KOMPSAT-3A SATELLITE DATA QUALITY CONTROL PARAMETERS & CHARACTERISTICS

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ABSTRACT: KARI successfully had been done Calibration and Validation (Cal/Val) activities for the KOMPSAT-3A (KOrea Multi-Purpose SATellite-3A) after launch at March 25th 2015.
The satellite data of quality control parameters in KOMPSAT-3A is consist of radiometric, spatial and geometric quality parameters. The radiometric parameters control the radio-metrically quality on image data for example an amplitude of noise, noise characteristics and systematic noise. The spatial parameters is represented of MTF value of artificial edge target measured. In this paper, I introduce KOMPSAT-3A system architecture, data pre-processing system of IRPE (Image Reception & Processing Element), KOMPAST-3A product and quality performance of each radiometric, spatial and geometric parameters of LEOP result and normal phase.

1. INTRODUCTION

KOMPSAT-3A, which was launched on March 25, 2015, is a sister spacecraft of the KOMPSAT-3 developed by the Korea Aerospace Research Institute (KARI). KOMPSAT-3A's AEISS-A camera is similar to KOMPSAT-3's AEISS but it was designed to provide PAN (Panchromatic) resolution of 0.55m, MS (Multi-Spectral) resolution of 2.20m, and TIR (Thermal Infra-Red) at 5.5m resolution as presented in Table 1. The altitude of KOMPSAT-3A is 528km which is lower than that of KOMPSAT-3 (685km) for better spatial resolution sacrificing the swath width. The main mission objectives of KOMPSAT-3A System are to provide continuation of satellite earth observation after KOMPSAT-2 and KOMPSAT-3 to meet national need firstly, provision of the high-resolution EO (Electro-Optical) images required for GIS establishment and the applications for environmental, agriculture and ocean monitoring, and provision of IR (Infrared) images for GIS application and for monitoring the forest fire, the volcanic activity, the waste heat pollution in lakes and rivers, the flood damage, the urban heat island.
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Table 1. KOMPSAT-3A Specification

	PAN	MS
Spectral bands	450-900 μm	Blue: 450-520 μm Green: 520-600 μm Red: 630-690 μm NIR: 760-900 μm
GSD (Ground Sample Distance)	0.55m at nadir	2.2m at nadir
Focal length	8.6 m	8.6 m
Swath width at nadir	12 km	12 km
Data quantization	14 bit	14 bit
CCD detector	Array of 24,000 pixels (2x12,000)	Arrays of 4(RGB and IR) x 6,000 pixels (2x3,000)
Pixel pitch	8.75 μm	35 μm

2. KOMPSAT-3A IMAGE RECEPTION AND PROCESSING ELEMENT INTRODUCTION

The Image Reception and Processing Element (IRPE) provides the capability to receive and store the KOMPSAT-

3A collected data, generate standard and value added imagery products, and user interface. The User Interface Subsystem (UIS) is to process user's request. The Image Collection Planning Subsystem (ICPS) is to generate image collection plan and transfer it to the Mission Control Element. The Direct Ingestion Subsystem (DIS) is to receive mission data and transfer it to the PMS. The DIS consists of X-band antenna, RF and computer equipment for raw data processing. The Product Management Subsystem (PMS) is to generate level products. The Post-Processing Tools (PPT) is to generate valued added product from level product transferred from the PMS.

