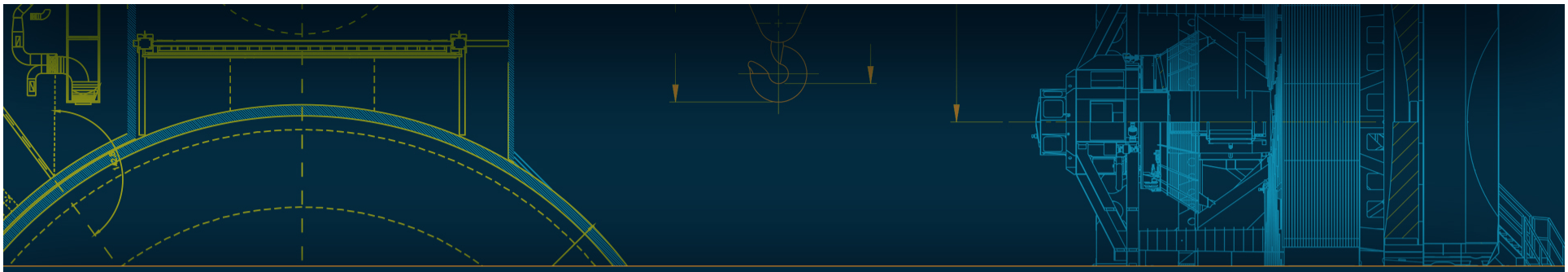


LSST Operations: A Model for a Distributed System

Chuck F Claver - LSST System Scientist
Beth Willman – LSST Deputy Director & Interim Director of Operations

ESA Science Operations 2017

Large Synoptic Survey Telescope

Wednesday, October 18, 2017

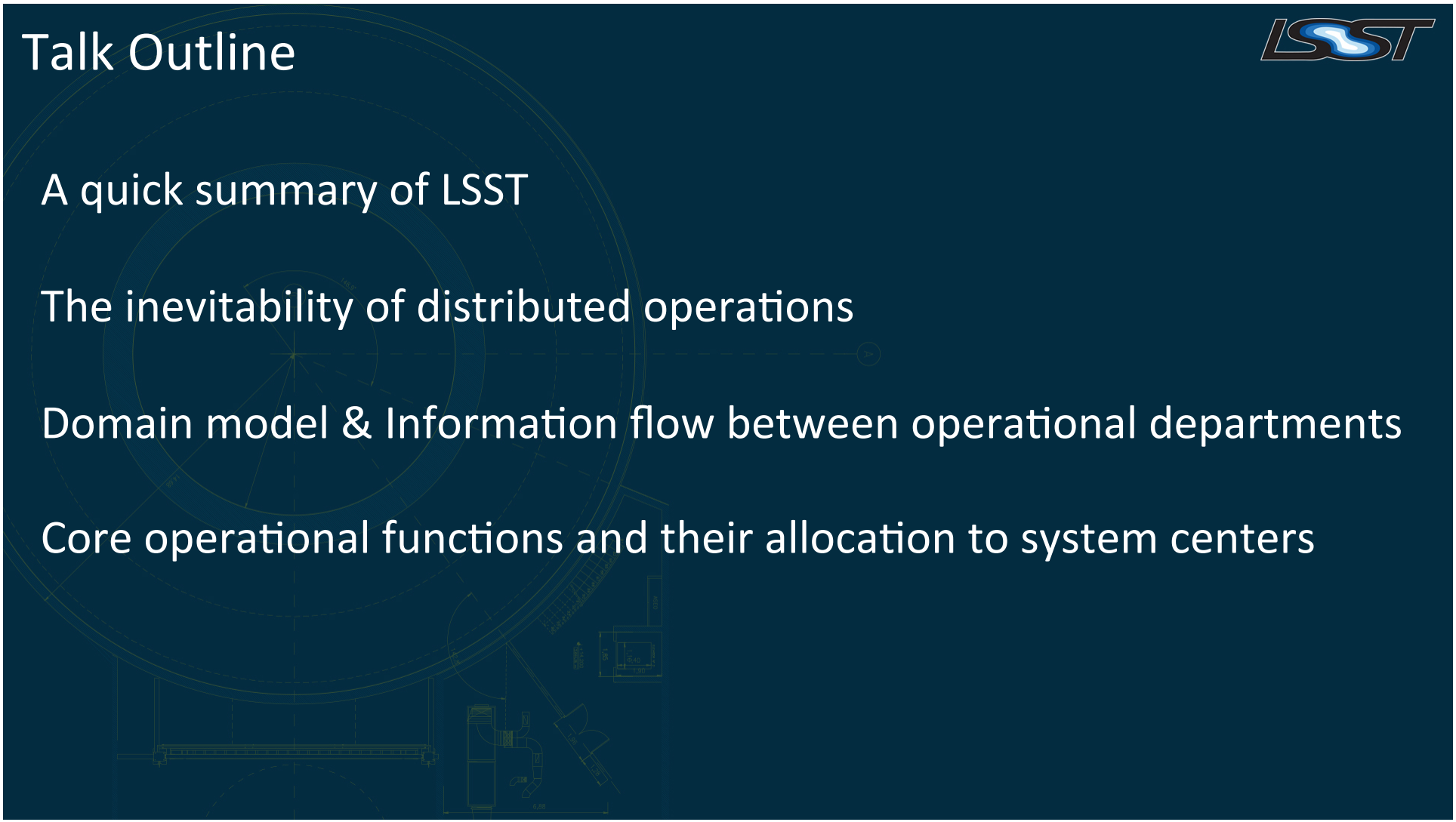
Talk Outline

A quick summary of LSST

The inevitability of distributed operations

Domain model & Information flow between operational departments

Core operational functions and their allocation to system centers



LSST is motivated by 4 science themes

- Understanding Dark Mater and Dark Energy
- Exploring the transient & time domain universe
- Taking a census of the Solar System
- Mapping the structure of the Milky Way galaxy

Each theme drives complementary system requirements and design. A system built to these requirements enables a wide range of scientific inquiry. The result is a large area multi-color multi-epoch sky survey.

