GOES-R Post-launch Product Science Validation Strategy and Plans

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May 28, 2015

Joint MTG LI Mission Advisory Group & GOES-R GLM Science Team Workshop

Outline

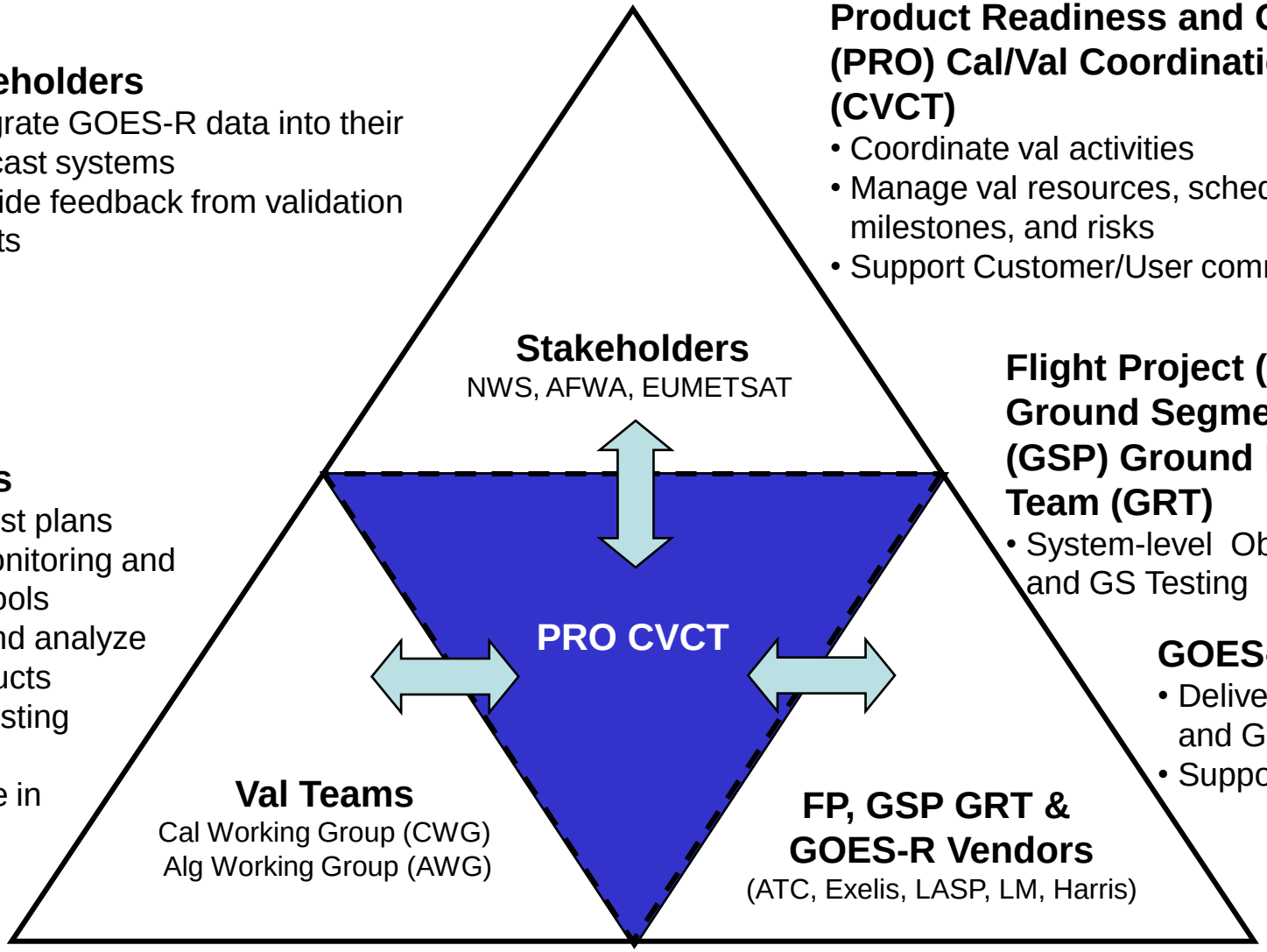
Validation of the GOES-R 10 Level 1b (L1b) and 24 Level 2+ (L2+) Science Products:

- Roles and Responsibilities
- Objectives and Plans
- Overarching Process and Methods
- Risk Reduction and Readiness Preparations
- Success Criteria
- Anomaly Resolution
- Schedule
- Product Availability and User Interaction