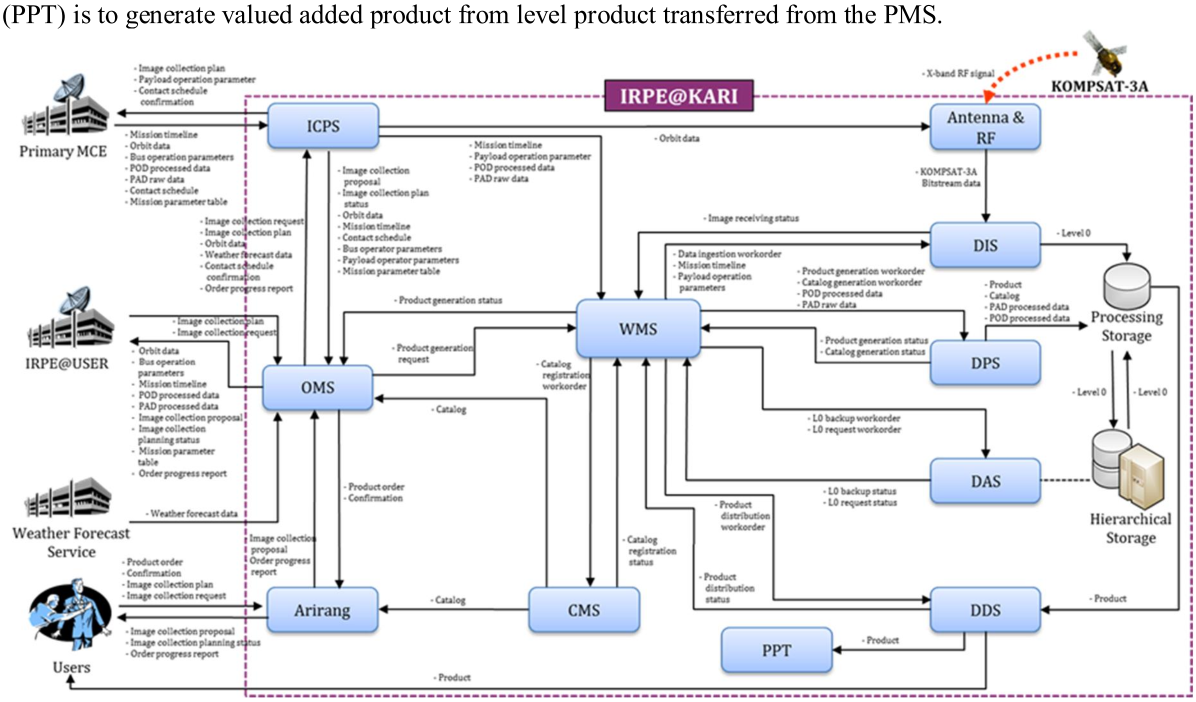

Figure 1. Image Reception and Processing Element Overview

The product of KOMPSAT-3A is classified as Level 1R product and Level 1G product. Level 1R product is the result of processing of radiometry and spatial. So, Level 1R product contains Earth's imagery which is corrected radiometrically and spatially. Level 1G product is the result of processing in view point of geometric. Table 2 shows the specification for Level 1R and Level 1G product.

Table 2 KOMPSAT-3A product specification

Product Level	Accuracy(m), CE90	Maximum Off-Nadir (deg)	Maximum GSD (m)	Processing
1R* (Basic)	285.0	30	0.55	- Without GCP - Using OD/AD - Radiometric correction - Sensor correction - MTF compensation - PAN-MS registration
1R* (Option)	70.0	30	0.55	- Without GCP - Using POD/PAD - Radiometric correction - Sensor correction - MTF compensation - PAN-MS registration
1G (standard)	70.0	30	0.55	Without GCP - Using POD/PAD - Radiometric correction - Sensor correction - MTF compensation - Geometrical correction - PAN-MS registration

*exclusive of terrain effects

*Imaging mode: strip, one-pass stereo image
The KOMPSAT-3A product has image data which consists image files for pan, blue, green, red, NIR with GeoTIFF format and there are ancillary and RPC data. The ancillary data has several information such as ephemeris, projection type, coordinate and image information.

