REQUIREMENT AND INITIALIZATION OF KOMPSAT-5 CALIBRATION AND VALIDATION

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ABSTRACT:

KOMPSAT-5 that will be launched at the end of 2008 has a SAR (Synthetic Aperture Radar) payload. Since the Calibration and Validation of a satellite SAR is different from a passive optical camera as KOMPSAT-2 MSC and KOMPSAT-3 payload, we have started from the basis of SAR system. Firstly, the general SAR Cal/Val parameters have been gathered and defined. Secondly, we have been choosing the Cal/Val parameters suitable to KOMPSAT-5. Thirdly, the methods of SAR Cal/Val with the parameters have been studied. Fourthly, the requirement of Cal/Val devices and Cal/Val site has been studied.

KEY WORDS: KOMPSAT-5, Calibration, Validation, SAR, Satellite

1. INTRODUCTION

The Calibration and the Validation for KOMPSAT-5 SAR data has been prepared by KARI one by one so far and so on, and the Cal/Val activities for KOMPSAT-5 will be carrying up for 4-5 months from KOMSPAT-5 launch to first release of SAR data to Users. Because KARI has designed and developed the KOMPSAT-5, KARI has a responsibility for the Cal/Val of KOMPSAT-5. Although KARI Cal/Val team fortunately has an experience for the Cal/Val of KOMPSAT-2, the Cal/Val of KOMPSAT-5 SAR is so different from the one of KOMPSAT-2 MSC by a parameter, a method, site and device for Cal/Val. So, we have to start from the basis of SAR system.

Firstly, we has gathered and defined the general SAR Cal/Val parameters for KOMPSAT-5. Next, the method, site and device of KOMPSAT-5 Cal/Val have been studied.

2. KOMPSAT-5 CAL/VAL OVERVIEW

- Main Goal for Cal/Val
  - to get the best SAR image data quality

- One of the main processes to be established is the Calibration of the instrument.
  - to reduce to the maximum extent any deviation from the nominal conditions of any parameter which affect the SAR performance
  - to know and reduce any deviation to a residual value inside the accuracy limits defined in the design phase of the instrument and consequently to allow a re-assessment of performance

- Three basic processes
  - ***On-ground Characterization***, whose objective is to define the accuracy and the knowledge of parameters of the instrument;
  - ***In-Orbit Commissioning***, whose objective is to define the actual performance of the in-flight instrument;
  - ***Routine (Periodical) Calibration***, whose objective is to maintain any deviation from nominal values of the instrument within a residual limit;

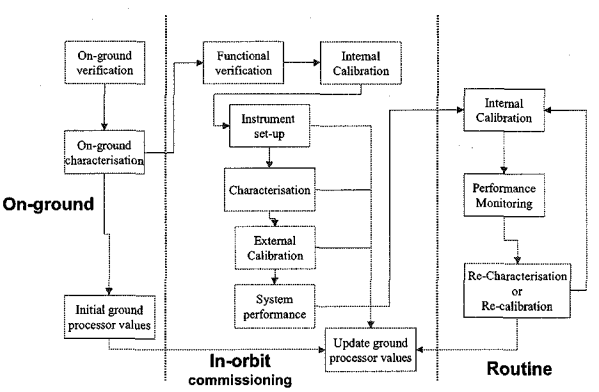

Figure 1. Cal/Val basic process

- On-ground characterization
  - to be exercised directly during the verification phase of the instrument in the laboratory

- Internal Calibration

- the Tx and Rx chains quality (amplitude and phase) is monitored throughout time periods ranging from a pulse repetition interval to the lifetime of the instrument.

- External Calibration
  - using on-ground dedicated facilities
  - proper signals are transmitted from the instrument to the on-ground facilities and can be acquired from those or can be reflected back to the instrument itself
  - to ensure the control over any derivation of the antenna beam patterns and an assessment of the impulse response function (IRF)
  - on-ground facilities have to make use of targets of known radar cross-section (i.e. accurate) properly arranged along the access area of the instrument
  - man-made artifacts (corner reflector) or natural ones (Amazon Rain-tropical Forest)