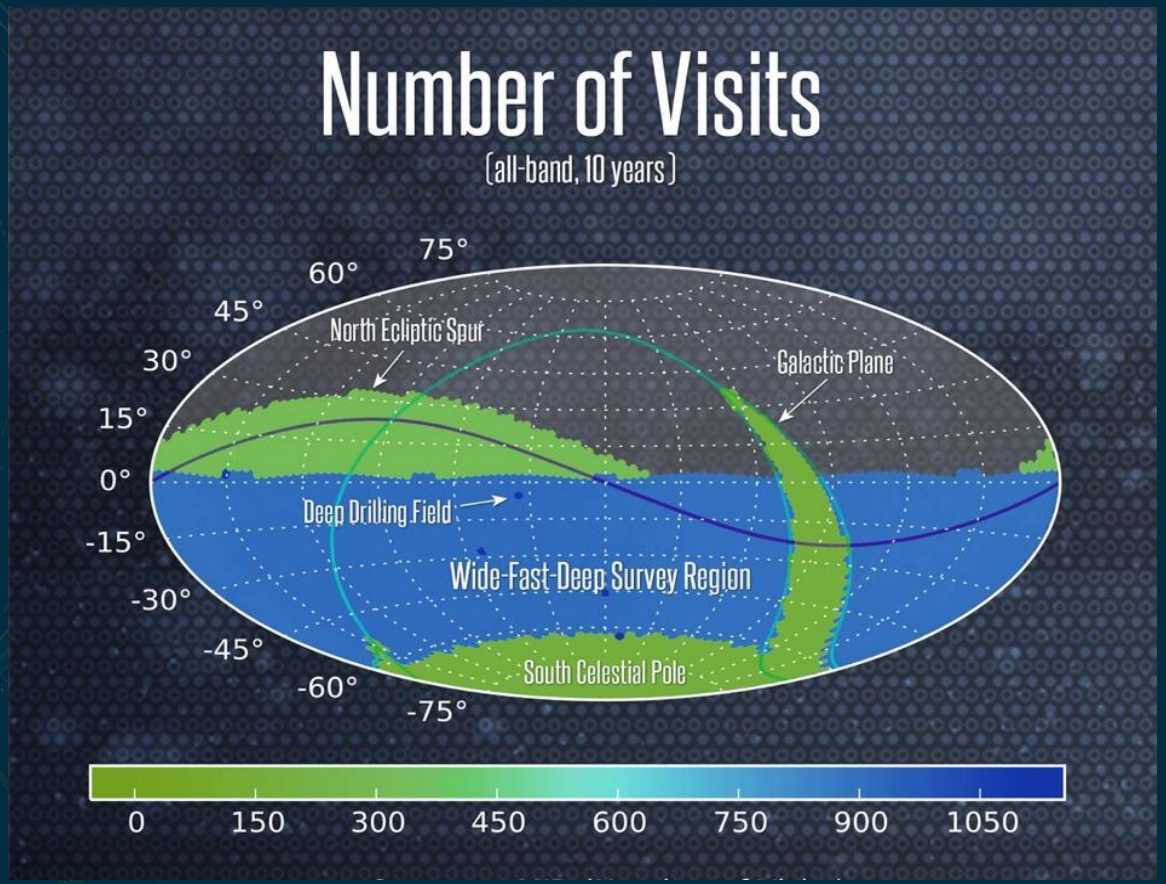
The LSST Survey Design

The survey area includes:

- Deep, Wide, Fast Region
  - ~18000 square degrees
  - High density observations
- South Celestial Pole
- Galactic Plane
- North Ecliptic Spur
- Deep Drilling Fields
  - Very high density observations of select fields

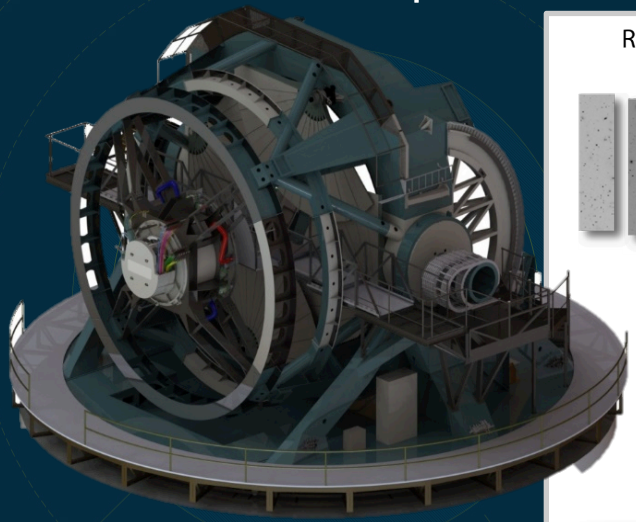
Observations are defined by a "visit":

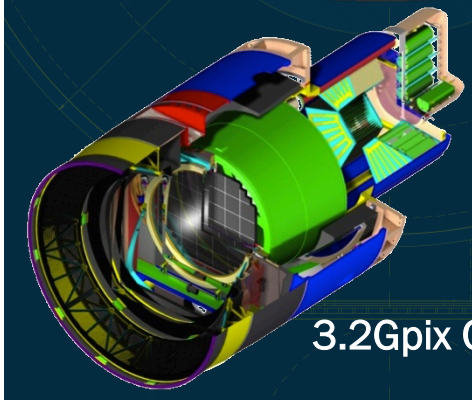
- A "visit" lasts ~35 sec. - each capturing 2x15sec exposures
- 2.5 million "visits" will be obtained over a 10-year period.
- Visits will be obtained in six filter bands (ugrizy) covering the visible spectrum from 320-1050nm



