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# Calibration, Validation, and Image Data Quality Control for KOMPSAT

September 6, 2016

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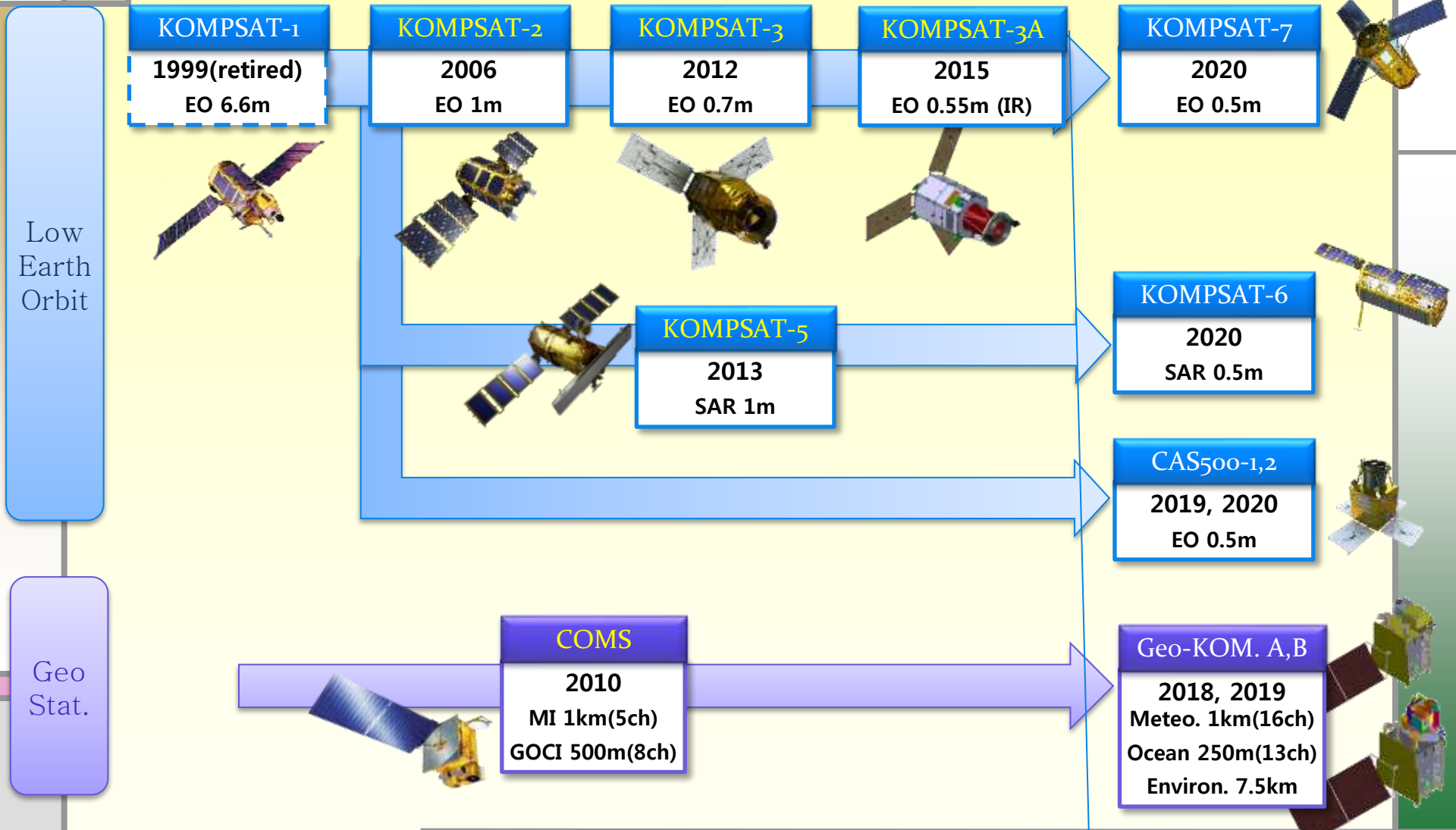
Korea Aerospace Research Institute (KARI)

