fig. 3 shows the configuration of H/W for processing system.

Key features for processing system are as followings.

- The CGM located in Tromso and Toulouse receives Pre-Level 0 data through dedicated network line at a rate of 45Mbps.
- The PGM produces Level 1R and Level 1G products with connecting online storage, which is called external RAID connecting to CGM by network shared folder.
- The Backup system for Level 0 and Level 1A product provides disk backup function and backup disk management function.

2) Software Design

(1) Receiving System

Fig. 4 describes software installed at receiving system shown in Fig. 2. "Automatic run program" of S/W is to be executed/ finished automatically without any manipulation of an operator. "StorageManager" is installed for remaining storage space management

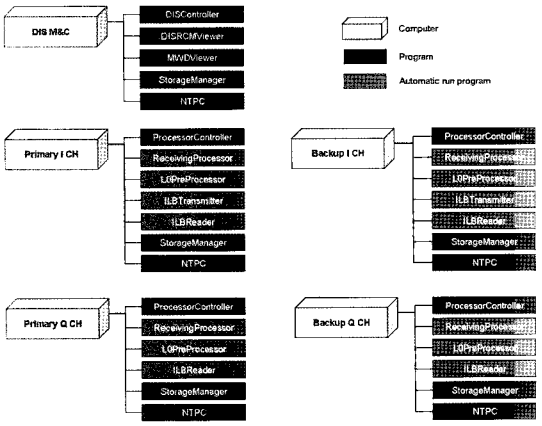

Fig. 4. Configuration of S/W for receiving system.

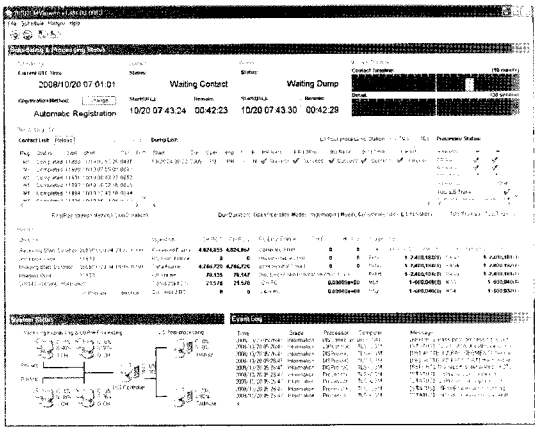

Fig. 5. GUI of DISRCMViewer.

and "NTPC" is for time synchronization in each system universally.

The "DISRCMViewer", which is installed at DIS monitoring and control system, provides the interface by which the operator in remote place monitors state of health of both receiving system and processing systems and controls it.

Receiving system is on monitoring through DISRCMViewer in current Svalbard, Tromso, Toulouse and KARI. The GUI of "DISRCMViewer" is illustrated in Fig. 5.

(2) Processing System

Fig. 6 describes S/W installed at processing system shown in Fig. 3. The "StorageManager" and

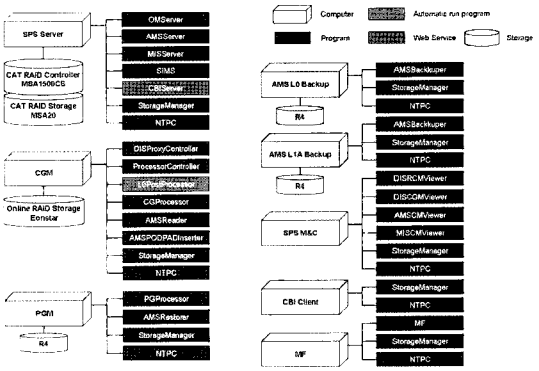

Fig. 6. Configuration of S/W for processing system.

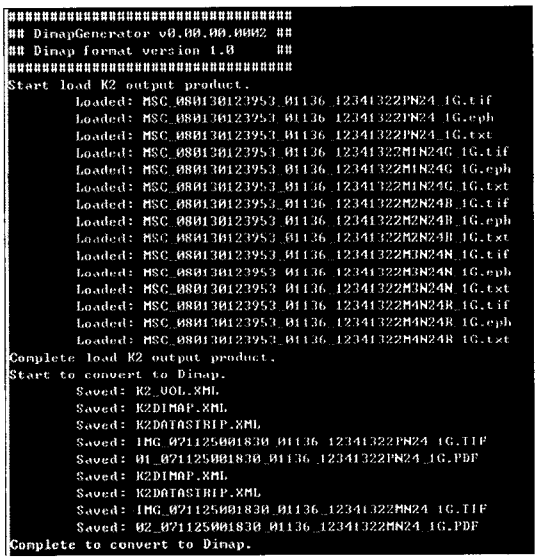

Fig. 7. Execution log for DIMAP Generator.

"NTPC", which are installed and operated in receiving system, are also installed and operated in the processing systems.