Product Science Validation Roles and Responsibilities

Stakeholders
- Integrate GOES-R data into their forecast systems
- Provide feedback from validation efforts

Product Readiness and Operations (PRO) Cal/Val Coordination Team (CVCT)
- Coordinate val activities
- Manage val resources, schedules, milestones, and risks
- Support Customer/User community



Flight Project (FP) and Ground Segment Project (GSP) Ground Readiness Team (GRT)
- System-level Observatory and GS Testing

Val Teams
- Provide test plans
- Create monitoring and analysis tools
- Monitor and analyze data products
- Provide testing reports
- Participate in anomaly resolution

GOES-R Vendors
- Deliver instrument and GS
- Support val efforts

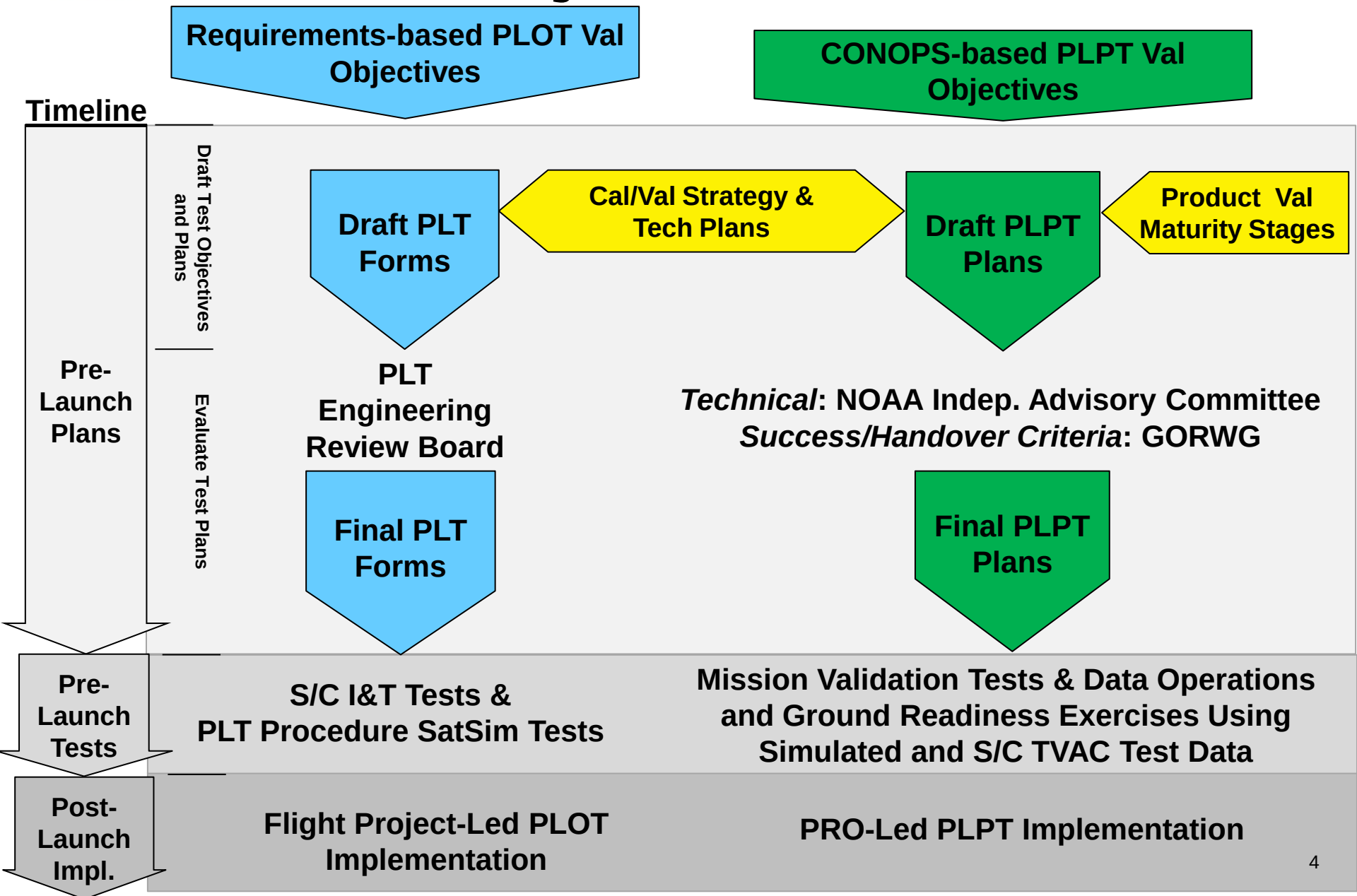
Post-launch Testing Definitions

Post-launch Testing (PLT) – Post-launch observatory re-certification and product performance validation measured relative to expectations based on pre-launch predicted performance.