# Satellite Program in KARI

# Space Program in Korea



# KARI Operating Satellite

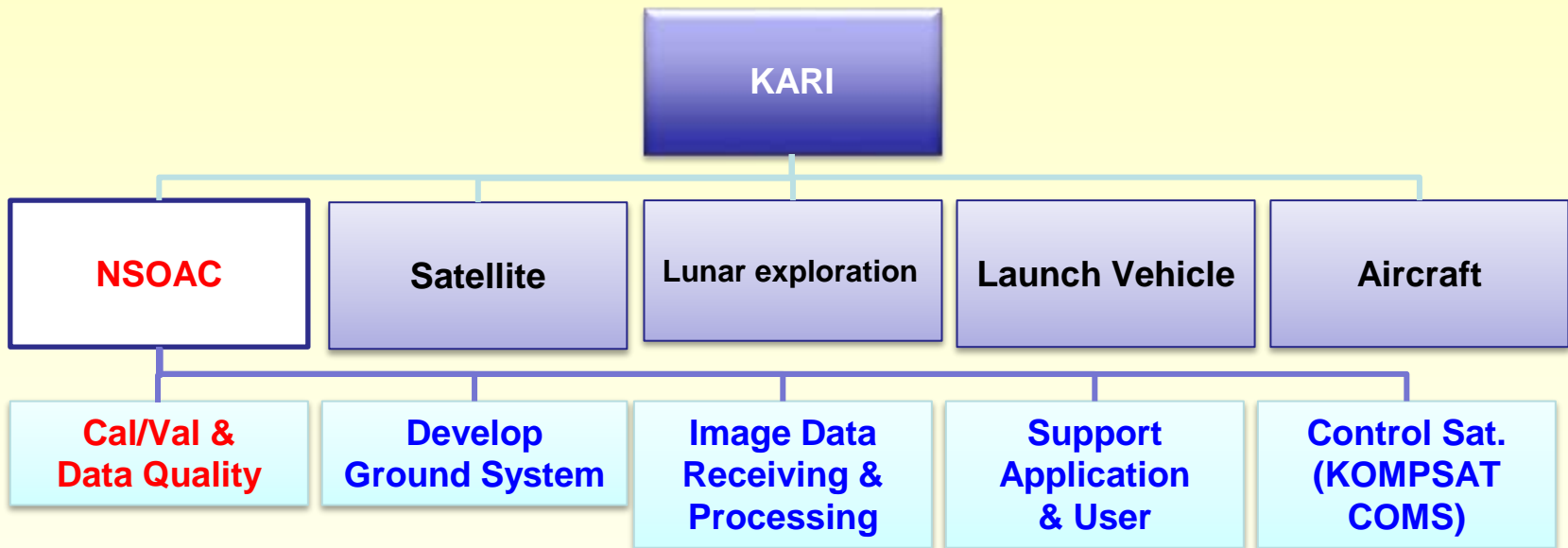


CEOS WGCV-41 (2016)

Korea Aerospace Research Institute (KARI)  
Satellite data Calibration and Validation team (SCV)

# Cal/Val team in KARI

- Calibration/Validation/Evaluation collaboration including information related to Image Data Processing and Quality



- National Satellite Operation and Application Center in KARI (NSOAC)

## Cal/Val team in KARI

### Cal/Val

- Characterization
- Calibration & Validation
- Image data Restoration
- KOMPSAT-2, 3, 3A, 5
- GK2, CAS, KOMPSAT-6, 7
- Cal/Val site: Develop/Monitoring
- Cal/Val S/W, Equip.: Develop
- Abs.Radio.Cal. (3,3A,7,CAS,GK2)
- SAR Processor & Product Processor: Develop

### Image Quality Control

- Image data Quality Monitoring / Improvement
- IQ (Image data Quality)
- QR (Quality Report)
- Image data Quality Enhancement
- Meeting with Users Group
- CEOS WGCV IVOS/SAR

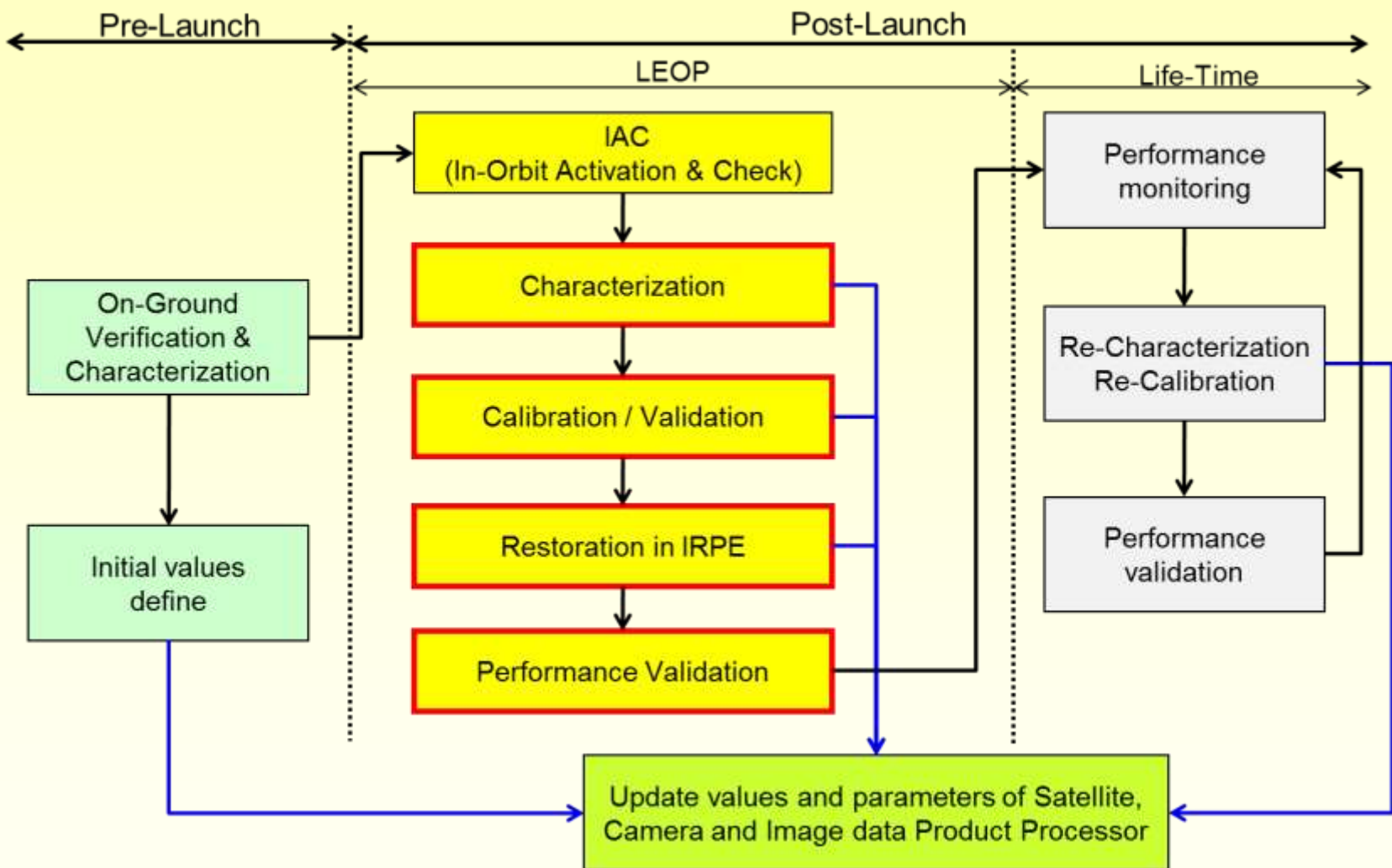
## **Cal/Val Preparation for EO (KOMPSAT-3, 3A, 7, CAS)**