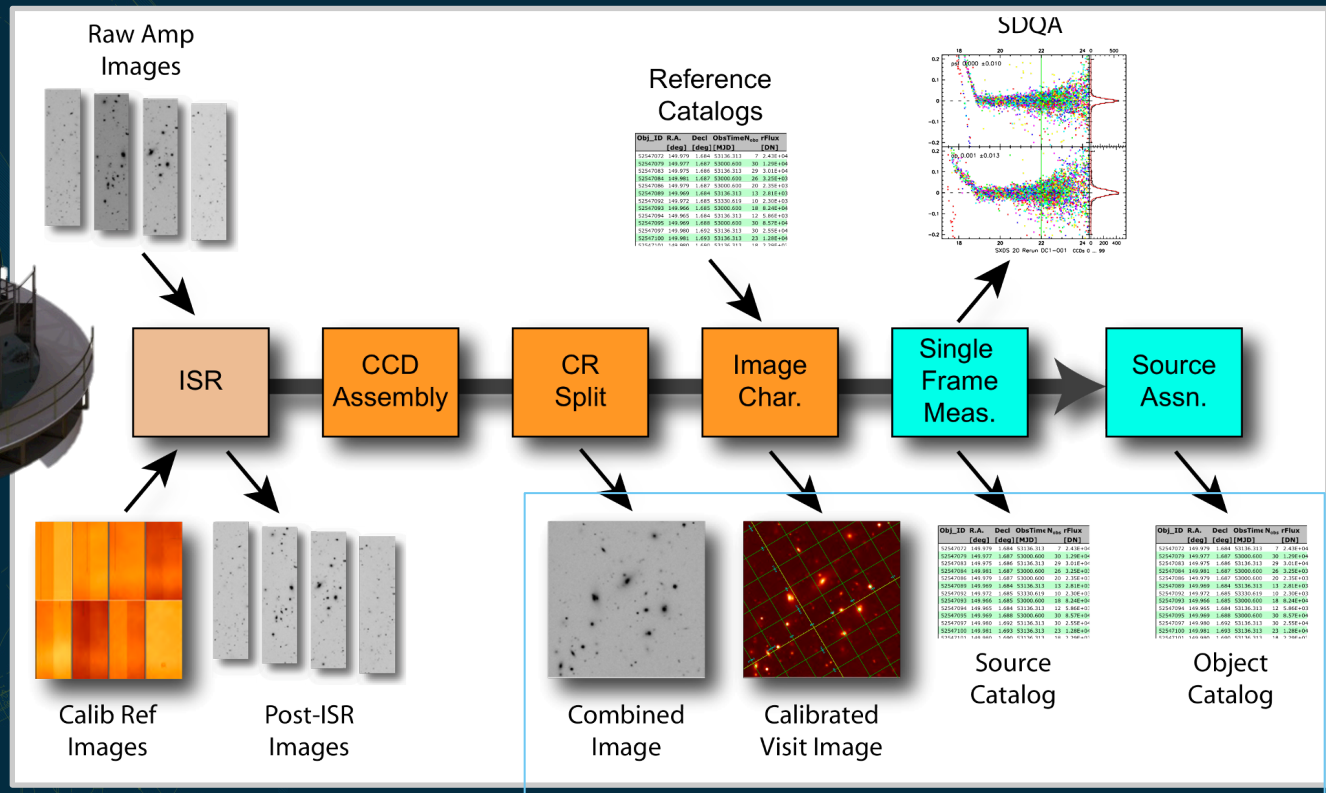
The LSST is a System of Systems

8.4m Wide Field Telescope



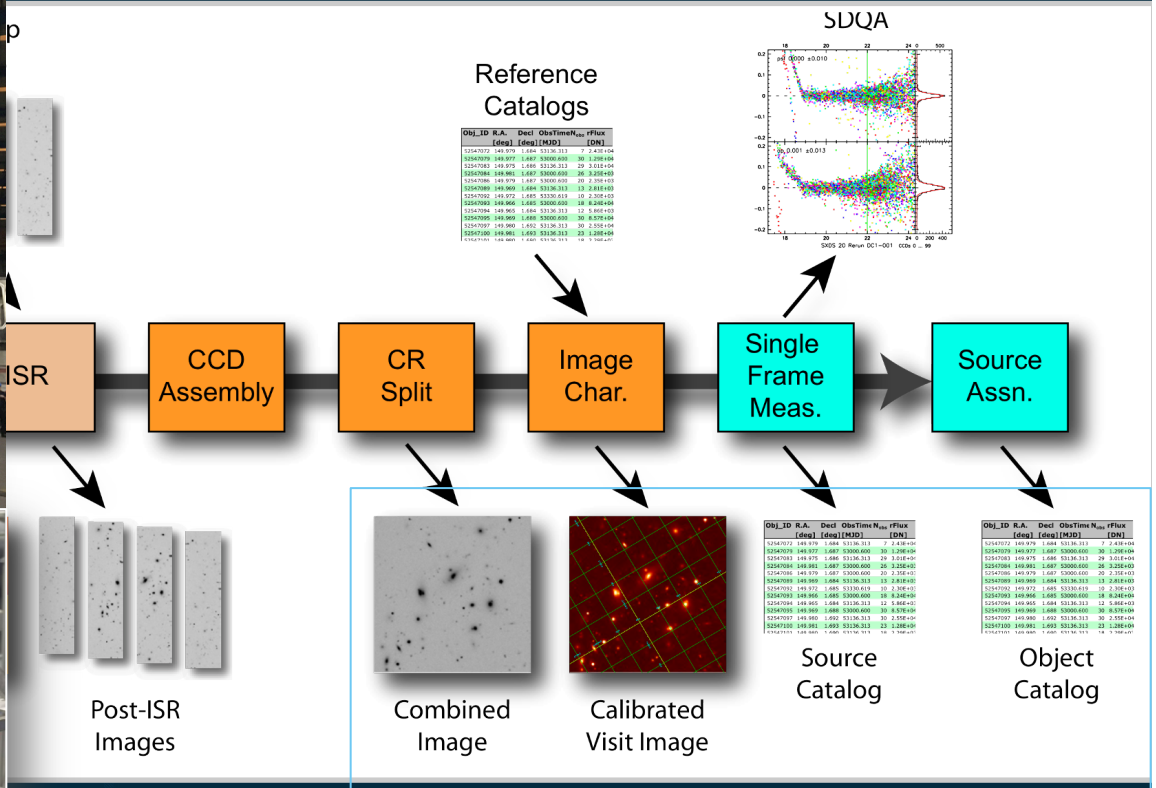


3.2Gpix Camera



Data Access Centers provides Community Services

The LSST is a System of Systems



Data Access Centers provides Community Services

3 Flavors of LSST Data Products

"Prompt" (≤24 hours) Processing:

- Within 60-sec. after a "visit" alerts are analyzed from a difference image using a reference template

- Alerts, anything that has changed in brightness or position, are published immediately thereafter.

- Within 24 hours orbits are calculated from detected moving objects and added to the online database

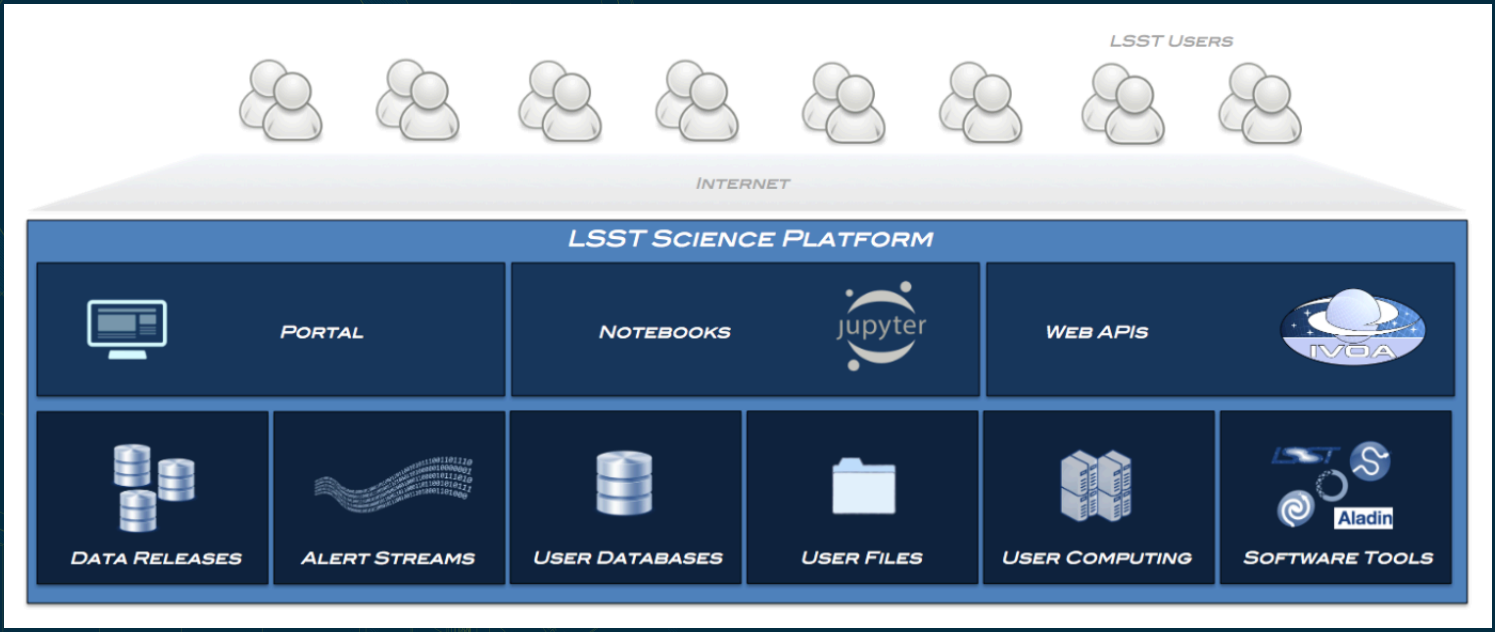
Data Release Processing (DRP):

- Annually all "visits" collected to date are processed as a single data set to produce:
  - Deep co-added images
  - Optimal photometry and internal calibration
  - Refined astrometry for parallax and proper motion
  - Reprocessed time history of detected transients
  - ... and much more

