Landsat Data Continuity Mission On-orbit Calibration and Validation Development

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U.S. Geological Survey

Outline

- Overview of Government Calibration and Validation Team
- Overview of Ground System
- Development of Cal/Val tools
- Current Status

Government Calibration and Validation Team (CVT)

- Made up of both NASA GSFC and USGS EROS personnel

- Lead by NASA prior to commissioning
  - Pre-launch calibration

- On-orbit operations turned over to USGS
  - Continued monitoring throughout mission life
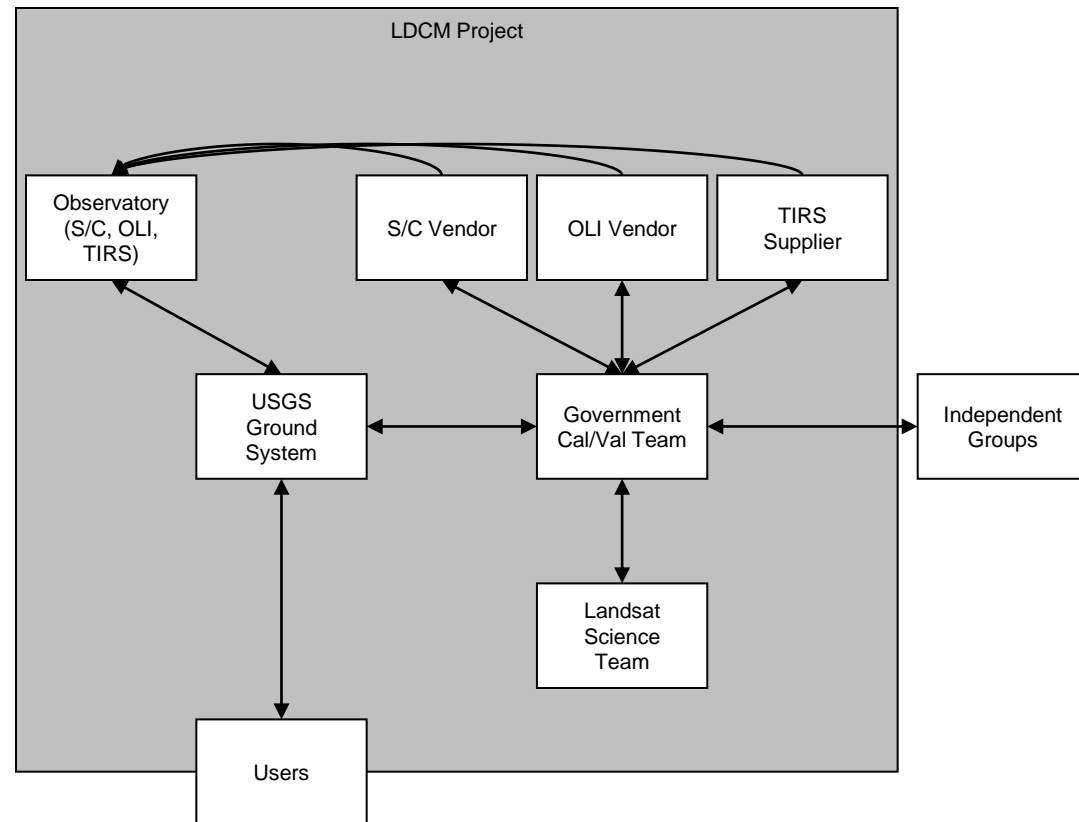
Calibration and Validation Functions

- Oversight and coordination of Cal/Val activities
  - Covers portions of ground system, spacecraft, instruments and other external entities

- Algorithm development
  - Review instrument provider algorithms
  - Deliver algorithms to ground system developers
  - Data processing, characterization and calibration
  - OLI and TIRS data simulators

Calibration and Validation Functions

- Instrument performance characterization
  - Pre-launch, on-orbit checkout and on-orbit operations
  - Supports instrument acceptance