< Cal/Val Preparation for SAR (KOMPSAT-6) >

Please see the next presentation at CEOS WGCV SAR Workshop.

“KOMPSAT-6 Mission and External Calibration System Design” by Dochul Yang

# Cal/Val Work Flow in KARI





# Cal/Val Flow after Launch (EO, IR)

## Characterization

- Dynamic range, PAN selection
- Noise (Random, Periodic, Non-Linearity)
- MTF, SNR, GSD
- Geo-accuracy



## Cal/Val

- Decide TDI Gain, Equalization (Vp, HF NUC)
- OD, POD, AOCS on-orbit Cal.+PAD
- PSF, MTF



## Restoration

- Equalization (LF NUC, Butting zone, Uniformity)
- Reduce Noise, MTFC
- Registration, Planimetric accuracy
- Geo-accuracy with IRPE
- DN to Radiance



## Enhancement

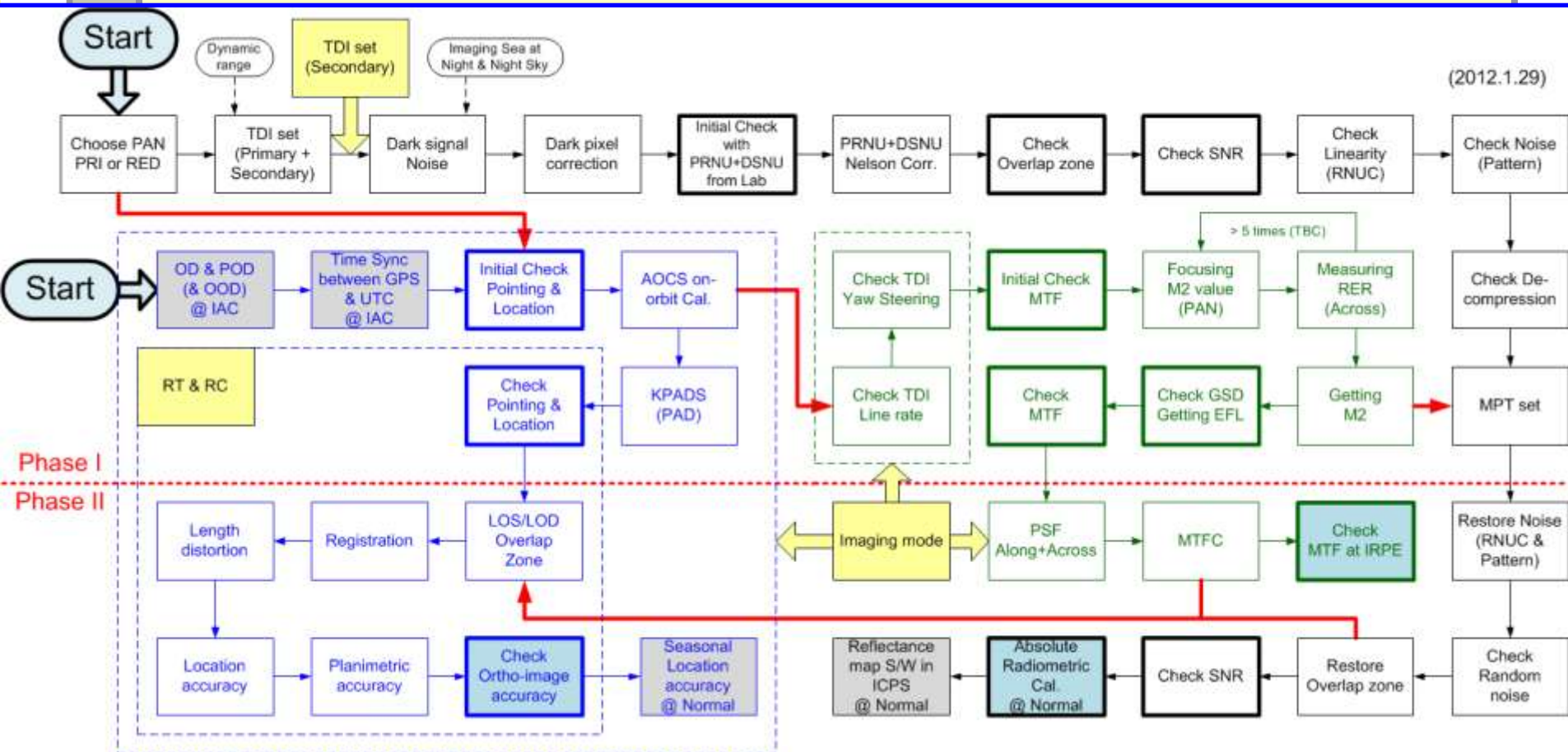
- Linear Stretch
- Fusion (PAN Sharpening)
- User's Application