As an additional stand alone S/W for DIMAP product format, DIMAP Generator was developed to convert to DIMAP format for compatibility with processing system of SISA for separate use.

DIMAP generator performs to convert Level 1R and Level 1G product of K2PS and K2 IRPE to DIMAP format according to "KOMPSAT-2 Guidelines for DIMAP format"

4. System Operations

The operation of K2PS starts from the acquisition of product order from user. There are two kinds of product order : New Tasking Order (NTO, hereafter) and Archive Order (AO, hereafter). NTO means the process of receiving KOMPSAT-2 image and generation of Level 0, Level 1A and catalogue. AO means the process of searching the catalogue through CBI and generation of Level 1R and Level 1G product.

1) Operation Flow of NTO

K2PS operator requires new task through KOMPSAT Customer & User Support Team ("KOCUST", hereafter) to receive an image data from KOMPSAT-2. KOCUST makes mission plan and provides information needed to receive image to K2PS. Fig. 8 describes overall NTO flow from request of new task to Level 1A product generation [2].

1) KOCUST receives NTO from users.
2) MCS makes mission plan and generates mission timeline.
3) Mission Timeline is sent to KOCUST.
4) KOCUST sends mission timeline to MIS via FTP server.
5) MIS transfers collected receiving information to OM.

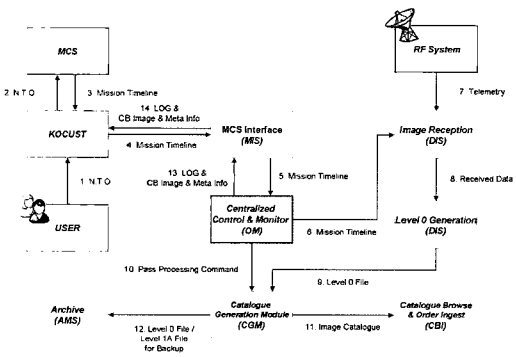

Fig. 8. Operation Flow : NTO.

6) OM transfers mission timeline to receiving system and receiving system generates receiving schedule.
7) Image is received from satellite.
8) Pre-Level 0 data is generated in receiving system.
9) Pre-Level 0 data is transferred to both processing systems in Tromso and Toulouse through 45Mbps dedicated line.
10) OM sends command for further processing to the Catalogue Generation Module (CGM, hereafter) to produce level 0 and Level 1A products and catalogues using Pre-Level 0 data.
11) Catalogue browse images and meta data generated by CGM are transferred to Catalogue Browse & Order Ingest (CBI, hereafter)
12) CGM transfers Level 0 and Level 1A products to Archive Management System (AMS, hereafter) for backup on Level 0 and Level 1A products in HDD.
13) OM transfers log file and catalogue browsing image and meta data to MIS.
14) MIS sends processing log file, catalogue browsing images and meta data to KOCUST.

2) Operation Flow of AO

The AO is acquired through CBI and processed. Fig. 8 shows the operation flow applied to processing AO.

1) A user searches a catalogue through CBI.
2) CBI provides searching results to user.
3) User sends Product Order for AO through CBI.
4) CBI transfers AO to OM.
5) OM transfers a command for level product generation to Product Generation Processor (PGP, hereafter) of Product Generation Module (PGM, hereafter).
6) PGP asks archiving subsystem for Level 1A product to produce the level product.
7) AMS transfers Level 1A product to PGP.

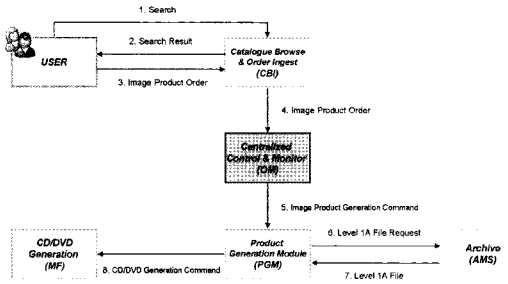

Fig. 9. Operation Flow : AO.

8) PGP produces the product from Level 1A product requested by user. The PGP transfers the level product to Media Formatter (MF, hereafter) to write the level product to CD or DVD as user's request.

5. Performance Test Results

This section summarizes test results to verify acquisition, processing, mass production and archiving requirement concerning with performance requirements addressed in chapter 2.

1) Acquisition & Processing

The test for receiving and processing capability has been performed to verify requirements presented in chapter 2.1 and chapter 2.2. The test has been successfully completed from the 3rd to 9th July at this year. Table 1 describes the test results performed on the 1st day [3].

2) Mass Production

The test for checking product generation performance has been performed to verify requirements presented in chapter 2.4. [4]. The test has been successfully completed with the consideration on various processing options such as MTF compensation and Rational Polynomial Coefficients (RPC, hereafter) generation.