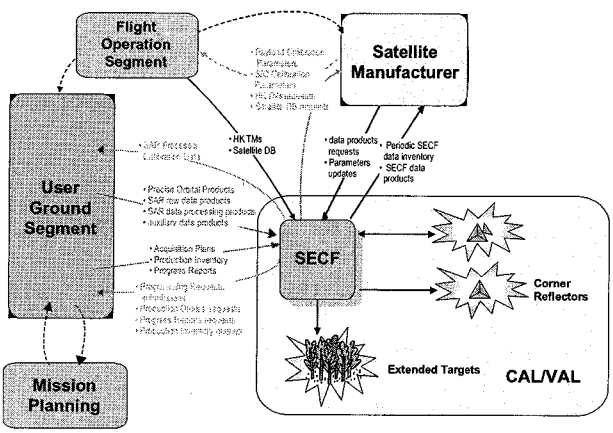

Figure 2. Cal/Val Process

3. CAL/VAL PARAMETERS

3.1 Classification

- Cal/Val Purpose
  - Sensor parameters: Fundamental performance of Satellite system
    - ✓ Parameters for K5 & SAR initializing (with command)
    - ✓ Parameters for improvement of K5 & SAR performance
    - ✓ Parameters that are only validated
  - Product parameters: FOR End user

- SAR system has 3 Cal/Val groups (TBR)
  - Radiometric, Geolocation, Pointing

3.2 Candidates

- Main SAR system parameters (image quality)
  - SAR System Gain
  - SAR Antenna Beam Pattern
- Internal Cal. (using on-board technique)
  - Output RF Power
  - Receiver Sensitivity
  - Noise measurement, Replica pulse measurement, Calibration pulse measurement, Gain of Electronic

- External Cal. (using on-ground equipment)
  - Absolute calibration for one scattering cross section at several locations across the swath
  - Relative calibration across the swath by interpolation between absolute calibration points

- End-to-end *SAR System gain or SAR System noise equivalent* (with accuracy 1 dB), needed for image quality assessment and SNR measurement
- *Main lobe antenna pattern* in the elevation and azimuth cut (with accuracy 0.5 dB), needed for radiometric image correction
- *Side lobe antenna pattern* levels in the elevation and azimuth cut (with accuracy 2 dB), needed for ambiguity assessment
- *Antenna pointing accuracy* (with accuracy 0.050)
- *SAR Impulse response function* measurement
- *SAR Image geometric distortion*
- Others
  - UTC (GPS time) & OBT & SAR time Sync
  - POD
  - Linearity - Radiometric Transmitter & Receiver
  - Yaw Steering
- *Resolution* (3dB width) in Azimuth and Range (Spot)
  - An array of three corner reflectors with RCS of 27 dBsm
- *Maximum Range*
  - In order to verify that the system is able to operate at long ranges, the noise equivalent σ_0 will be measured.
  - three corner reflectors with RCS of 27 dBsm
- *Image Pointing Accuracy* (Spot) – CR
- *Imaging Time*
- *Absolute Radiometric Calibration*
  - The calibration constant K_{abs} and hence the transfer function, which converts measured signal power into calibrated normalized RCS.

4. DEVICE

- SAR Cal/Val Equipment
  - Corner Reflector
  - Transponder & Ground Receiver
  - Others: Tone Generator, etc.
  - Cal/Val S/W

4.1 Corner reflector

- Triangular Trihedral Corner Reflector
- RSC of CR must be, at least, 20 dB more than the total power scattered from the SAR resolution cell.

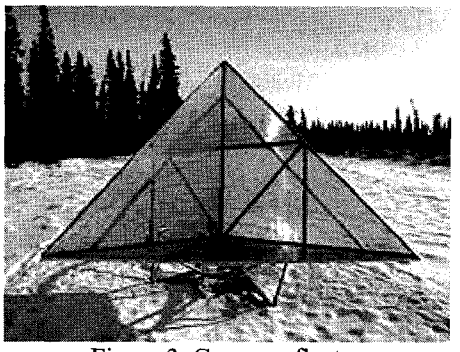

Figure 3. Corner reflector

4.2 Active transponder

- To perform Antenna pattern measurement, Transponder and its Ground receiver is used.
  - SAR Antenna must be pointed to the Transponder.
  - In Strip SAR imaging mode
  - Ground Receiver records the entire trace of SAR signals, which defines azimuth pattern.