3. KOMPSAT-3A IMAGE QUALITY PARAMETERS

Generally, because the present remote sensing satellite technique cannot satisfy user's requirements for image data quality directly, the Cal/Val for image data quality must be carried out after launch before distributing the imagery to the user. In the broad concept of Cal/Val, the Cal/Val of the remote sensing satellite can be divided into two parts if we recognize the technical gap between the satellite technique and the users' requirements; Cal/Val to calibrate and validate the requirements of satellite (Cal/Val Phase I; CVP I), and Cal/Val and image data restoration to guarantee the image data quality for the user (Cal/Val Phase II; CVP II). The KOMPSAT-3A Cal/Val has been carried out with this concept. Before KOMPSAT-3A launched, KARI Cal/Val team had prepared and developed Cal/Val sites, equipment and Cal/Val code for KOMPSAT-3A in KARI's own way. After launch, we have been doing the Cal/Val work according to the KOMPSAT-3A Cal/Val procedure. After CVP I, the KOMPSAT-3A has been calibrated and validated by the Cal/Val team, and during CVP II, the processing system of the KOMPSAT-3A image data has been calibrating and validating with the result of CVP I and the result of Cal/Val in CVP II.
The figure 2 shows characterization parameters.

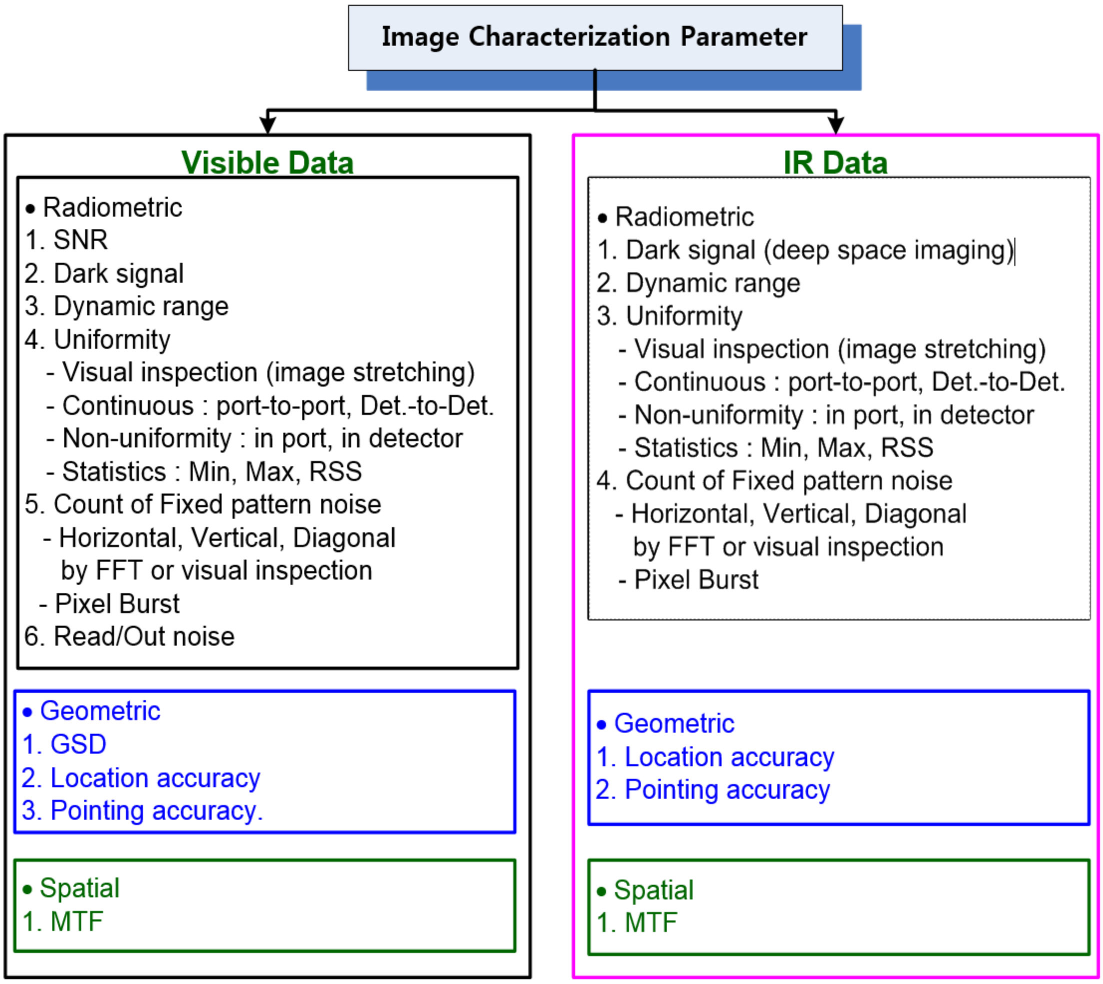

Figure 2. Characterization parameters

The KOMPSAT-3A calibration work is focus on the satellite hardware system alignment and time synchronization. This activities base on image data, ground truth data and each sensor measurement data. The main calibration works are following;