- Calibration parameter determination & validation
  - Pre-commissioning validation of vendor provided parameters
  - Validated parameters ensure quality products
  - Determine parameters during operations

- Independent calibration verification and calibration continuity
  - Ensures traceability and continuity with historical products

- Product performance characterization
  - Reports for science and user community

- Anomaly resolution
  - Includes anomalies in product generation and image assessment
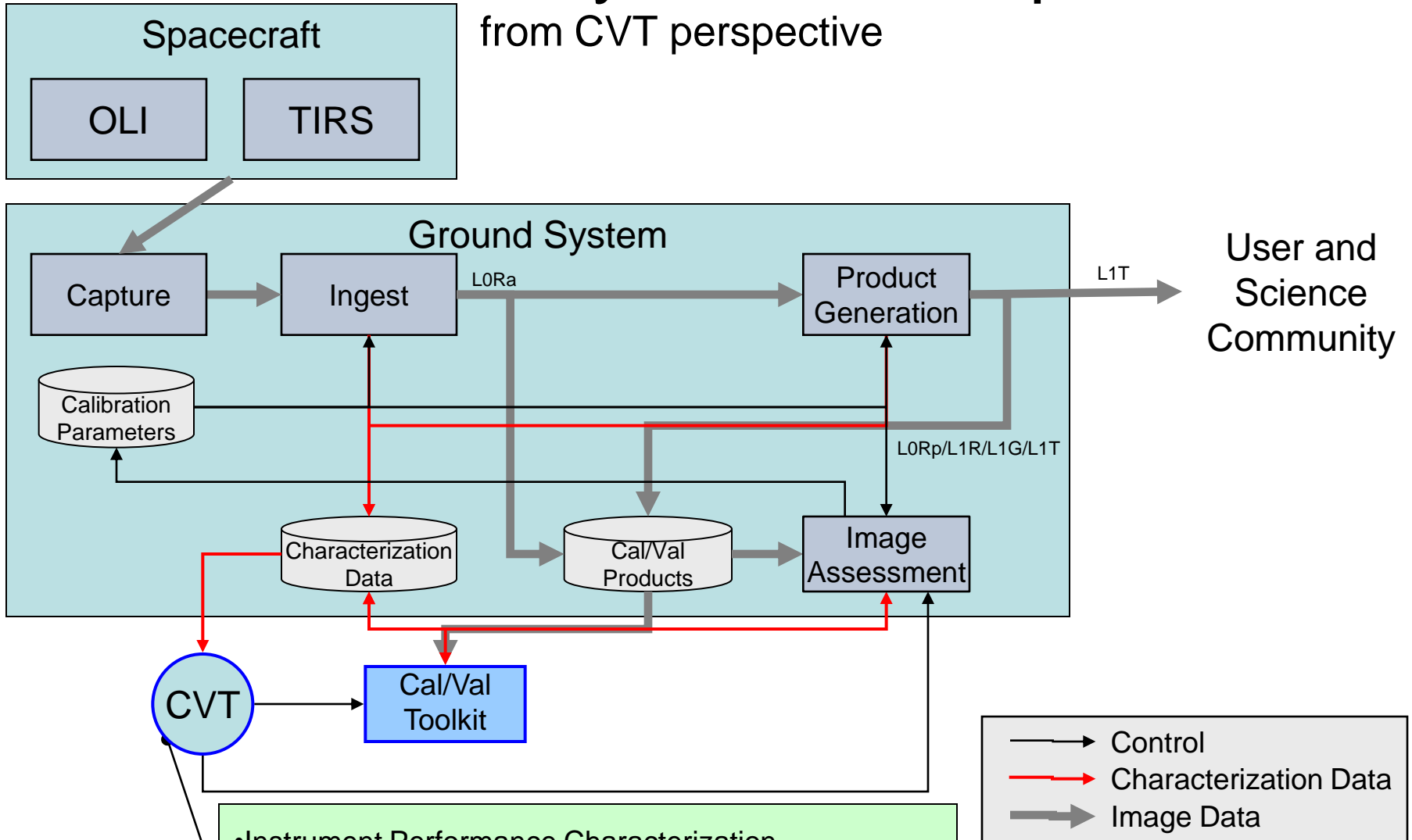 - Supports observatory and other anomaly resolution