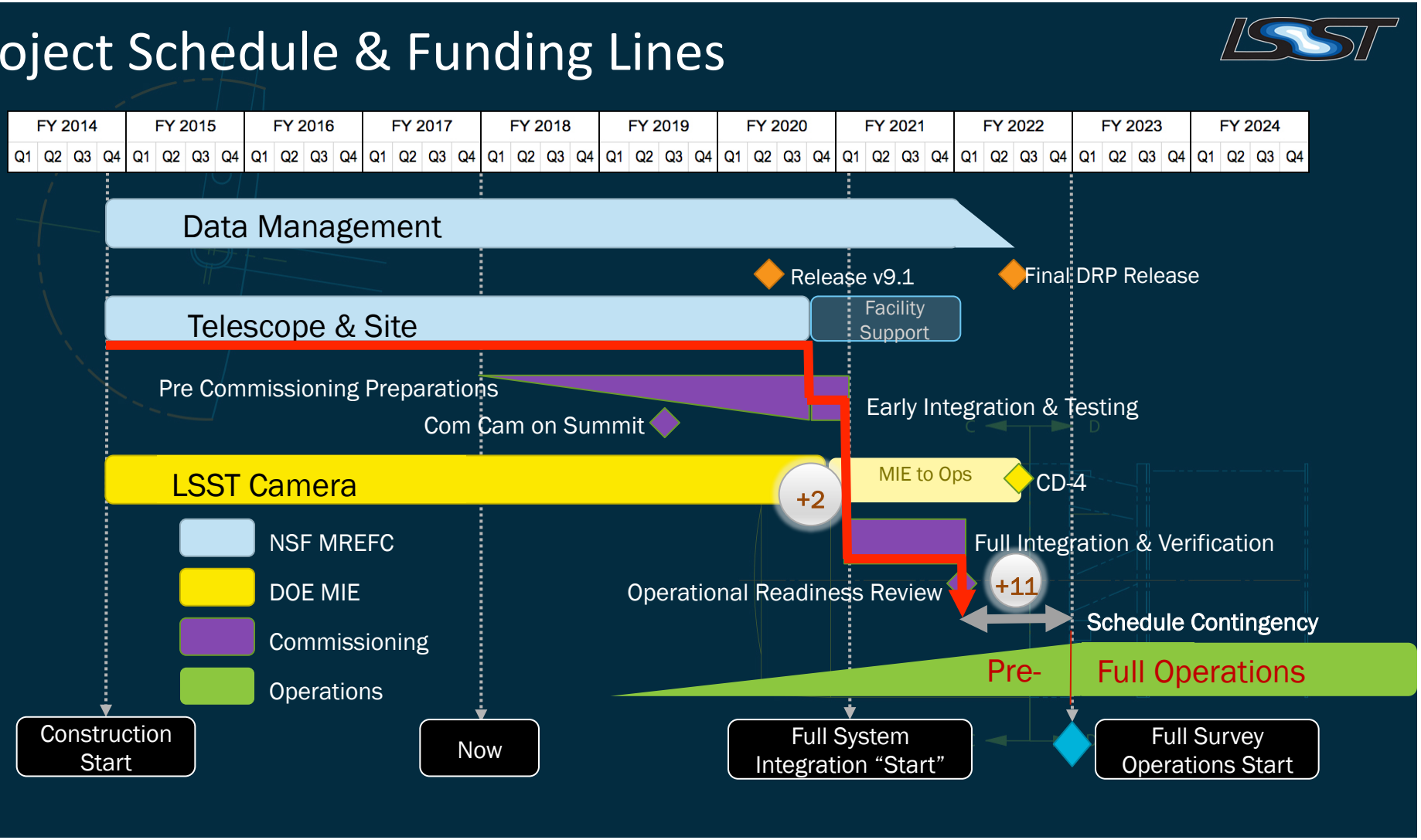
User derived data products

Services for User Access & Analysis

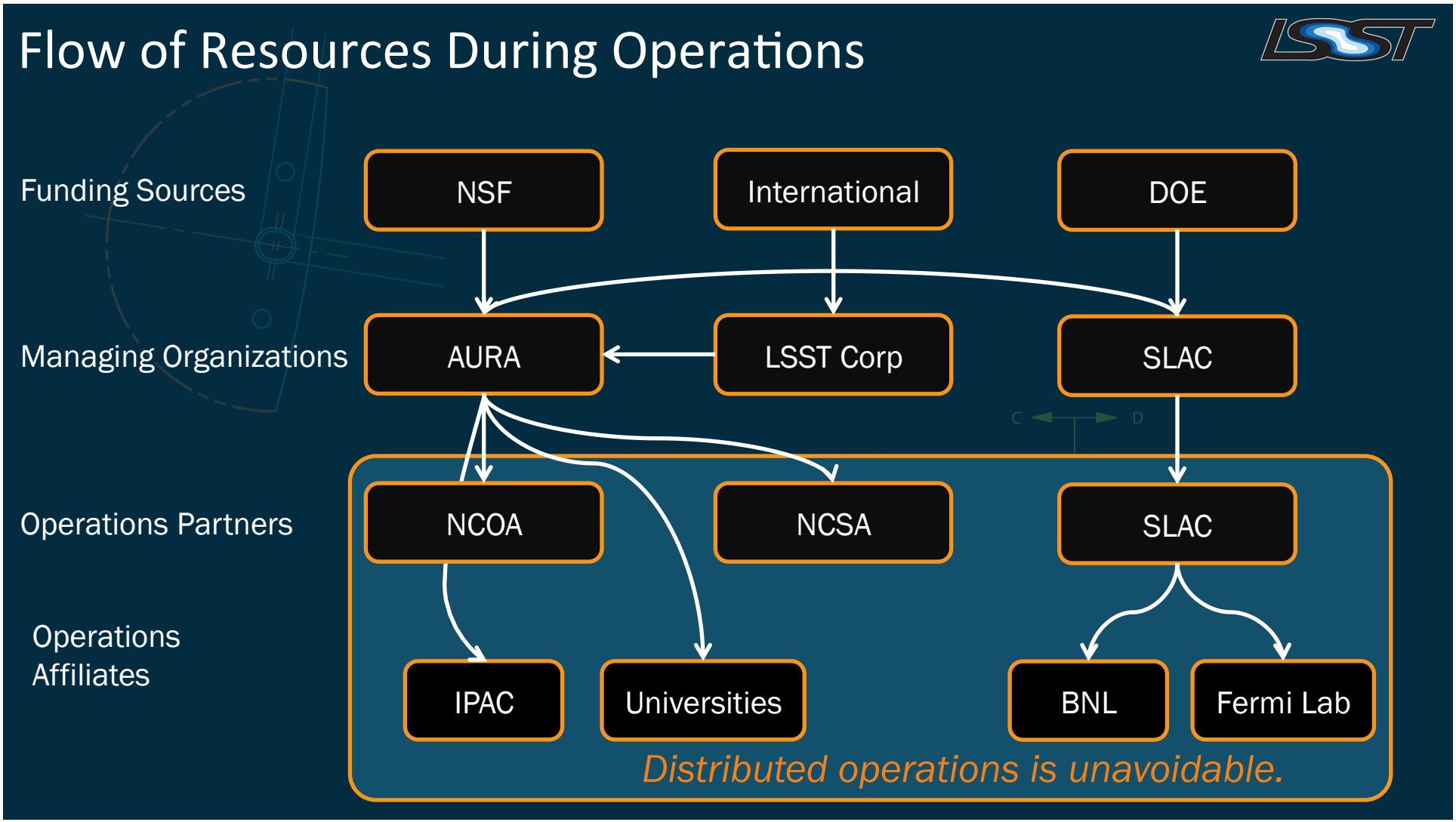
Six user services are provided through 3 interfaces allow catalog and image access and computing at the source of the data.



Project Schedule & Funding Lines



Flow of Resources During Operations




SLAC Center
Data Products Production Support
Science Operations and Community Support
Observatory Operations Camera Support
French satellite center
(CC-IN2P3, Lyon, France)
Data Release Processing (50%)
Long-term storage (copy 2)
French DAC
CCIN2P3
NCSA
Archive Site
Data & Archive Center
Alert (Prompt) Processing
Data Release Processing (50%)
Long-term Storage (copy 1)
Data Access Center
Data Access and User Services
NCOA HQ Site
Science Operations headquarters
Operations office
Education and Public Outreach
NCOA Summit and Base Sites
Telescope and Camera Operations
Data Acquisition
Chilean Data Access Center

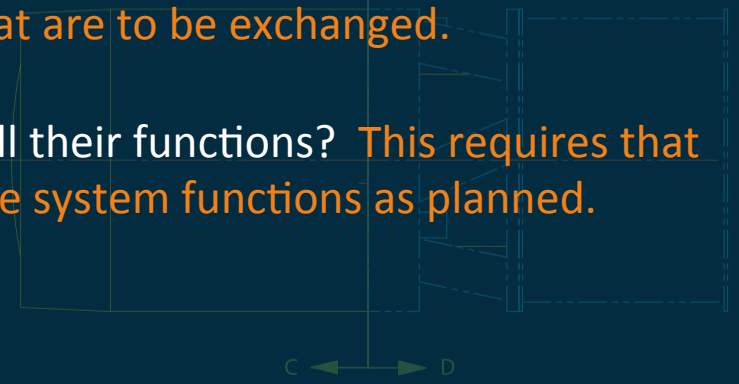
4 Challenge questions?

Who are the critical stakeholders – both internal and external? Maintaining coordination and communications between stakeholders will be critical for success.