(1) After CCD PRNU and DSNU correction, Uniformity verification
(2) After focus calibration, MTF value verification
(3) AOCS On-orbit Calibration

(4) Pointing accuracy verification
(5) Calibration of focal length and CCD alignment each bands
(6) Overlap area and band-to-band registration

4. KOMPSAT-3A PRODUCT QUALITY PERFORMANCE

The main product quality parameters are consist of SNR, MTF and location accuracy. The MTF is measured during LEOP (Launch Early Operation Period) under conditions that approximated a 10% of MTF and over 100 of SNR with reflective target. Figure 3 shows the MTF value of each target.

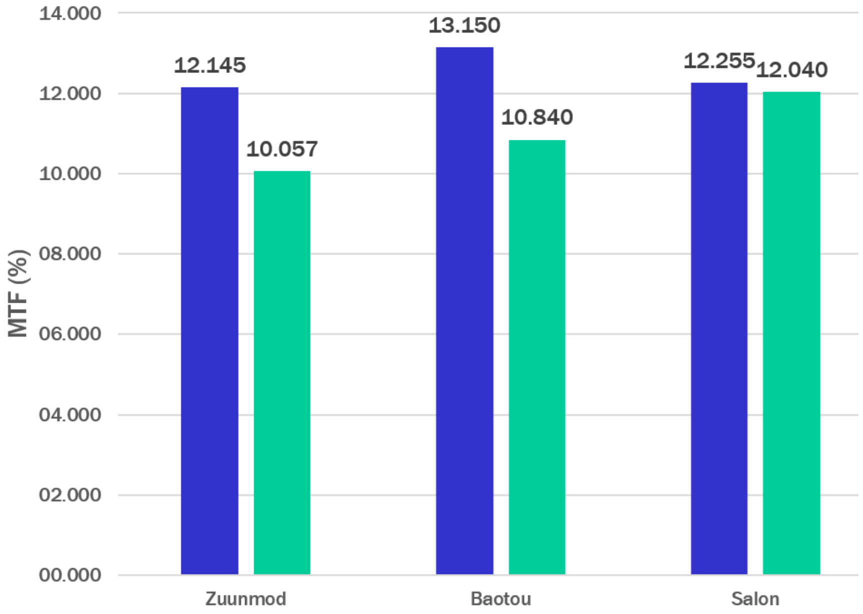

Figure 3. MTF value of each edge target (Blue bar: across-track MTF, Green bar : along-track MTF)