Cal/Val Interfaces During Development

– Vendor/Supplier

  • OLI

  • TIRS

  • Spacecraft

– Ground System

  • Data Processing and Archive System

– Landsat Science Team

– Independent Groups

  • Vicarious Calibration

Ground System Concept

from CVT perspective

Spacecraft

OLI   TIRS

Ground System

Capture → Ingest → L0Ra → Product Generation → L1T

User and Science Community

Calibration Parameters

L0Rp/L1R/L1G/L1T

Characterization Data

Cal/Val Products

Image Assessment

CVT

Cal/Val Toolkit

Control
Characterization Data
Image Data

• Instrument Performance Characterization
• Calibration Parameter Determination and Validation
• Product Performance Characterization
• Anomaly Resolution

USGS

August 29—S...

L A N D S A T
LDCM
Data Continuity Mission

NASA

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Calibration and Validation Toolkit

- **Description**
  - Mixture of different languages (C, Matlab, IDL, Excel)
  - Configuration controlled by CVT using Subversion
  - Analyst intensive, low efficiency, non-operational code
- **Uses**
  - Validate algorithms and verify ground system implementation
  - Improve algorithm functionality
  - Investigate processing and instrument anomalies
  - Support instrument acceptance
- **Contains working copies of all algorithms**
  - Instrument provider algorithm baseline
  - Ground system algorithm baseline (ingest, product generation, image assessment)
  - Algorithm prototyping/working versions, including algorithms not implemented in the ground system

Cal/Val Tool Development
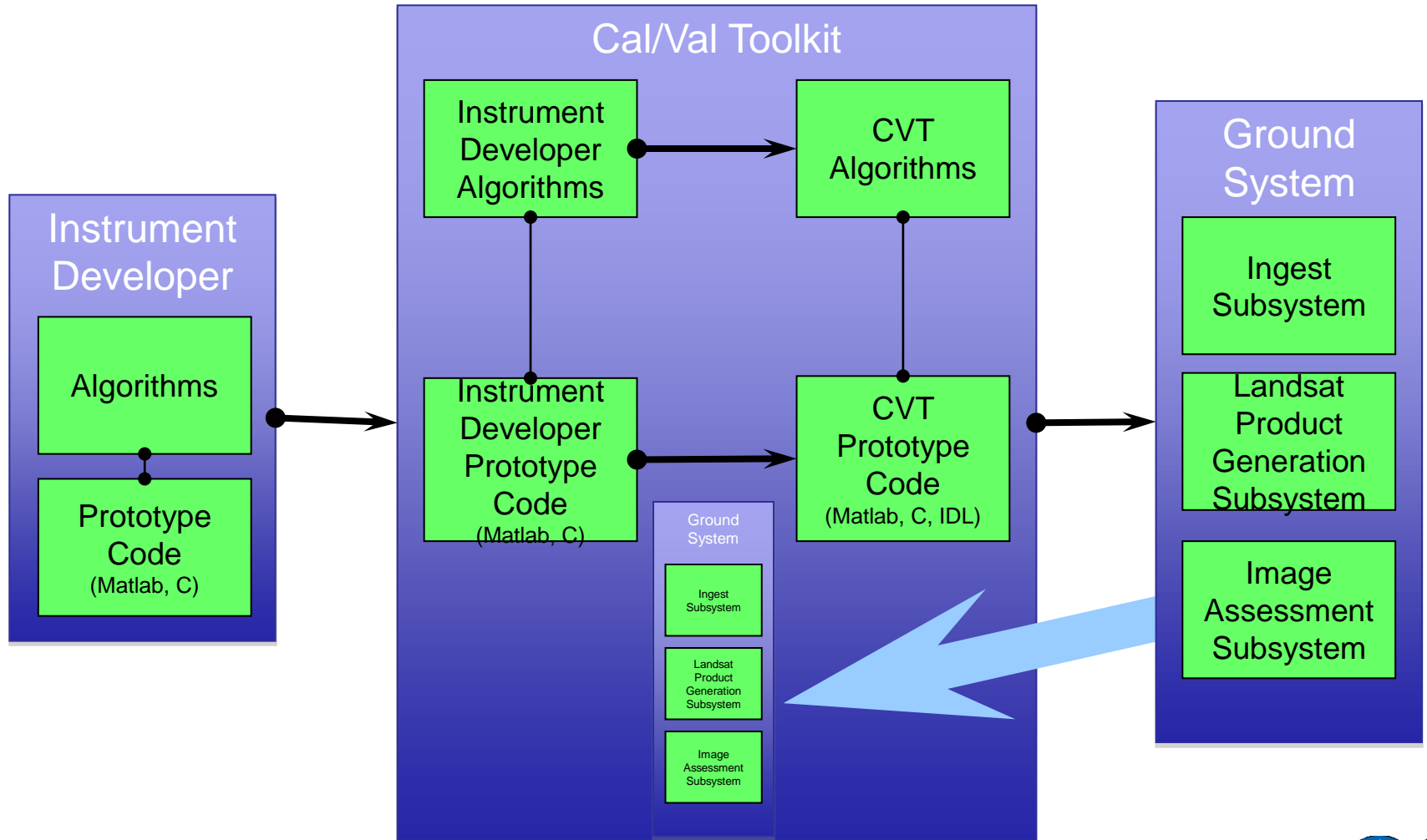
Phased Algorithm Development