PLT Sub-Tasks

- **Post-Launch Observatory Testing (PLOT) –** Initial PLT period of instrument and spacecraft functional and performance testing.
- **Post-Launch Product Testing (PLPT) –** Focused product quality validation after PLOT.

Product Science Validation Test Objectives & Plans



Overarching Product Science Validation Methods

- **Product inspection**
  - Visualization of product, intermediate and/or diagnostic output fields using in-house software tools
  - ***Justification:*** Assess qualitative product performance
  - ***Success Criteria Characteristics:***
    - Product is generated at expected times and over expected coverage areas (*e.g.*, Full Disc, CONUS, Meso)
    - Measurements fall within expected ranges determined by analysis-based pre-launch predicted product performance parameters
- **Comparison to reference/correlative/ground truth data**
  - Collocate product and applicable reference/correlative/ground truth datasets and compute quantitative statistics (accuracy, precision, etc) using in-house or Global Space-based Inter-Calibration System (GSICS – L1b only) developed software tools
  - ***Justification:*** Assess and characterize quantitative product accuracy and precision
  - ***Success Criteria Characterics:***
    - Product quantitative performance relative to ground truth measurements is compared against analysis-based pre-launch predicted product performance parameters

Risk Reduction: *Product Science Validation Plan Technical Reviews*

- **Aerospace Corporation Independent Assessment (IA)** *(September –December 2014)*
- **GOES-R Program PLT/PLPT Peer Review** (Independent review panel chaired by the GOES-R Program Systems Engineering Lead) *(12-13 November 2014)*
- **GOES-R briefing to the NOAA Independent Advisory Committee (IAC)** *(3 February 2015)*
- **GOES-R briefing to the NOAA GOES-R Operational Requirements Working Group (GORWG)** *(1 April 2015)*

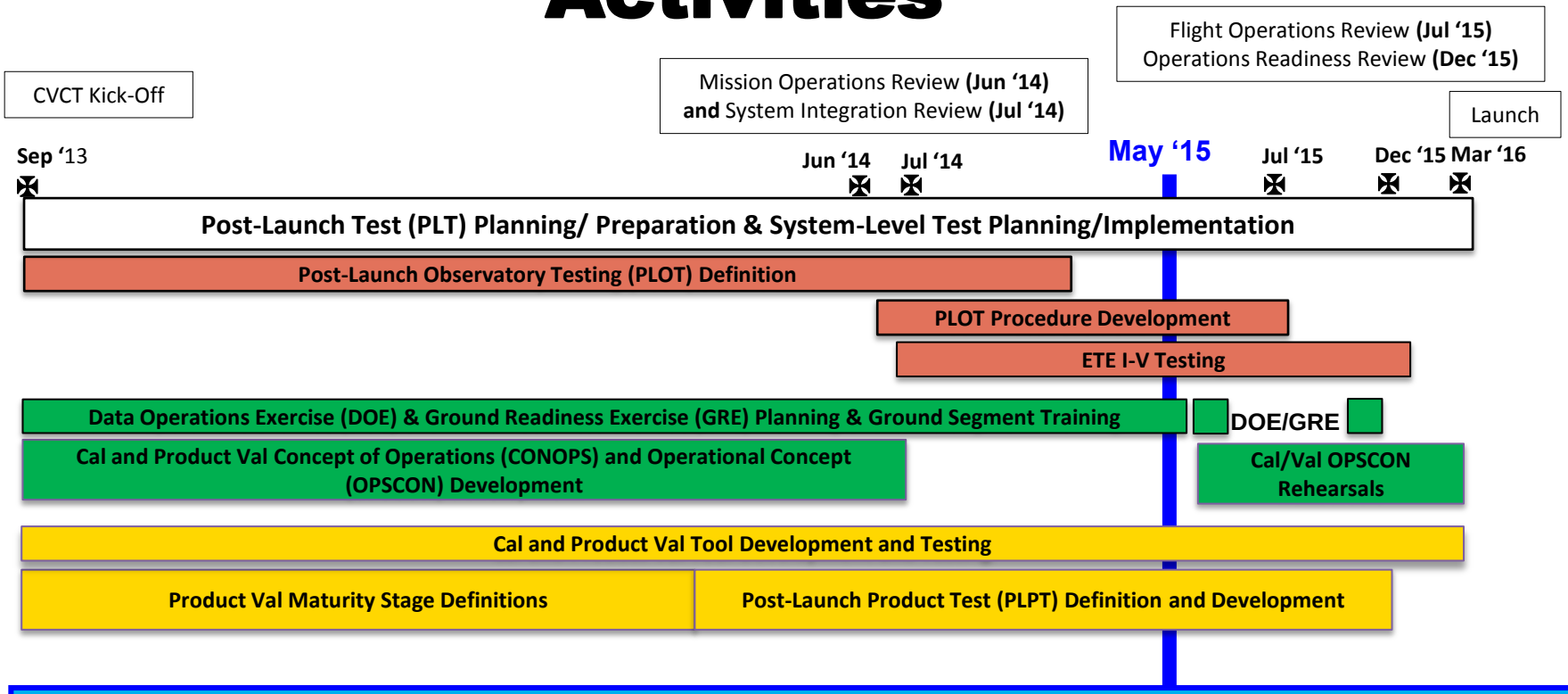
Validation technical methods are considered sound and properly contained within Program scope