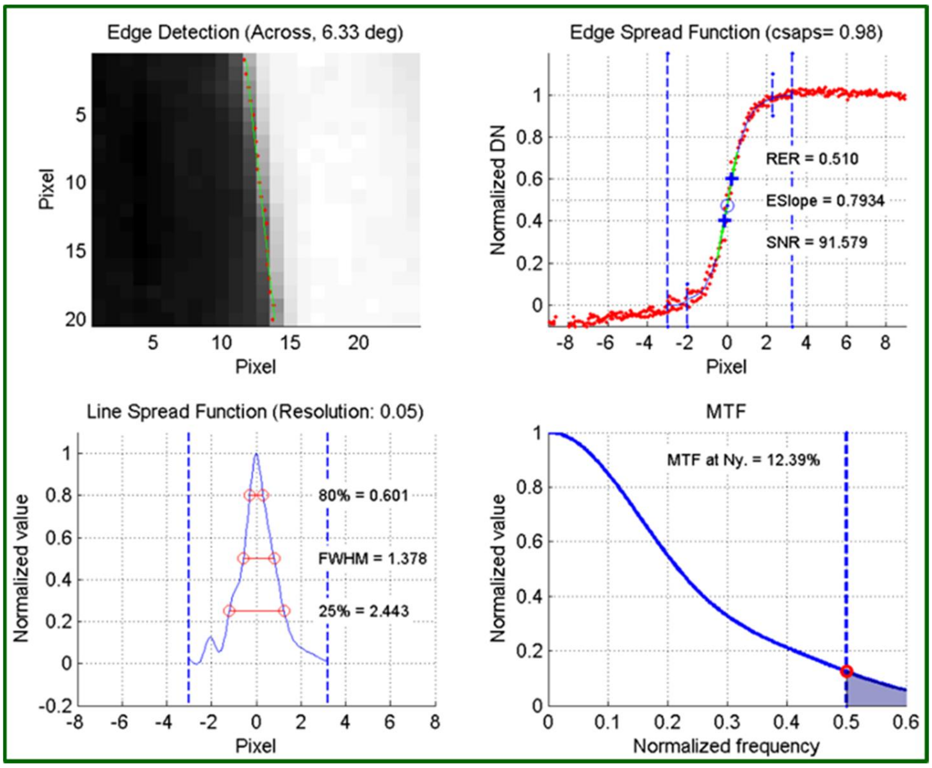

Figure 4. Example of spatial quality on KOMPSAT-3A PAN data

The location accuracy measurement process for KOMPSAT-3A satellite images, is used more accurate data such as PAD (precision attitude data) and POD (precision orbit data) etc. The method used to estimate the absolute location accuracy is based on a KOMPSAT-3A direct geo-referencing modeling of the acquisition and the use of GCPs (ground control points).
Table 3 shows the validated location accuracy according to acquisition modes. Table 3 presents the horizontal accuracy for various image acquisition modes in CE90. The strip mode showed the best accuracy among the acquisition modes with 8.9m(RMSE) and 13.5m(CE90). The one-pass stereo mode showed about one meter larger error range than the strip mode. In the cases of multi and wide-along modes, the accuracy decreased to 13~14m(RMSE) and 20~21m(CE90).

Table 3. Location accuracy of each imaging mode during LEOP

Imaging mode	Location accuracy
Strip	13.5 m
Stereo	14.9 m
Multi	20.9 m
Wide-Along	19.6 m