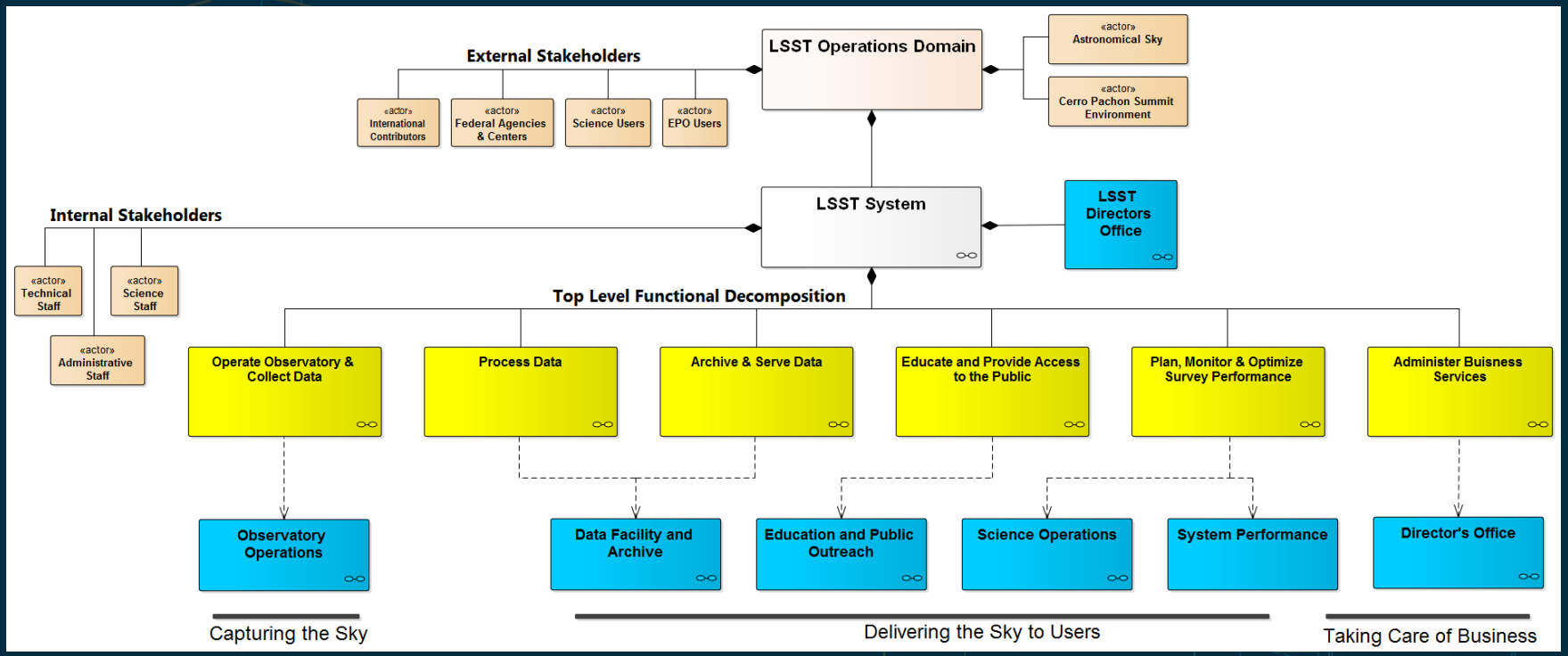
What are the critical roles and functions & how are they distributed across the operational centers? We want to minimize redundancy and inefficiencies across centers.

What information needs to be shared between operational centers? This requires defining interfaces, data, events and status that are to be exchanged.

Does each center understand how they will fulfill their functions? This requires that operational processes be defined to ensure the system functions as planned.



Components of the LSST Operational System



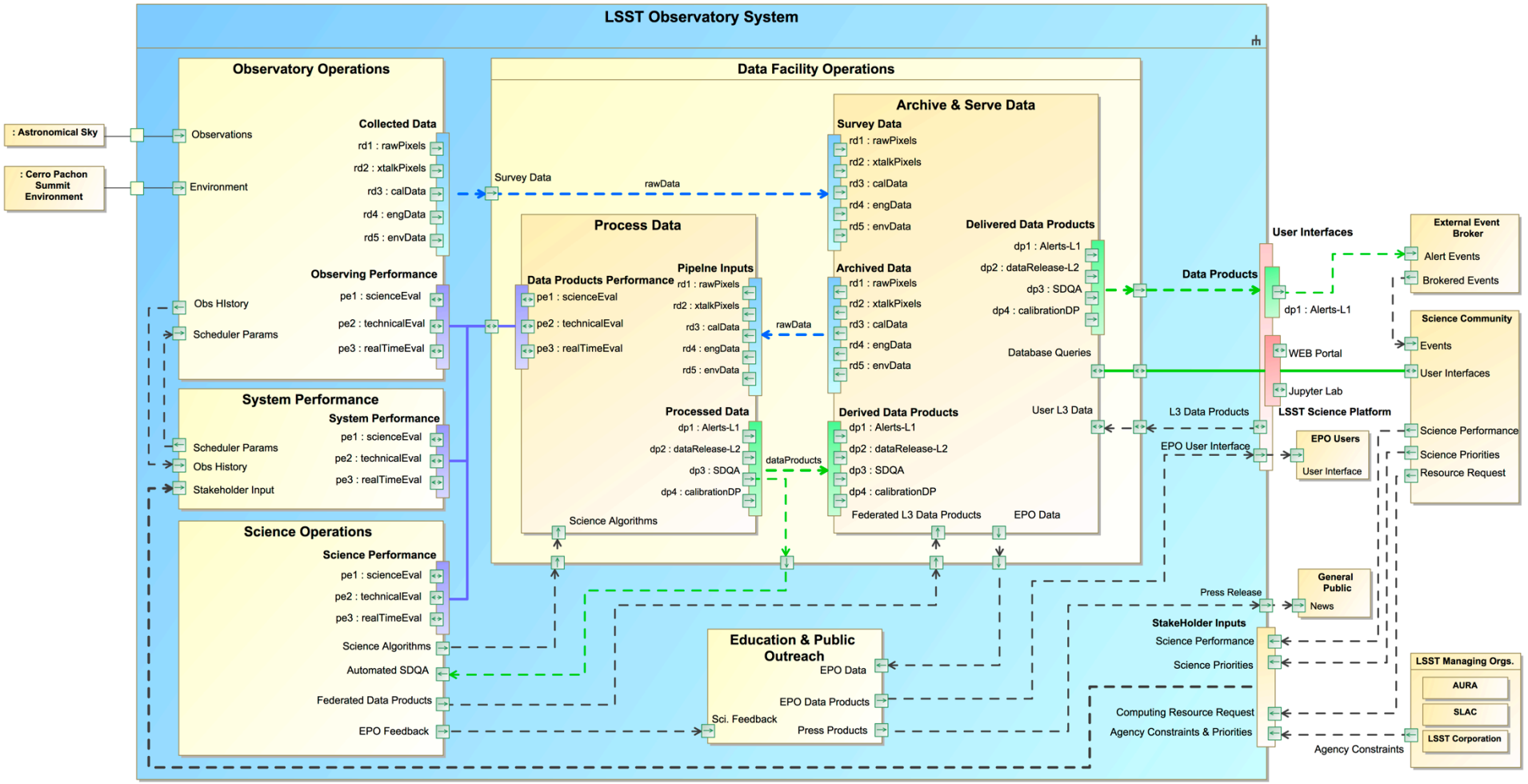
"LSST Operations Domain block" defines the *System Context*

Internal and External Stakeholders are identified

Decomposition of system into 6 Top Level Functions (yellow)

Functions Allocated to Organizational Structure (Departments - blue)