Risk Reduction: *GOES-R & JMA AHI Collaboration*

- AHI Calibration (L1A) and Radiance (L1b) Product Analysis
  - On-board calibration data
  - Lunar data
  - L1b product data with respect to radiometric measurements from other operational polar and geostationary imagers
- AHI Derived (L2+) Product Analysis
  - Process AHI L1b data using the GOES-R L2+ product algorithms as applicable
  - Compare AHI L2+ products with those derived from applicable reference/ground truth observations from other observing platforms (e.g., similar products derived from polar orbiting and geostationary imagers; ground-based observations, etc)
- GOES-R Product Operations
  - Share ground segment operational concepts for AHI and ABI calibration, image navigation and registration (INR) and product science performance monitoring, analysis and anomaly resolution

Collaborative testing of AHI L1A data and L1B/L2+ products is well underway during the In-Orbit Test period prior to HIMAWARI full operational status

Pre-Launch PLT Readiness Activities



- Planning PLOT
- Planning PLPT
- Completing Cal/Val monitoring and analysis tools
- Defining PLPT Cal/Val rehearsals and implementing them during Data Ops Exercises (DOEs) and Ground Readiness Exercises (GREs)
- Training relevant Cal/Val personnel to use Core Ground Segment capabilities

Product Science Validation Success Criteria Framework

- Test objectives and activities that fulfill validation scope
- Product data collected at frequencies and over geographical areas and time durations needed to achieve adequate sampling to reduce measurement uncertainties
- Output performance parameter artifacts resulting from product inspection and analysis
- Established qualitative and quantitative success benchmarks
- Comparisons of on-orbit product performance relative to the qualitative and quantitative success benchmarks

Product Science Validation Success Criteria Determination

GOES-R Pre-Launch Verification:
"The process of determining that the deliverable item meets specified requirements, using methods such as test, demonstration, analysis, and inspection."

***GOES-R Post-Launch Validation*:**
"The process of determining that the deliverable item satisfies its intended use in its intended environment"

GOES-R LIRD, MRD, PORD Requirements

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Instrument Design, Fabrication, and Test

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Instrument Performance

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Model Analysis to Predict On-Orbit Product Performance

GOES-R CONOPS

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Defined PLPT Analysis Methods and Val Reference Data Spatial/Temporal Coverage Limits

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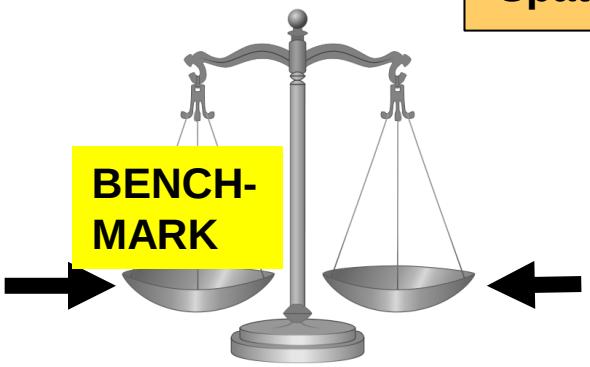
PLPT Analysis to Determine On-Orbit Product Performance



