Calibration and Validation for KOMPSAT in KARI

September 30, 2009

Korea Aerospace Research Institute
Satellite Information Research Institute
Introduction to KARI

- Government Funded Space Research Institute
  - Established in 1989 by the government based on the special law
  - KARI with its 800 engineers/scientists plays the central role in the space development in Korea
Introduction to KARI

KARI

SIRI

Satellite

Aerospace

Rocket

Cal/Val

Develop Receiving & Processing system

Receiving Processing

Application & User support

Control KOMPSAT

Me

DevelopingReceiving & Processing system

Receiving Processing

Application & User support

Control KOMPSAT

Me
# Space Program in KARI

<table>
<thead>
<tr>
<th>KOMPSAT-1</th>
<th>KOMPSAT-2</th>
<th>KOMPSAT-3</th>
<th>KOMPSAT-5</th>
<th>COMS</th>
<th>KOMPSAT-3A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload</td>
<td>EOC, OSMI</td>
<td>MSC</td>
<td>AEISS</td>
<td>COSI</td>
<td>MI, GOCI</td>
</tr>
<tr>
<td></td>
<td>Visual</td>
<td>Visual</td>
<td>Visual</td>
<td>SAR-X</td>
<td>Meteorology</td>
</tr>
<tr>
<td>Performance</td>
<td>6.6m (EOC)</td>
<td>1m, 4m 10bit</td>
<td>0.7m, 2.4m 14bit</td>
<td>1m, 3m X-band</td>
<td>500m</td>
</tr>
<tr>
<td>Image mode</td>
<td>Strip</td>
<td>Strip</td>
<td>Spot, Strip, Wide</td>
<td>Spot, Strip, Wide</td>
<td>Spot, Strip, Wide</td>
</tr>
<tr>
<td>Swath</td>
<td>15km</td>
<td>15km</td>
<td>15km</td>
<td>15km</td>
<td>2,500km</td>
</tr>
<tr>
<td>Orbit</td>
<td>Geo-sync</td>
<td>Geo-sync</td>
<td>Geo-sync</td>
<td>Geo-sync</td>
<td>Geo-Station</td>
</tr>
</tbody>
</table>

KOMPSAT-6 (SAR) & 7 (Visual) will be developed by KARI after KOMPSAT-5 & 3
KARI & SIRI until 2009

- ISO19115 XML Schema by KARI
- Web service by KARI (EoDB)
- KOMPSAT-1 (EOC, OSMI)
- MODIS
- EoPortal (EOLI)
- ASEAN+3 DB system
- Sentinel ASIA DB system

http://eodb.kari.re.kr
KARI & SIRI until 2009

RPC + NITF + DIMAP
Web service - Space Capture 2

http://www.spacecapture.kr

KOMPSAT-2 (MSC)

SPOT Images Inc.
UAE, Taiwan
KAI Images Inc.
KARI & SIRI from 2009

- KOMPSAT-5 from 2010
- KOMPSAT-3 from 2011

KOMPSAT-3
AEISS

KOMPSAT-5
COSI

Cal/Val by KARI
Mongolian Cal. site with NRSC
AU Cal. site with CSIRO (TBD)
International Standardization in KARI

- International Standardization Activities for Remote Sensing Satellite image data & Cal/Val
  - ISO19115 – Metadata (QA4EO-QAEO-GEN-DPK-002)
  - ISO19130 – Sensor and data models for imagery and gridded data
  - ISO19138 – Data quality measures
  - CEOS WGCV & ISPRS Commission
    - International Workshop on Radiometric and Geometric Calibration at Gulport, 2003

- In KARI
  - Has developed the XML Schema for ISO19115 by KARI
    - KOMPSAT-1 EOC, OSMI & MODIS data has already been serviced with ISO19115 in Web.
  - NITF for Remote sensing satellite image data
    - has already been serviced from KOMPSAT-2 MSC image data.
  - DIMAP(XML) for SPOT image inc.
    - has already been serviced from KOMPSAT-2 MSC image data.
  - NIIRS
    - Has been developed to get the NIIRS value from KOMPSAT-3 image data automatically.
    - KOMPSAT-3 AEISS image data = NIIRS 6
Image data Quality for Users in KARI

- Image data Quality for Users
  - There is a technical gap between the requirement for manufacturing the satellite and the requirement for the image data quality for Users.
  - Need & Define the quantitative value for the image data quality for Users
    - Almost Users have a eye without the concept of the quantitative image data quality~!
    - Spatial: GSD, MTF
    - Radiometric: Radiometric resolution, Noise (SNR), Absolute radiometric Cal.
    - Geometric: Pointing, Geo-location, Planimetric accuracy, Registration

- KARI has plans of..
  - Periodic Cal/Val of KOMPSAT
  - Workshop, Conference, Seminar
  - Beta User group
Calibration & Validation in KARI

- If no Cal/Val, NO guarantee the basic requirement of a Satellite.
- If basic Cal/Val, you can guarantee the ONLY basic requirement of the Satellite.
- If Cal/Val, you can get the full compliance of the satellite image data quality for Users.

- A Space agency (KARI) that is just developing a Satellite
  - MUST validate and verify the satellite and the satellite image data.
  - MUST calibrate the satellite and satellite image data.
  - MUST show up the status of the satellite image data for Users

- A Space agency (KARI) that is just developing a Satellite
  - MUST guarantee the Satellite image data quality for Users

- Impossible ‘Full(Real)’ test before Launch
  - After Launch, the final status of satellite will be known.