Satellite  
&  
Sensor

Image data  
Product  
Processor

User

# KOMPSAT-3 Cal/Val work Flow in LEOP Example)



- **Think line box:** Checking K3 Spec. value
- **Blue painted box:** Final Cal/Val work
- **Gray painted box:** @ IAC & @ Normal

- **Black box:** Radiometric Cal/Val
- **Green box:** Spatial Cal/Val
- **Blue box:** Geometric Cal/Val

# KOMPSAT Cal/Val Target, Equipment

Target	Cal/Val Parameter	Site
Night Lamp	MTF, PSF	Portable
Star	MTF, PSF	Night
Tarp	Linearity, Radiometric	Portable
GCP DB	Pointing & Location accuracy KPADS, AOCS, Registration Mapping quality	Korea, Mongol
MAP data	Pointing & Location accuracy KPADS, AOCS, Registration	Korea, Mongol, Worldwide
Radiometric equipment	Spectro-radiometer	Portable
	Sun-photometer	
	Multi-Filter Rotating Shadow band Radiometer Ultraviolet Multi-Filter Radiometer Temperature measurement equipments	
Geometric equipment	GPS instrument	Portable
	Total station	

Target	Cal/Val Parameter	Site
S/W	Imatest (MTF)	Commercial
	ENVI, ERDAS (Remote Sensing S/W)	
	MODTRAN (Atmospheric simulation)	
	STK (Imaging Planning)	
	Matlab, Visual Studio (Developing Tool)	
	Cal/Val SW	Develop
	MTF Measurement SW	Develop
GRDB	Geometric Cal/Val site, Ortho image	Develop
	MS SQL DBMS & Server+RAID	
Radiance Map in Worldwide	Radiance map in Worldwide	Develop
	Radiance prediction S/W for ICPS	

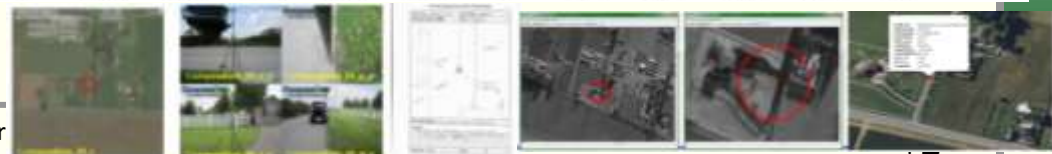
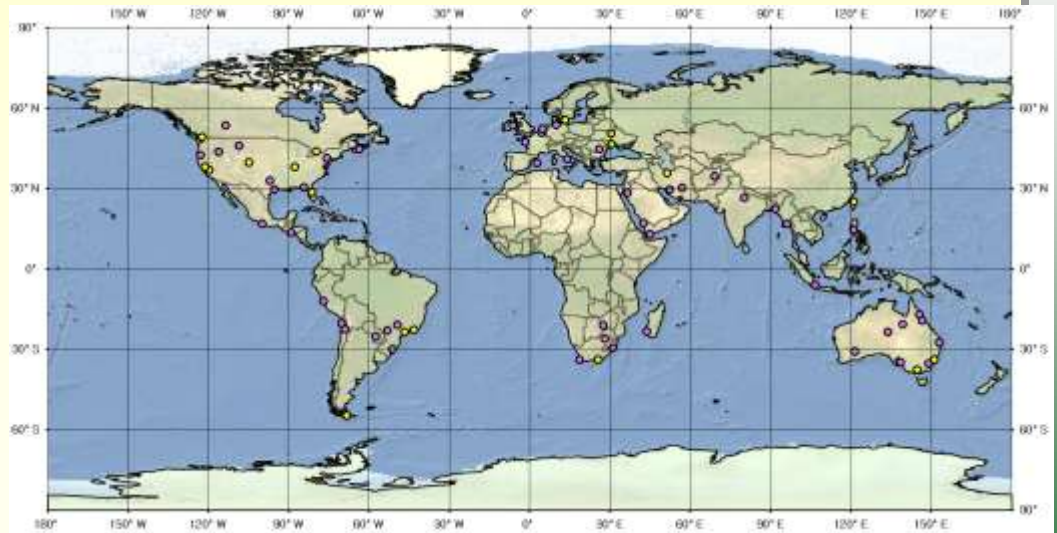
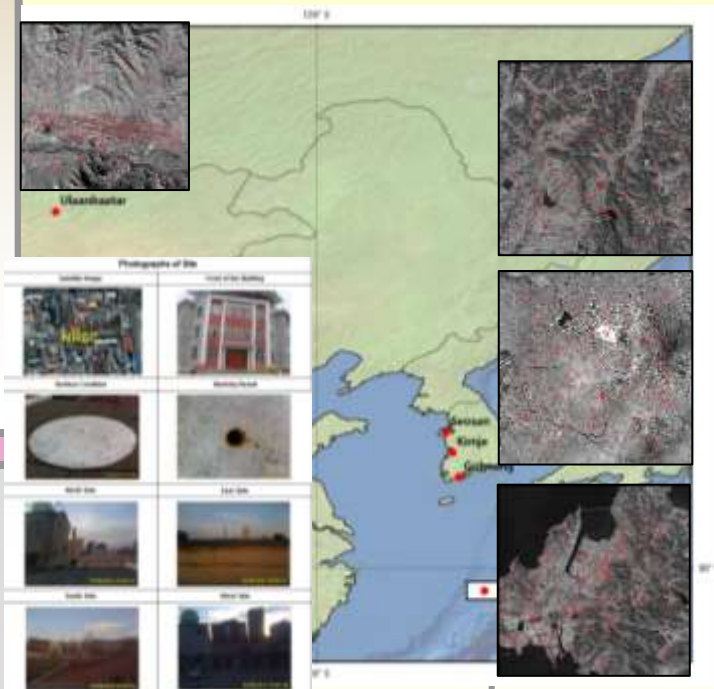