- **Algorithm delivery synchronized with instrument and ground system major reviews**

  - ☑ Phase 1
    - Includes brief descriptions
    - Supports ground system preliminary design
  - ☑ Phase 2
    - Based on preliminary provider algorithm descriptions
    - Supports ground system detailed design
  - ☑ Phase 3
    - Based on instrument testing
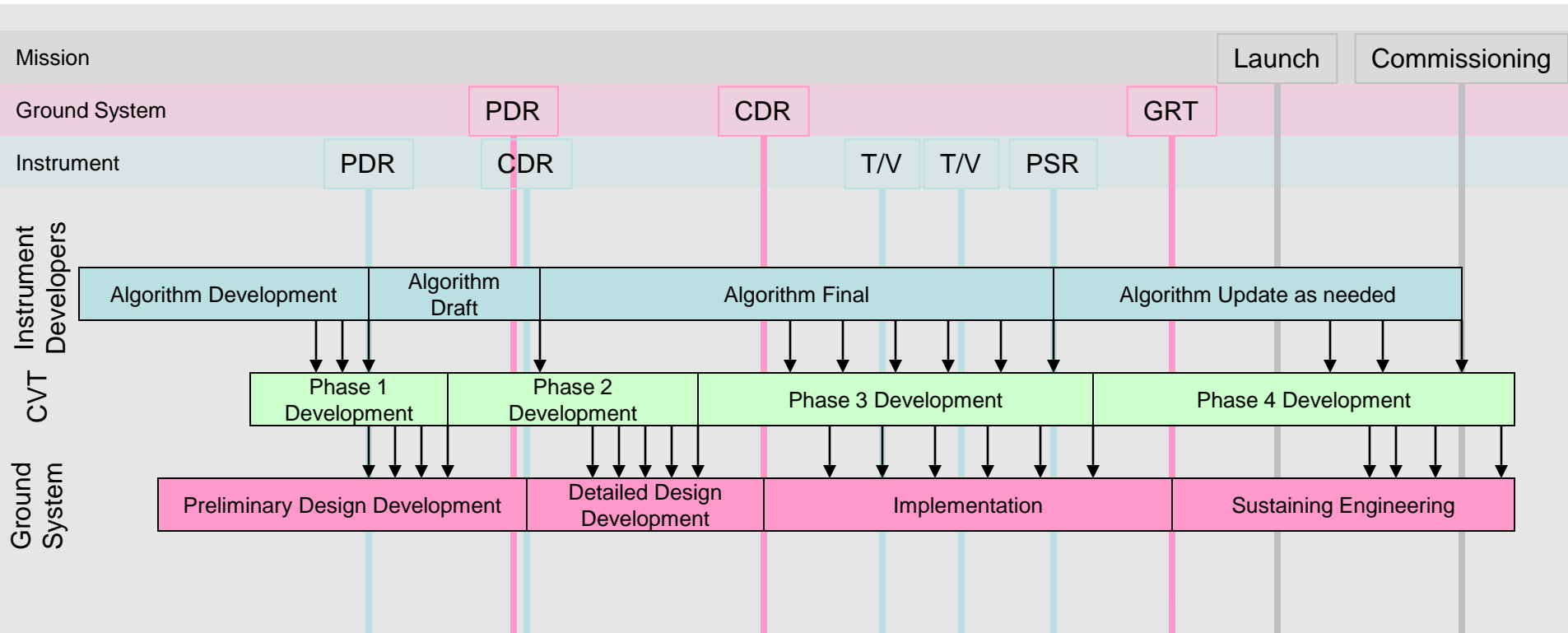   - Supports ground system implementation
  - – Phase 4
    - Based on on-orbit instrument analysis
    - Supports post-launch ground system update