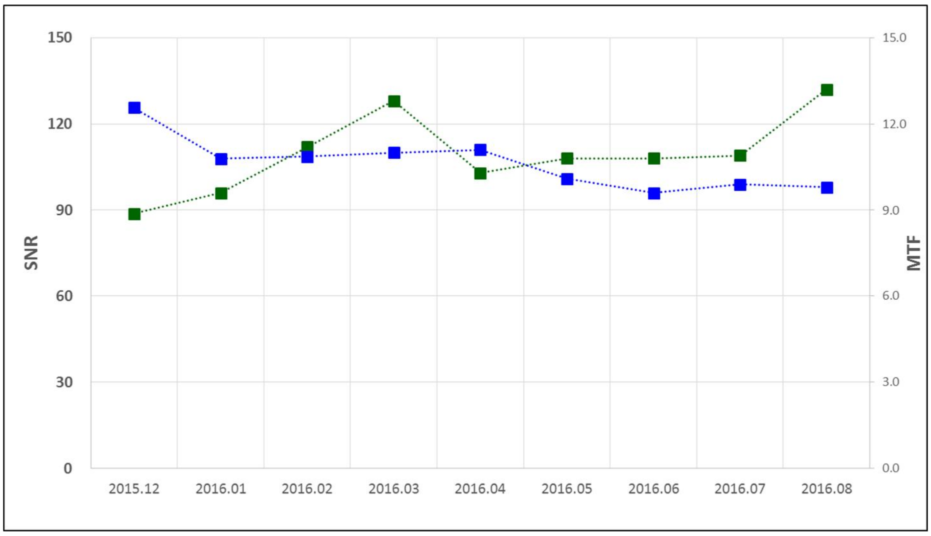

Figure 5. MTF and SNR value during KOMPSAT-3A normal operation

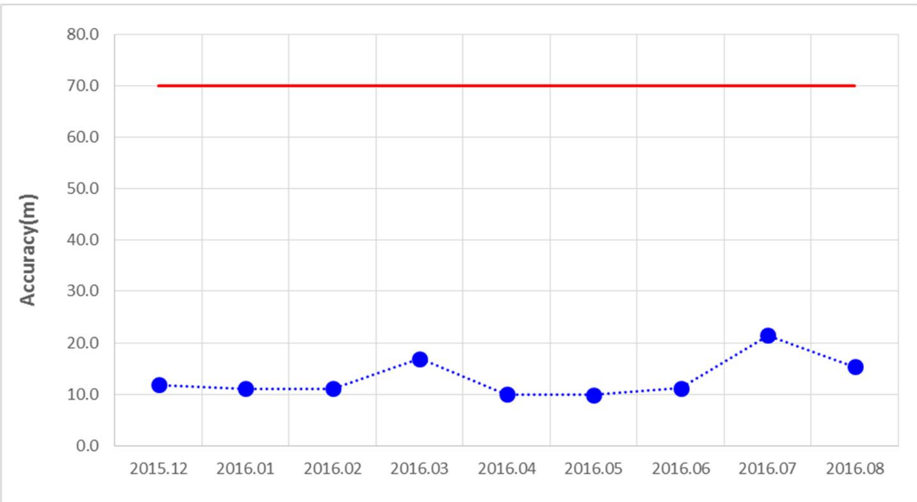

Figure 6. Location accuracy during KOMPSAT-3A normal operation

5. CONCLUSION

We presented the KOMPSAT-3A system architecture, data pre-processing system of IRPE (Image Reception & Processing Element), KOMPAST-3A product and quality performance of each radiometric, spatial and geometric parameters of LEOP result and normal phase.

References

1. Kornus, W.; Lehner, M.; Schroeder, M. Geometric In-flight Calibration by Block Adjustment Using MOMS-2P Imagery of the Three Intersecting Stereo-strips. ISPRS joint workshop "Sensors and Mapping from Space 1999", Hanover, Germany, 27-30 September 1999.
2. Jacobsen, K. High-Resolution Imaging Satellite Systems. 3D-Remote Sensing Workshop, Porto, Portugal, 6-11 June 2005.
3. Toutin, Th.; Blondel, E.; Rother, K.; Mietke, S. In-flight Calibration of SPOT5 and Formosat2, ISPRS Commission I Symposium on From Sensors to Imagery, Paris, France, 04-06 May 2006.
4. Kubik, P.; Lebegue, L.; Fourest, S.; Delvit, J.M.; de Lussy, F.; Greslou, D.; Blanchet, G. First In-flight Results of Pleiades 1A Innovative Methods for Optical Calibration. Proc. Int. Conf. Space Opt, Ajaccio, Corse, 9-12 October 2012, pp.1-9.
5. Chen, Y.; Xie, Z.; Qui, Z.; Zhang, Q.; Hu, Z. Calibration and validation of ZY-3 optical sensors, IEEE T GEOSCI REMOTE 2015, Vol. 53, No. 8, pp.4616-4626, DOI: 10.1109/TGRS.2015.2403957.
6. Seo, D.C.; Hong, G.B.; Jin, C.G. Kompsat-3A Direct Georeferencing Mode and Geometric Calibration/validation, Asian Conference on Remote Sensing, Quezon City, Manila, Philippines, 19-23 October 2015.
7. Seo, D.C.; Lee, C.N.; Oh, J.H. Merge of sub-images from two PAN CCD lines of Kompsat-3 AEISS, KSCE J CIV ENG 2016, Vol. 20, No. 2, pp. 863-872, DOI: 10.1007/s12205-015-0124-7.