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# Cal/Val site for Geometric

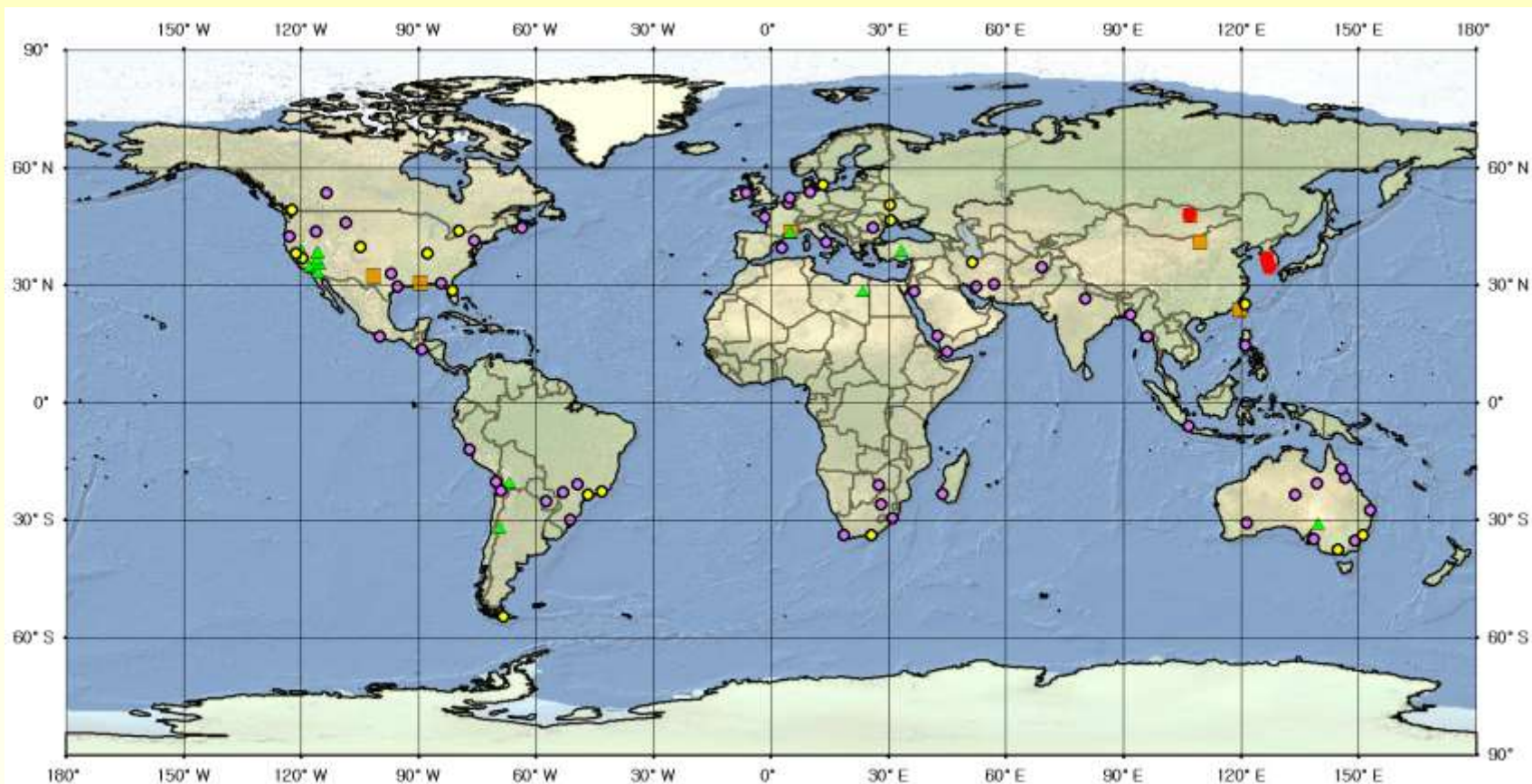
## Geometric Cal/Val Site

- Level 0 site
  - Geometric Calibration : Detector & Band distortion, Alignment, AOCS absolute calibration, Mapping accuracy
  - Accuracy < 3~10cm, Mongolia, GoHeung, KimJe, SeoSan in Korea
- Level 1 site
  - Geometric validation : Location accuracy, Pointing accuracy
  - Accuracy < 5m, Worldwide area : 50 sites