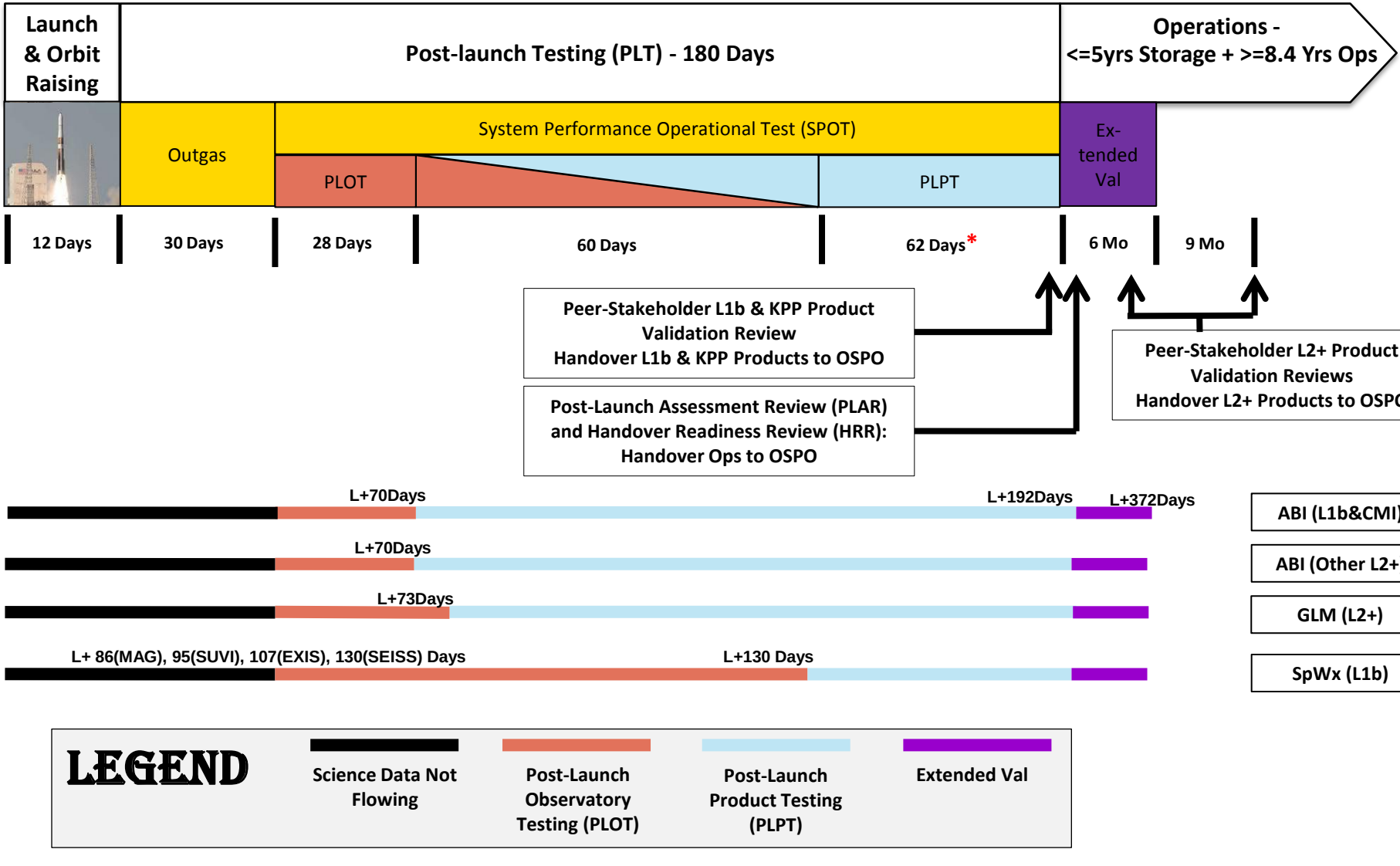
Comparison between determined and predicted on-orbit product science performance

Overview of an Algorithm Change Process

Regardless of system, all changes follow the same path….

- Detect/Identify discrepancy (Algorithm Issue) in operational data product
- Report to Algorithm Action Tracker and to Project and Teams at Algorithm Action Team Meetings
- Prioritize after evaluation to determine if change is within scope and resources
- Investigate cause
- Resolve the issue in the code, deliver change package, and approve the change to the baseline
- Implement the solution in the operational system
- Verify solution implemented correctly in operational system

Product Science Validation Baseline Schedule



* Two-day data blackout during this period due to COOP test.