Table 1. Acquisition & Processing Test Result (2008/07/03)

Orbit	Image take Duration (sec)	Pre L0 Start	Pre L0 End	Post L0 Start	Post L0 End	L1A Start	L1A End
1	420	1:38:43	1:44:32	1:44:43	2:27:59	1:46:02	2:30:24
2	420	3:16:03	3:22:03	3:22:16	4:00:46	3:23:39	4:03:37
3	125	4:55:49	4:57:32	5:02:06	5:11:46	5:02:30	5:13:42
	295	4:57:51	5:01:54	5:13:51	5:39:10	5:14:45	5:46:34
4	290	6:34:48	6:38:42	6:41:11	7:04:21	6:42:04	7:09:31
	130	6:39:02	6:40:59	7:09:48	7:23:35	7:10:19	7:24:22
5	330	8:12:43	8:17:15	8:19:06	8:46:48	8:20:12	8:51:23
	90	8:17:36	8:18:53	8:51:44	9:00:45	8:52:06	9:01:16
6	170	9:49:45	9:52:12	9:56:18	10:10:11	9:56:55	10:13:22
	250	9:52:31	9:56:06	10:13:34	10:36:40	10:14:22	10:42:05
7	420	11:26:56	11:33:01	11:33:13	12:08:57	11:34:37	12:18:14
8	260	19:45:42	19:49:16	19:52:34	20:15:31	19:53:23	20:17:01
	80	19:49:36	19:50:48	20:17:15	20:23:53	20:17:34	20:25:29
	80	19:51:07	19:52:22	20:25:36	20:32:17	20:25:58	20:34:12
9	120	21:24:40	21:26:27	21:31:45	21:41:44	21:32:10	21:43:56
	120	21:26:47	21:28:33	21:44:05	21:54:27	21:44:30	21:57:33
	180	21:28:53	21:31:33	21:57:44	22:16:54	21:58:24	22:17:59
10	420	23:02:35	23:08:29	23:08:42	23:47:41	23:09:58	23:50:00

Table 2. Average Processing Time

Condition		Level 1R Average Processing Time	Level 1G Average Processing Time
MTFC	RPC		
ON	ON	4 min 25 sec	5 min 12 sec
OFF	ON	2 min 56 sec	3 min 24 sec
ON	OFF	3 min 25 sec	4 min 12 sec
OFF	OFF	1 min 56 sec	2 min 24 sec

Table 3. Product Generation Performance per a Day

Condition		Level 1R Product / Day	Level 1G Product / Day
MTFC	RPC		
ON	ON	326	276
OFF	ON	490	423
ON	OFF	421	342
OFF	OFF	744	600

Table 2 shows the statistics of processing time consumed to the Level 1R and the Level 1G product generation. Consequently, test results shows that the K2PS comply with the performance requirement for product generation. If the system generate

continuously during a day, the result will be almost same with Table 3.

3) Archiving

The test for archiving capability has been performed to verify requirements presented in chapter 2.3. The test has been successfully completed at 3rd July in Tromso. Table 4 shows that the backup time for Level 0 product has been completed in 98minutes, which is orbital period of satellite and this led to the success of the verification

Table 4. Level 0 Backup Time (2008/07/03, Tromso)

Orbit	Image Take duration	Level 0 backup Time		
		Start	End	Duration
1	420sec	02:30:46	03:10:19	00:39:33
2	420sec	04:03:58	04:51:27	00:47:29
3	125sec	05:13:50	05:52:14	00:38:24
	295sec	05:52:15	06:23:10	00:30:55
4	290sec	07:09:46	07:51:46	00:42:00
	130sec	07:51:46	08:08:14	00:16:28
5	330sec	08:51:41	09:38:19	00:46:38
	90sec	09:38:19	09:48:39	00:10:20
6	170sec	10:13:33	10:54:58	00:41:25
	250sec	10:54:58	11:25:28	00:30:30
7	420sec	12:18:35	13:09:31	00:50:56
8	260sec	20:17:15	20:56:28	00:39:13
	80sec	20:56:28	21:04:13	00:07:45
	80sec	21:04:13	21:12:10	00:07:57
9	120sec	21:44:09	22:22:30	00:38:21
	120sec	22:22:30	22:34:26	00:11:56
	180sec	22:34:26	22:54:32	00:20:06
10	420sec	23:50:22	24:37:51	00:47:29
Average backup time (7min imaging)				00:56:44

6. Conclusion

The K2PS has been successfully developed as the image receiving & processing system based on the need for KOMPSAT-2 application and installed at its destination place. Consequently, the K2PS has been implemented with newly developed design and algorithms for receiving and processing to cover requirements and has been proven to comply requirements.

The level product provided by processing system in Tromso is to be provided to ESA for further research while the level product provided by processing system in Toulouse is to be commercially utilized for general user.

Development of K2PS operational system will contribute in stimulating international commercialization of KOMPSAT-2 products. Besides, HW/SW concept (System status monitoring, data archiving, data processing in high speed) applied to K2PS is expected to be applied upcoming KOMPSAT-3, 5 to be launched.

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