	Alg. Delivery Phase			
Section	**1.0**	**2.0**	**3.0**	**4.0**
Background	x	x	x	x
Inputs	x	x	x	x
Outputs	x	x	x	x
Maturity	x	x	x	x
Procedure		x	x	x
Prototype			x	x
Test Data			x	x
Verification			x	x

Relational Schedule

Mission										Launch	Commissioning
Ground System		PDR		CDR				GRT			
Instrument	PDR	CDR			T/V	T/V	PSR				

Instrument Developers

Algorithm Development	Algorithm Draft	Algorithm Final	Algorithm Update as needed

CVT

Phase 1 Development	Phase 2 Development	Phase 3 Development	Phase 4 Development

Ground System

| Preliminary Design Development	Detailed Design Development	Implementation	Sustaining Engineering

Current Status

- Algorithms received from instrument providers
- Algorithms delivered to ground system developers
- Initial release of image assessment subsystem completed
  - Only minor issues remain to be resolved with second release
- One more image assessment release to go
  - Lower priority algorithms
  - Changes found during testing

OLI Radiometric Processing Overview
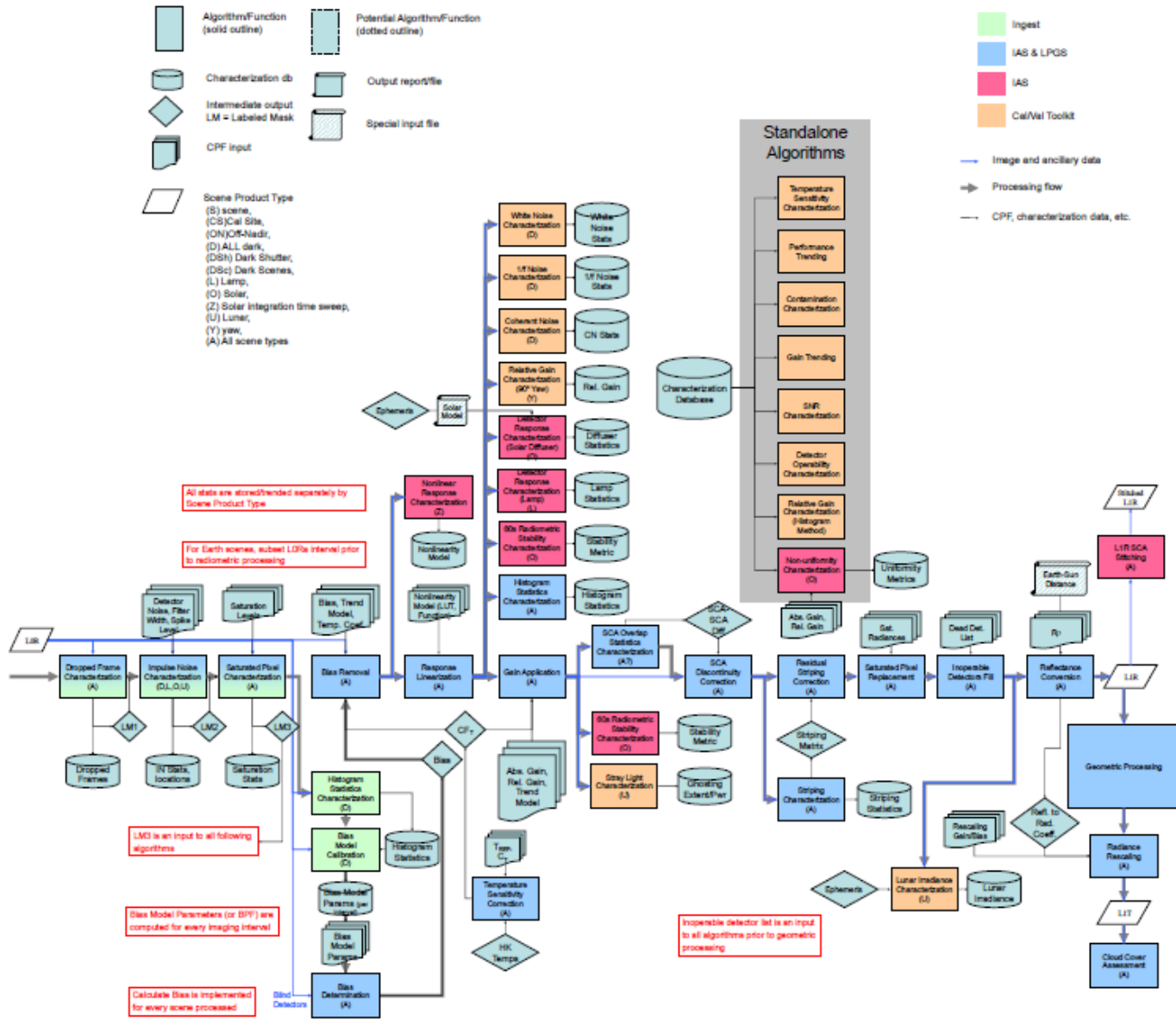
In-line Characterization Algorithms