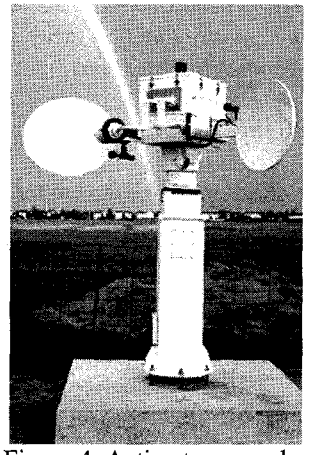

Figure 4. Active transponder

4.3 Deployment

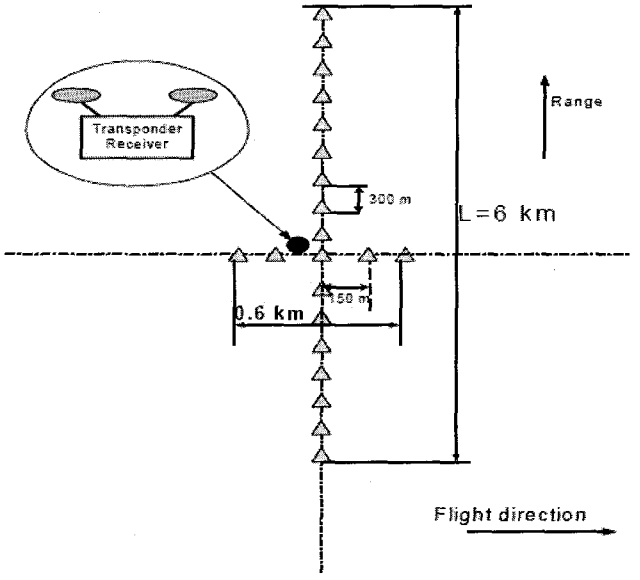

Figure 5. Cal/Val device deployment

- Accurate image correction – antenna pattern calibration - can be performed if the CR site in range has the same size as the image (5km). In azimuth direction it can be 10 times less.

5. SITE

5.1 Requirement

- Size of Cal/Val Site
  - Size requirement
  - Availability
- Technical requirement
  - Scattering
  - Relief
- K5 Orbit
  - Ascending Pass
  - Descending Pass
- Accessment

- SAR Cal/Val Site Requirement
  - Large area for measuring the SAR Antenna Pattern
    - ✓ Standard mode (Strip): 30km
    - ✓ Spot mode (High resolution)
    - ✓ Scan mode (Wide)
  - Area for getting the High Power Output (for X-band)
    - ✓ Uniform Reflection
  - 'Relief' is almost '0'
  - Deployment of Corner Reflector
  - Deployment of Transponder & Ground receiver
  - Adaptation of K5 Orbit

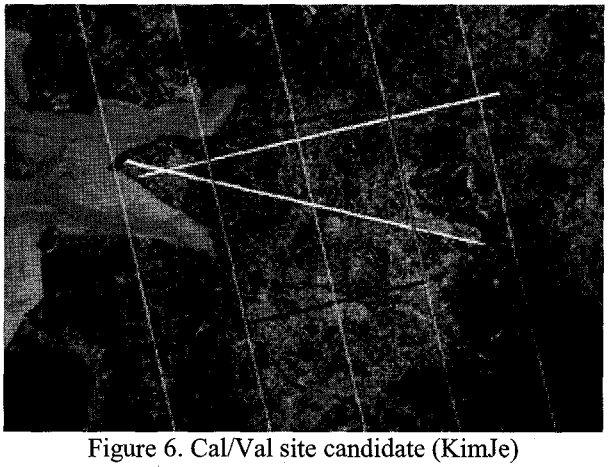

Figure 6. Cal/Val site candidate (KimJe)

6. FUTURE WORK

Although the KOMPSAT-2 Cal/Val activity has been working until the end of this year, KARI Cal/Val team has to do the preparation of the KOMPSAT-5 Cal/Val simultaneously. Firstly, the preliminary KOMPSAT-5 Cal/Val parameters will be defined by the end of this year.

Secondly, the KOMPSAT-5 Cal/Val device will start to be designed and developed with a manufacturer. Thirdly, the candidate of KOMPSAT-5 Cal/Val site will be selected by the end of this year. Additionally, KARI Cal/Val team will design and develop the S/W for the KOMPSAT-5 Cal/Val with the contractor of the KOMPSAT-5 SAR payload.

7. REFERENCE

Lee, D. H., etc., 2006. *Calibration and Validation Element*. KOPMSAT-5 SDR Package

Alcatel-Alenia Space, 2005, Cal/Val Notes