System wide information flows and interfaces



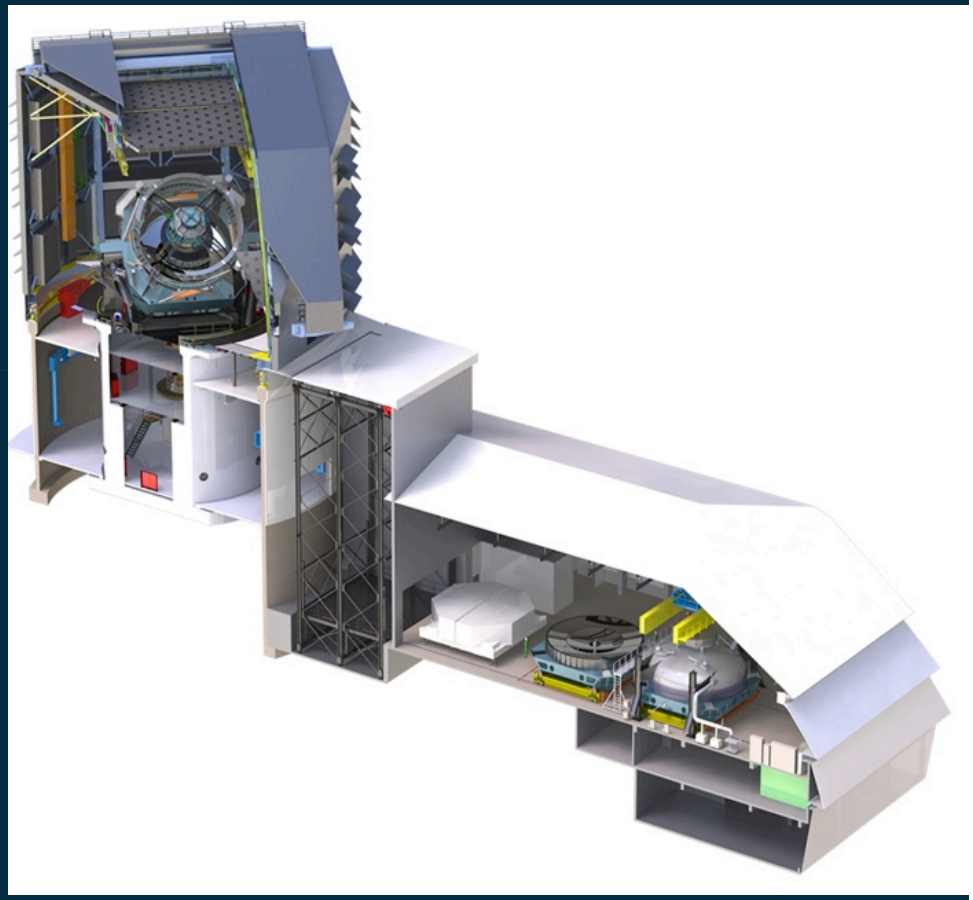
Observatory Operations:
NCOA – Chile

Summit Facility on Cerro Pachón:

- Telescope operations & maintenance
- Camera operations & maintenance
- Calibration operations & maintenance
- Scheduling of survey observations
- Image metadata services (hosting)

Base Facility in La Serena:

- Observatory Operations Offices
- Summit systems maintenance
- Science Data Quality Analysis (hardware)
- Chilean Data Access Center (hosting)
- Long term data storage (hosting)
- Source node for international network (hosting)



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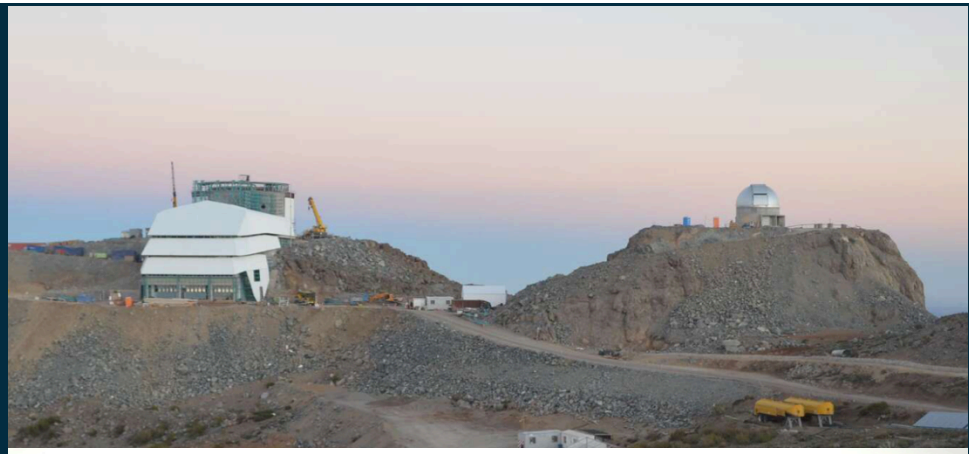

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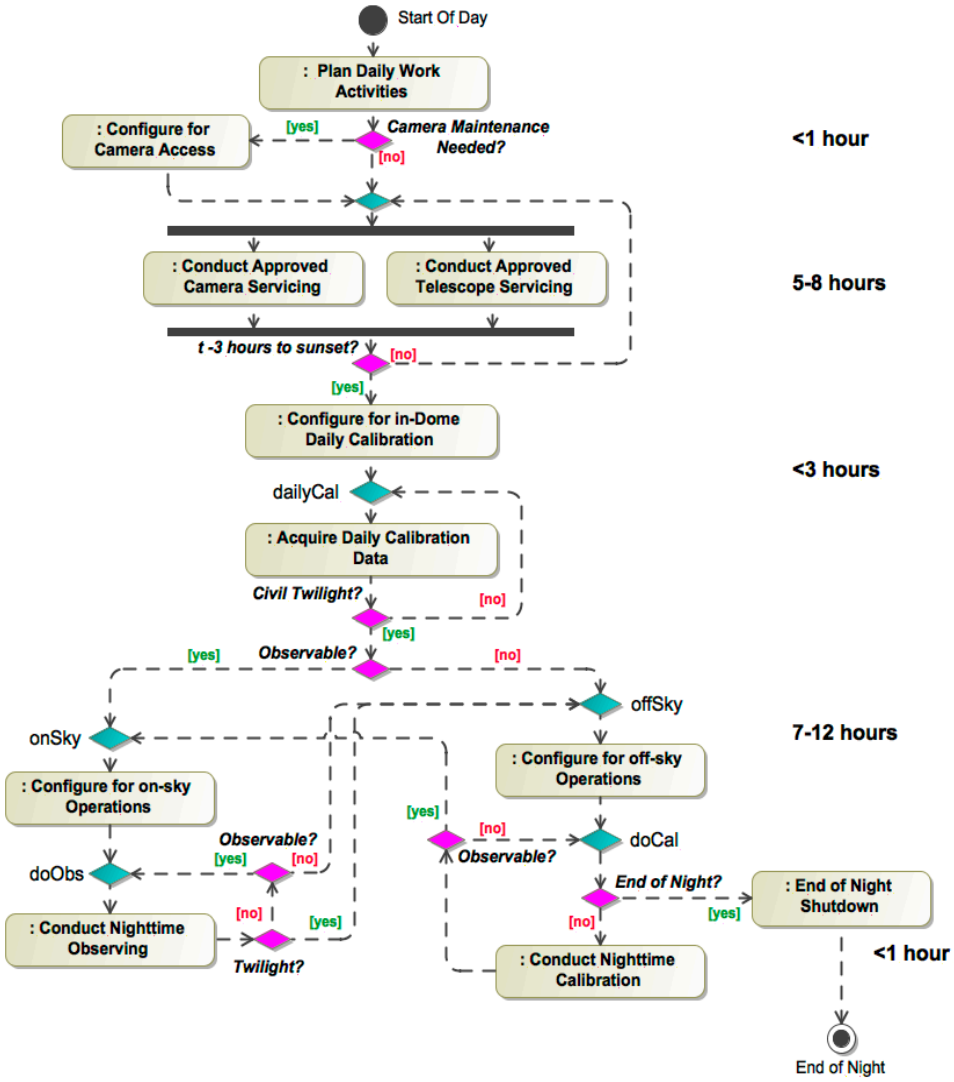
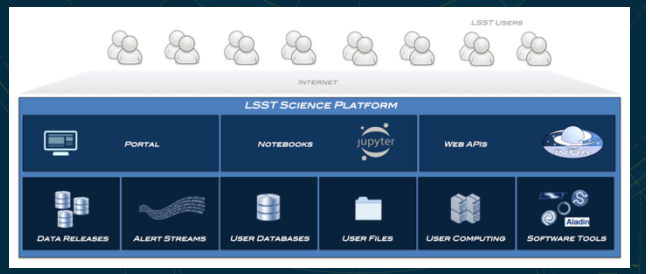


Data Facility and Archive: NCSA

- Computing infrastructure
- System Services
- “Prompt” Processing
- Data Release Processing
- Science Data Quality Analysis (Pipelines)
- User Services



LSST DATA FACILITY

Providing production services for the scientific processing, archiving, and dissemination of LSST data

Scientific Production Services

The reliable and timely generation of LSST science data products including prompt alert processing, nightly calibration and imaging, and annual data releases.