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Satellite data Calibration and validation team (SCV)

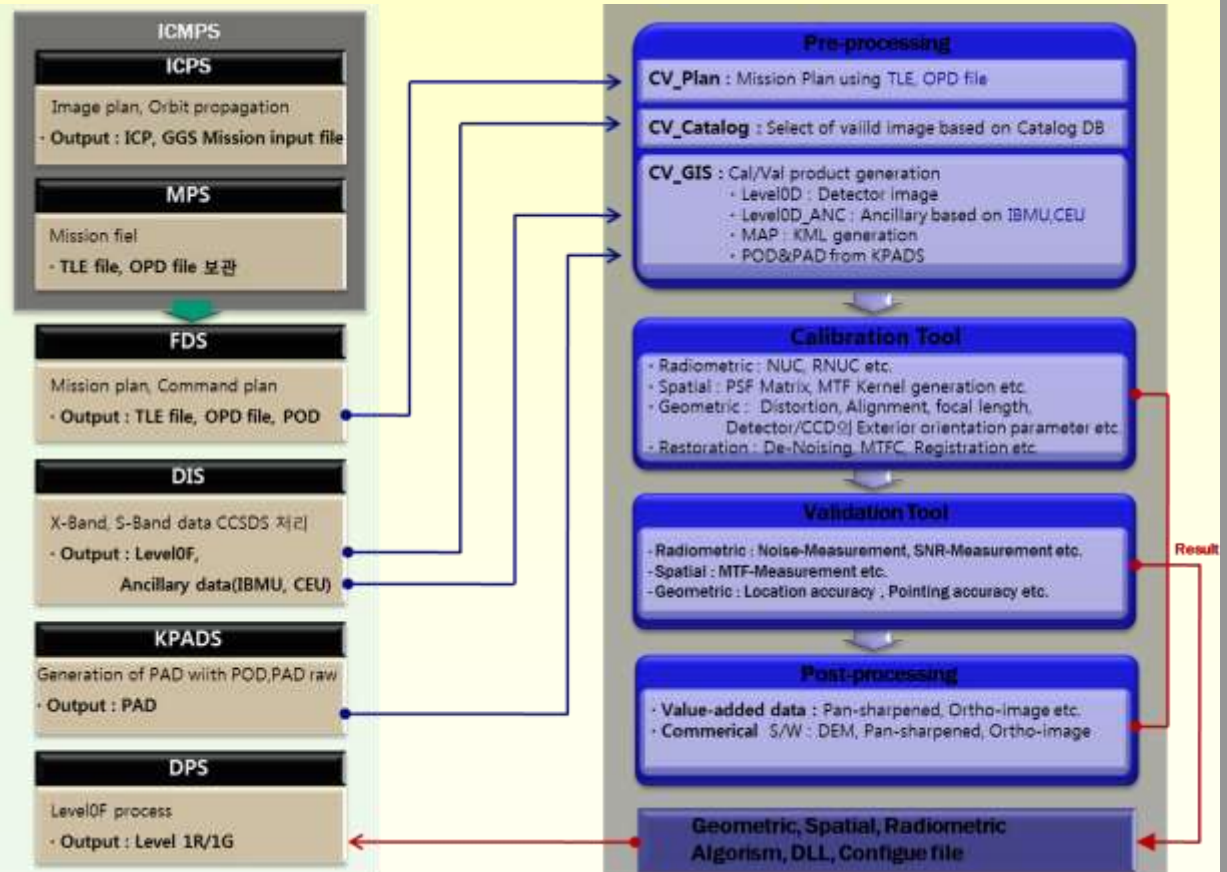
# GRDB (Cal/Val Ground Reference DB)



● ● ● Geometric cal/val site    ▲ Radiometric cal/val site    ■ Spatial cal/val site

# KOMPSAT Cal/Val S/W

- Cal/Val S/W
  - Ground Reference DB
  - Cal/Val Image Plan
  - Data Processing Module
  - Characterization Module
  - Calibration Module
  - Validation Module