✓ Dropped Frame Characterization

✓ Impulse Noise Characterization

✓ Saturated Pixel Characterization

✓ Histogram Statistics Characterization

✓ SCA Overlap Statistics Characterization

• Striping Characterization

Off-line Characterization Algorithms

- White Noise Characterization
- 1/f Noise Characterization
- Coherent Noise Characterization
- Relative Gain Characterization
  - Side Slither and Histogram Method
- ✓ Detector Response Characterization
  - Solar Diffuser and Internal Lamp
- ✓ Radiometric Stability Characterization
- Nonlinear Response Characterization
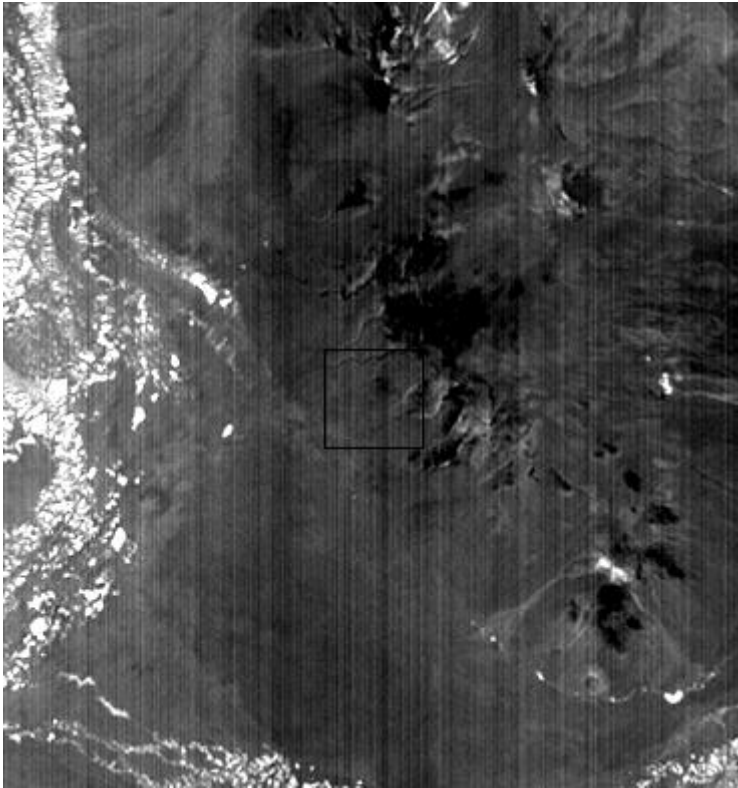- Lunar Irradiance Characterization

Processing Algorithms

- ✓ Bias Removal
    - – Bias Model Calibration
    - – Bias Determination
- ✓ Response Linearization
- ✓ Gain Application
- • SCA Discontinuity Correction
- • Residual Striping Correction
- • Saturated Pixel Replacement
- • Inoperable Detectors Fill
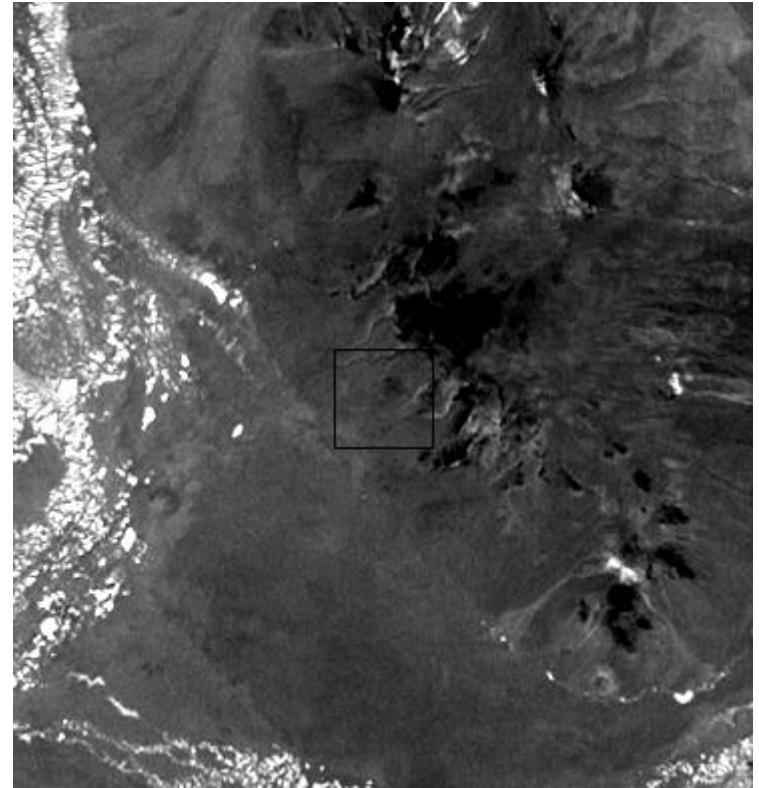- ✓ Reflectance Conversion

Initial Image Assessment Subsystem

Level 0R

Level 1R

Example of radiometric processing to generate floating point Level 1R "product" for band 1, SCA 1