Data, Computer, and IT Security Services

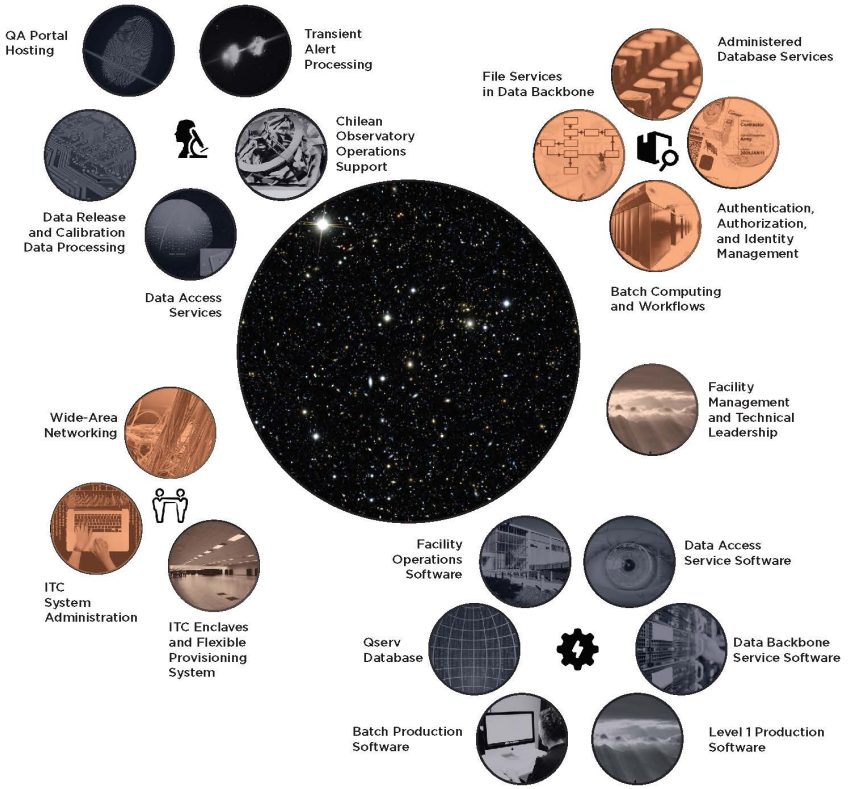
Operational support for foundational services at the key level of system-wide data transport, management of file-based data, database administration, authentication, authorization, and access, and operational network security infrastructure.

Production Service Software

Necessary maintenance of and enhancements to software infrastructure required to support production data processing at the LSST Data Facility.

ITC and Facility Operations

System administration and physical system operations of the LSST Data Facility computing, storage, and communications infrastructure.



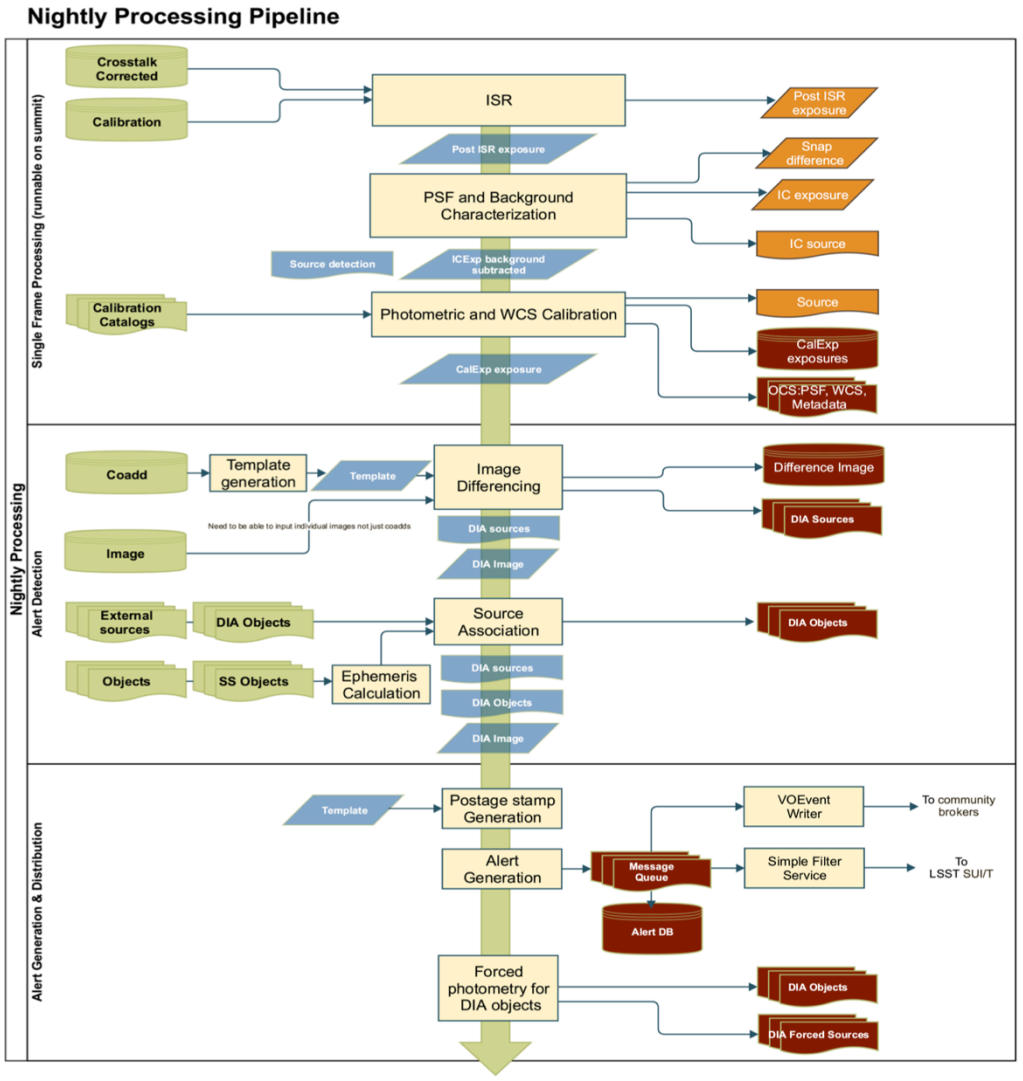
Prompt (≤24-Hours) Data Processing: NCSA

Nightly Processing (≤60 sec.):

- Data transfer and archiving
- Single frame processing
- Alert detection
- Alert Generation and Distribution

Follow-up Processing (≤24 Hours):

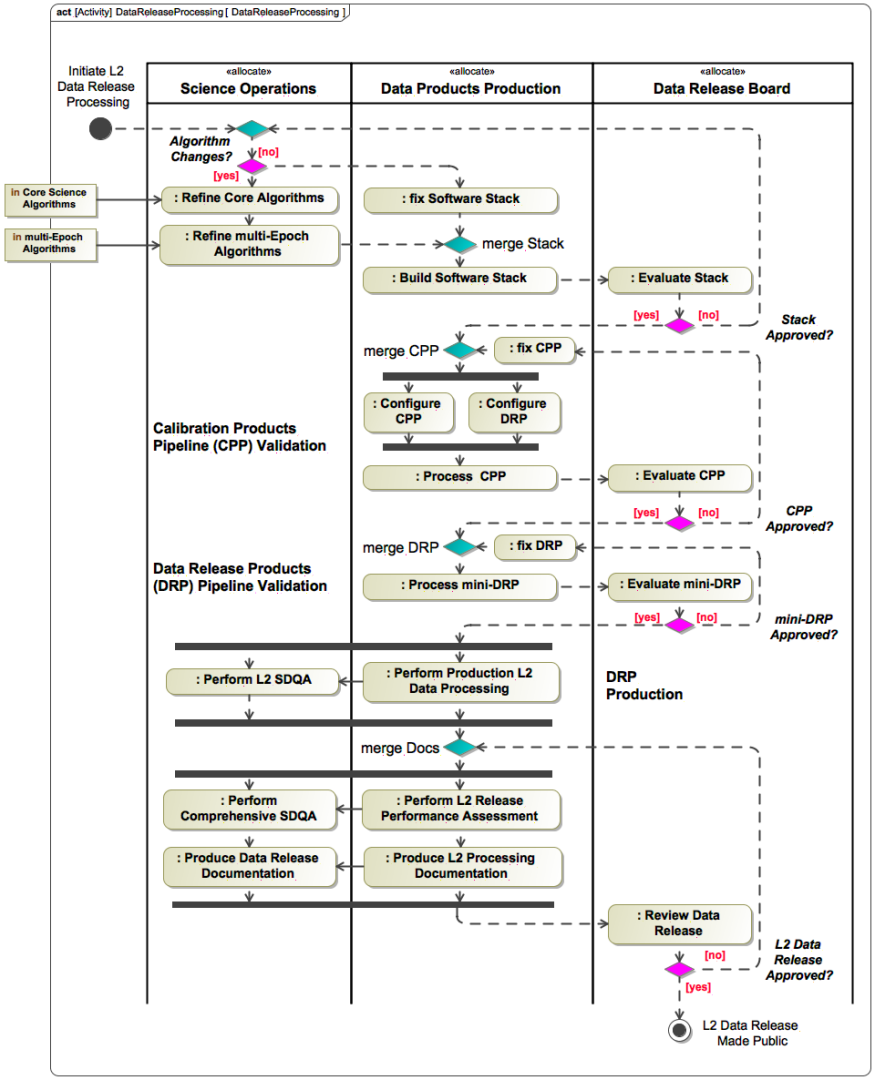
- Processing past visits on new alerts
- Moving Object Pipeline - Track linkage and orbit estimation