# KOMPSAT Cal/Val S/W

## Characterization Module

The screenshot displays the 'Characterization Module' of the KOMPSAT Cal/Val S/W. It features several tool windows:

- CVPS\_SUB\_0010**: A vertical menu of buttons for various checks: Check\_SNR, Check\_Dark Signal, Check\_Dynamic Range (highlighted), Check\_Dead Pixel, Check\_MTF, Check\_FPN, Check\_Uniformity, Check\_All, Check\_Statistics, Check\_Uniformity, and Check\_NUC Table.
- CVPS\_SUB\_0018**: Buttons for Check\_Statistics, Check\_Uniformity, Check\_NUC Table, Generate\_NUC, and Generate\_Scheduler NUC.
- CVPS\_SUB\_0020**: Buttons for Check\_Registration and Check\_PAI-Sharpener.
- CVPS\_SUB\_0030**: Buttons for Check\_Pointing and Check\_Location.
- CVPS\_SUB\_0090**: A button for Check\_Overlap.
- CVPS\_SUB\_0070**: Buttons for Check\_Statistics, Check\_Uniformity, and Check\_NUC Table.
- NUC Checker**: A window showing two tables of data. The top table has columns: '검출구분' (Detection Category), '행번호' (Row No.), '열번호' (Col No.), '값' (Value), '좌표번호 (X, Y, Z)' (Coordinate No. (X, Y, Z)), and '유형' (Type). The bottom table has columns: '검출구분' (Detection Category), '행번호' (Row No.), '열번호' (Col No.), '값' (Value), '좌표번호 (X, Y, Z)' (Coordinate No. (X, Y, Z)), and '유형' (Type).
- Check\_Overlap**: A window for selecting two image paths (Image 01 and Image 02) and executing an overlap check. It includes options for PAN, MS, and BI, and input fields for Col, Row, and other parameters.
- DeadPixel**: A window for checking dead pixels. It includes input fields for 'Min(Dist)' (set to 0) and 'Max(Dist)' (set to 20), and a 'Count(Dist)' field (set to 10).
- Check\_Registration**: A window for checking registration. It includes fields for File Path, PAN, MS B, MS G, MS R, MS H, and Output, each with a 'Select' button.
- BandSharpener**: A window for band sharpening. It includes fields for File Path, PAN, MS B, MS G, MS R, and MS H, each with a 'Select' button, and an 'Execute' button.
- Check\_TSI Check**: A window showing three line graphs representing TSI check results.

# KOMPSAT Cal/Val S/W

## Calibration/Validation Module



# Image Data Quality Control

# Product Quality Checking for Users during Normal period

## QR (Quality Report) for KOMPSAT-3 Image Data

QR No.	QR-K3-20130314-0001									
User No.	SI									
Product ID	K3_20130310175432_04341_19891327_L1R									
S/W Version	PMS. V1.0.130306.001									
Processing Date	2013-03-06				Processed By	KARI, Gil-Dong Hong				
Anomalies Image	Band (☉- Level 2, ●- Level 3)					Constraint (TBR)			Check	Comments
	MS				PAN	Level 1	Level 2	Level 3		
	B	G	R	N						
Dynamic range						> 1000	500-1000	< 500		
Saturation						< 1%	1-2%	> 2%		
Abnormal Pixel (except Blooming)						~2	3~10	> 10		
Equalization: inter-Detector (NUC)						20DN	20~50DN	> 50DN		
Pattern noise	diagonal, horizontal, vertical, First pixel					none	isolated noise	recurrent noise		
	Center Pattern					none	isolated noise	recurrent noise		
	Pixel burst (Port difference)					20DN	20~50DN	> 50DN		
Compression noise						none	isolated blocks	recurrent blocks		
Registration (MS-MS)						< 0.5	0.5-0.75	> 0.75		
Registration (MS-PAN)						< 0.5	0.5-0.75	> 0.75		
Location accuracy						< 70m	70-150m	> 150m		
Comments / Image chip										
Review Date					Reviewed By					
Review Comments										

❖ QR (Quality Report) is the Internal report in KARI to monitor the KOMPSAT-3 Product (Image data) Quality.