Availability of GOES-R Baseline Products

Pre-Public Release Data Distribution to EUMETSAT

- NESDIS and EUMETSAT to discuss how much and what type of data will be made available, and when and how that data will be made available.

Post-Public Release Data Distribution to Users (ABI L1b: ~ L + 6 Months; Other L1b: L + 6 Months - L +12 Months; L2+: L + 6 months – L + 18 Months)

- *L0 Data (Limited Distribution to Science Teams)*: Coordinated on an as needed basis with GOES-R L1b Cal/Val Teams
  - **ABI** – Center for SaTellite Applications and Research (STAR) at College Park, MD
  - **GLM** – NASA Marshall Space Flight Center (MSFC) in Huntsville, AL
  - **Space Weather** – National Centers for Environmental Information – Colorado (NCEI-CO) in Boulder, CO
- *L1b and L2+ Products and Instrument Calibration Data*
  - GOES Re-Broadcast (GRB) [*L1b products-only*]
  - Environmental Satellite Processing and Distribution System (ESPDS) Product Distribution and Access (PDA) [*EUMETSAT-only*]
  - NOAA Comprehensive Large Array-data Stewardship System (CLASS)

GOES-R Product Science Validation Team Interaction with Users

Key Activities

- **Identify user points of contact for each baseline product**
- **Early engagement and frequent coordination with users to communicate**
  - Data availability and pathways
  - GOES-R and user test plans involving GOES-R data products

Critical US-European data and information sharing agreements are paving the way for mutually beneficial collaboration during GOES-R PLT and beyond.

Summary

- GOES-R product validation team includes extensive expertise and experience in multiple disciplines, and brings multi-agency institutional knowledge.
- Intensive PLT planning and preparations are underway
- Important “PLT Day-One” risk reduction and readiness preparations are underway
- An overarching success criteria framework has been developed, and qualitative and quantitative benchmarks are expected by December 2015.
- Standard and “Fast-track” algorithm change processes are being developed
- User engagement and feedback during the post-launch checkout of products are critical elements for a successful PLT
- Detailed cal/val schedules and data availability plans are being developed for upcoming FOR/ORR

Backup Slides

Acronyms (A-H)

Acronym	Definition
ABI	GOES-R Advanced Baseline Imager
CLASS	NOAA Comprehensive Large Array-data Stewardship System
CMI	GOES-R Cloud and Moisture Imagery Product
CONOPS	Concept of Operations
CONUS	CONtiguous United States
COOP	COntinuity of OPerations
CVCT	PRO Calibration Validation Coordination Team
DOE	Data Operations Exercise
ETE	End-to-End Testing
EXIS	GOES-R Extreme Ultra-Violet X-Ray Irradiance Sensor
FOR	Flight Operations Review
FP	GOES-R Flight Project
GLM	GOES_R Geostationary Lightning Mapper
GORWG	GOES-R Operational Requirements Working Group
GRB	GOES Re-Broadcast
GRE	Ground Readiness Exercise
GRT	Ground Readiness Team
GSICS	Global Space-based Inter-Calibration System
HRR	Handover Readiness Review

Acronyms (I-O)

Acronym	Definition
I&T	Integration and Test
IA	Independent Assessment
IAC	Independent Advisory Committee
INR	Image Navigation and Registation
KPP	Key Performance Parameter
LIRD	Level 1 Requirements Document
L0	Level Zero Data
L1b	Level-1b Product
L2+	Level 2+ Product
MAG	GOES-R Magnetometer
MOR	Mission Operations Review
MRD	Mission Requirements Document
ORR	Operational Readiness Review
OSPO	NOAA/NESDIS Office of Satellite and Product Operations
OPSCON	Operational Concept

Acronyms (P-Z)

Acronym	Definition
PLAR	Pre-Launch Assessment Review
PLOT	Post-Launch Observatory Testing
PLPT	Post-Launch Product Testing
PLT	Post-Launch Testing
PORD	Performance and Operational Requirements Document
PRO	GOES-R Ground Segment Product Readiness and Operations Team
S/C	Spacecraft
SEISS	GOES-R Space Environment In-Situ Suite
SIR	System Integration Review
SUVI	GOES-R Solar Ultra-Violet Imager
TVAC	Thermal Vacuum