Data Release Processing:
NCSA + CC-In2P3

Date release processing (DRP) requires tight coordination with Science Operations:

- DRP starts with review/validation of software algorithms, updates are made as needed.
- Calibration Products Production run and verified
- Sub-scale DRP is run with same data processed by NCSA & CC-IN2P3 to validate process
- Full production splits data between NCSA & CC-IN2P3 with some overlap for quality checks
- Ends with final performance assessment and documentation



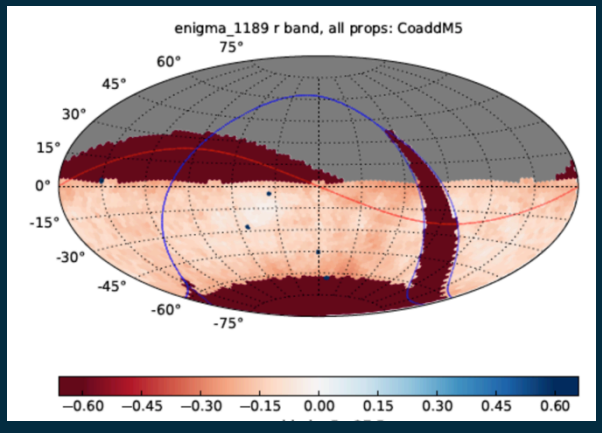
Science Operations & System Performance: NCOA –Tucson, AZ

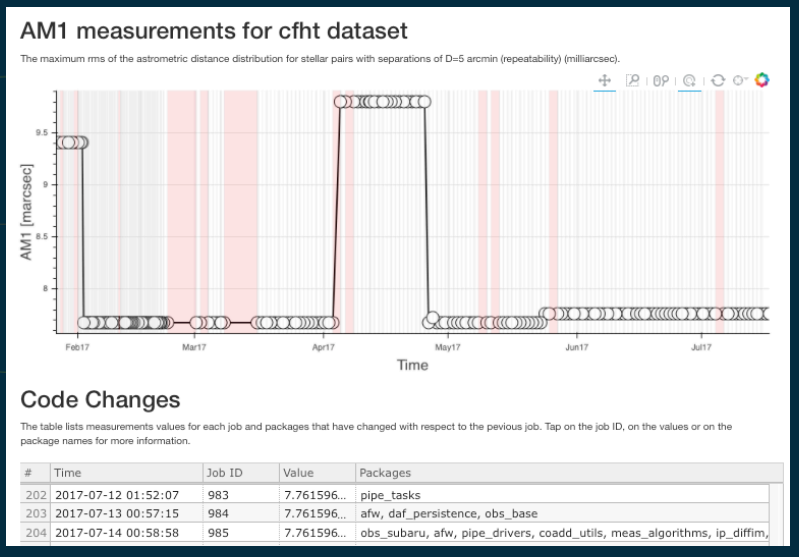
Science Operations:

- Survey performance monitoring
- Analysis of survey scheduler changes
- Science Data Quality Analysis (SDQA) & coordination over other centers
- Science user support & Help Desk
- Science algorithm maintenance and upgrades

System Performance:

- Change & Configuration Control
- Updates to scheduler parameters
- Process management & development
- Impact analysis of system performance on science products





Operations Headquarters & EPO: NCOA - Tucson, AZ

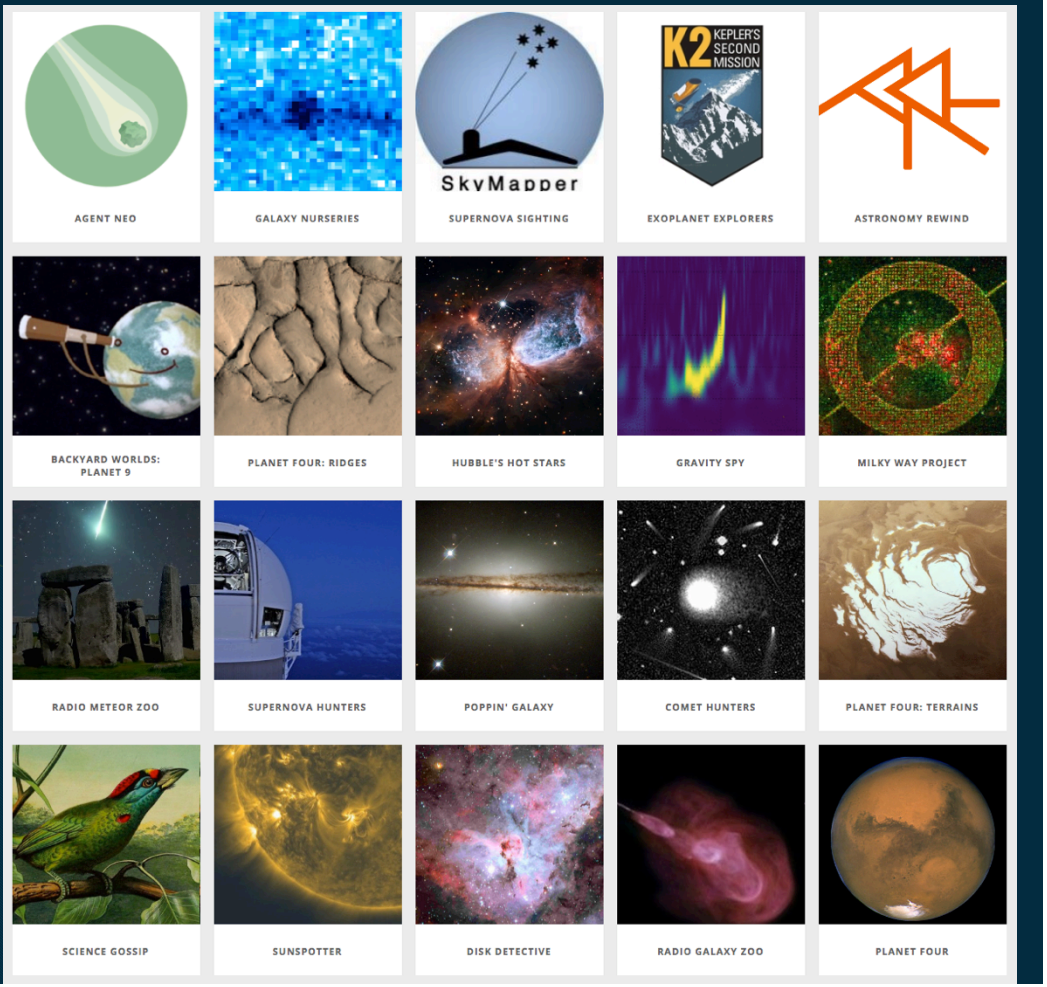
Directors Office:

- Agency interactions
- Safety and Compliance
- Business support

Education and Public Outreach:

- EPO Portal
- Formal Education and Data Access
- Citizen Science
- Planetarium and Science Center Support
- EPO data center (hosted)

zooniverse.org



Conclusions

Strengths of the LSST distributed system:

- Leverages expertise developed during the construction project.
- Places domain expertise where it is needed the most.

Challenges we will face:

- Maintaining coordination across the centers – communication needs are complex.
- Establishing processes to ensure overall system functionality as intended.