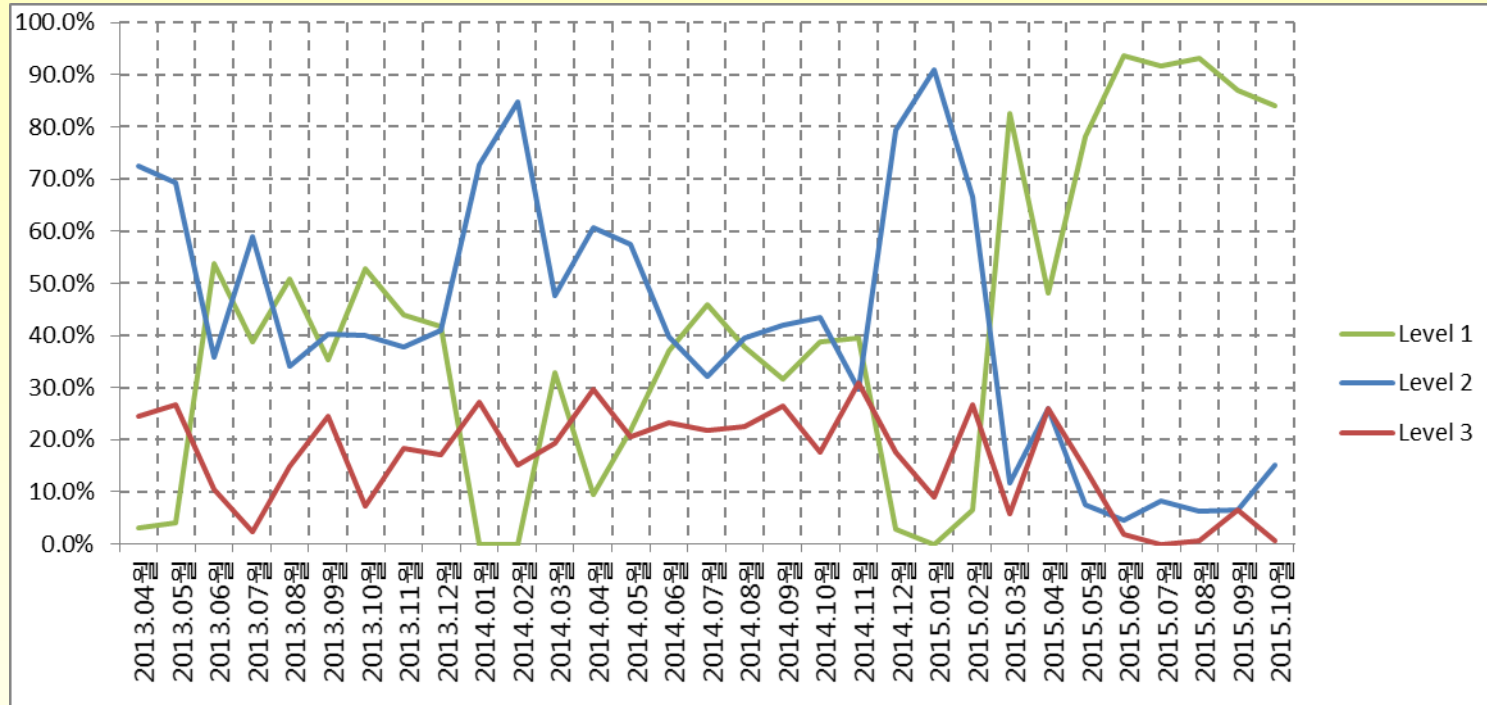
Isolated & Recurrent (TBR)

	Isolated	Recurrent
Number	2~4	>= 5
Area of 1 part	100x100	100x100
DN difference	20~50 DN	> 50 DN

Level 1: Accepted  
Level 2: To be Proposed  
Level 3: Rejected

⊗ Cloud, Water, Snow area: to be take off for constraints: saturation, compression, NUC and pattern noise

# Monitoring of KOMPSAT-3 Product Quality



- Reducing the Noise from Feb. 2015 after applying the additional Cal/Val
- But, Compression noise is still high.
  - ✓ Because User(reseller) can choose the Compression ratio and still use '5.5' for MS image data.

# Enhancement: K3 Digital Zooming

KOMPSAT-3  
(70cm)



KOMPSAT-3  
(50cm)

70cm



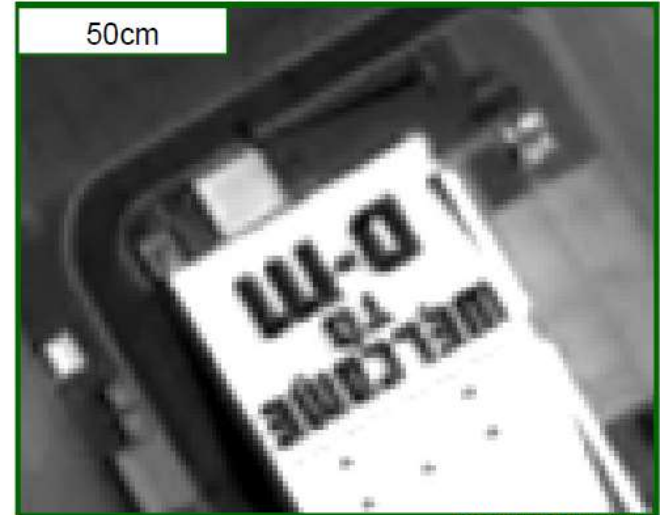
70cm



50cm



50cm



# KARI in CEOS WGCV

- CEOS WGCV IVOS #22, #23, QA4EO 2009
- CEOS WGCV IVOS #26, 2014.06.04~06, CalTech, Pasadena in California (4 presentations)
- CEOS WGCV #38, 2014.09.30~10.3, NOAA, College Park in Maryland (2 presentations)
- CEOS WGCV IVOS #27, 2015.11.18~20, ONERA, France (2 presentations)
- CEOS WGCV SAR Workshop 2015, 2015.10.27~29, Geneva, Swiss, (1 presentation)

WGCV #38



IVOS #27