- Only manufacturing satellite cannot get the image quality for the User
  - Cal/Val will fill up the gap between them
Calibration & Validation in KARI

- Cal/Val Requirements
  - Requirements in KOMPSAT System Specification
  - Requirements from Users

- Work Scope
  - Characterization & Calibration & Validation & Image data Restoration
    - Cal/Val work scope in KARI
  - Image Enhancement
    - User’s work scope

- Activities
  - Before KOMPSAT Launch
  - After KOMPSAT Launch (during LEOP)
  - In normal operation
-31(p2)-40(p4) pixels remove
-2 pixels added
X-man (?) in KOMPSAT-2

1. Magnification difference between CCD1 and CCD2
2. Move CCD2 to Right and Up

CCD1(P2)  CCD2(P4)

CCD2

4 3

CCD1

1 2

CCD3

5 6
MTF Compensation in KOMPSAT-2

Origin

MTF C. With 13

MTF C. With 7

SNR = 35.447

SNR = 33.551

SNR = 55.951

QA4EO
Sep. 30, 2009

Korea Aerospace Research Institute (KARI)
Satellite Information Research Institute (SIRI)
# Cal/Val Targets and Equipments

<table>
<thead>
<tr>
<th>Target</th>
<th>Cal/Val Parameter</th>
<th>Site</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siemens (TBD)</td>
<td>MTF</td>
<td>Korea</td>
<td>Ready</td>
</tr>
<tr>
<td>Edge</td>
<td>MTF, PSF, Absolute radiometric Cal.</td>
<td>Mongol</td>
<td>2010</td>
</tr>
<tr>
<td>Simul target</td>
<td>MTF, PSF, GCP, GSD</td>
<td>Portable</td>
<td>Ready</td>
</tr>
<tr>
<td>Night Lamp</td>
<td>MTF, PSF</td>
<td>Portable</td>
<td>Ready</td>
</tr>
<tr>
<td>Tarp</td>
<td>MTF, PSF, Radiometric</td>
<td>Portable</td>
<td>Ready</td>
</tr>
<tr>
<td>GCP DB, MAP data</td>
<td>Interior Orientation, Geo-accuracy, KPADS, AOCS, Planimetric, Registration</td>
<td>Korea, Mongol, Worldwide</td>
<td>2005 ~ 2010</td>
</tr>
<tr>
<td>DSM</td>
<td>Planimetric, Registration</td>
<td>Korea</td>
<td>2009 ~ 2010</td>
</tr>
<tr>
<td>Radiometric equipments</td>
<td>Spectrometer, Sky-radiometer, etc.</td>
<td></td>
<td>Ready</td>
</tr>
<tr>
<td>Geometric equipments</td>
<td>Total station, DGPS Receiver</td>
<td></td>
<td>Ready</td>
</tr>
<tr>
<td>S/W</td>
<td>Imatest, ENVI, ERDAS, Matlab, Modtran, Visual studio, Algorithm, etc.</td>
<td></td>
<td>Ready, 2009 ~ 2010</td>
</tr>
</tbody>
</table>
Cal/Val Targets and Equipments

3.5%  23%  35%  53%
# KOMPSAT Cal. site in Mongolia

<table>
<thead>
<tr>
<th>Items</th>
<th>Target Type</th>
<th>Specification</th>
<th>Requirement</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial</td>
<td>Concrete square</td>
<td>120m x 120m</td>
<td>Concrete basis and Painting on Black part</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Night lamp</td>
<td>1kw (6~9EA)</td>
<td>On ground</td>
<td></td>
</tr>
<tr>
<td>Radiometric</td>
<td>Tarp</td>
<td>20m x 20m per</td>
<td>4 gray level with fixed reflectance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grass field</td>
<td>40m x 40m</td>
<td>Spectroradiometer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Desert</td>
<td>40m x 40m</td>
<td>Spectroradiometer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bare land (soil)</td>
<td>40m x 40m</td>
<td>Spectroradiometer</td>
<td></td>
</tr>
<tr>
<td>Geometric</td>
<td>Digital Map</td>
<td>Map coverage: 20km x 20km</td>
<td>Map scale: 1/5000 ~ 1/10000 Accuracy&lt;5m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ortho image</td>
<td>Coverage: 20km x 20km</td>
<td>Accuracy&lt;5m, GSD=1m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GCP Target</td>
<td>Diameter=3m</td>
<td>White or Black painting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coverage: 16km x 16km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOMPSAT-5</td>
<td>Corner Reflector</td>
<td>Install</td>
<td>Around 52 CRs</td>
<td>Install with Concrete basis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![120m](image1.png)  

120m
KOMPSAT-5 Corner Reflector in Mongol

ST (45dBm²)

HR (35dBm²)
Mongolia~!
KARI’s Future works

- Standardization of KOMPSAT image data
  - Image data Quality
  - Image data Storage format
  - Communication with Users
  - CEOS WGCV & QA4EO

- Calibration & Validation
  - Share the Cal/Val site, target & activity
    - Mongolian Cal/Val site & targets
    - Korean Cal/Val site & targets
    - Cal/Val activities