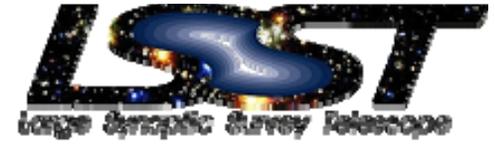


High level end-end DAQ *Group's Charge*

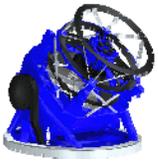


Develop and deliver a high-level block diagram(s) which describes the functions and relationships of all major components of the LSST data acquisition and end-to-end data flow, from the focal plane sensors to the final archive, sufficient to guide further design / development for all DAQ products and activities.

Including:

- image data acquisition and processing
- quality checks and feedback points
- wavefront sensor information
- global image motion compensation ("guiders")
- control signal acquisition and distribution (to actuators)
- engineering or housekeeping data
- and any other data-acquisition-related items
- **Calibrations**

➤ Progress but need iteration before final delivery



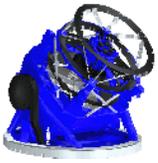
Working Report

Terry Schalk (chair)

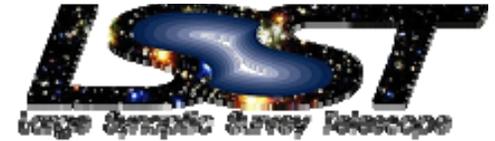
- Tim Axelrod
- Chuck Claver
- Mike Huffer
- Chris Smith

- Bill Althouse
- Jeff Kantor

• 8/18 19 9/9 23 29 10/6 13

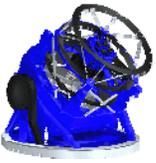


Time Scales of Data

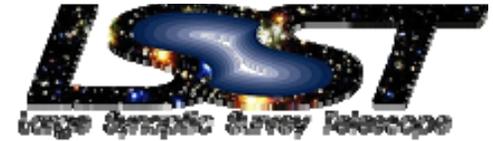


What do systems need to know in order to function and how often do they need it?

- Fast (less than 15sec.)
- Exposure-to-Exposure (~15-30sec)
- Visit-to-Visit (minutes)
- Nightly/Daily (hours)
- Weekly
- Monthly
- Yearly



Short time scales



➤ During an Exposure (<15 sec)

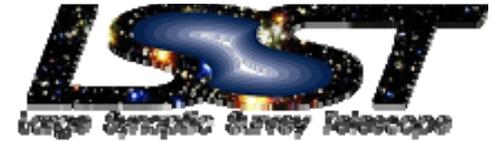
- Telescope Tracking ~1hz from camera guider(s)
- Telescope servos (many different one) (eg 20 hz)
- Emergency response (eg stop)
- All facility data acquisitions (eg power) includes ALL housekeeping and vendor supplied subsystems
- Camera exposure activities
 - Guiding ~100hz camera FPA
 - Shutter control
 - Camera Readout

➤ Exposure-to-Exposure (~15-30sec)

- Seeing information to scheduler
- Transparency information to scheduler
- Wavefront sensor data to TCS Reconstructor
- PSF shape info cross check
- Camera readiness/health/safety
- Electronics readiness/health/safety
- Telescope readiness/health/safety
- Facility readiness/health/safety
- Weather conditions updated
- Initiate/control/suspend exposure activities



Intermediate Time Scales



➤ Visit-to-Visit (minutes)

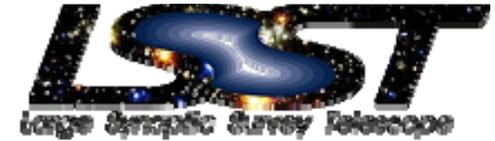
- Dome controls
- Telescope controls (eg slew complete)
- Active optics (mirrors+camera body)
- Aux telescope updates, input, usage
- Scheduler updates
- Facility data acquisition
- Filter changes
- WCS information
- Transient alerts?
- WCS solution
- Data repository ack/nak

➤ Nightly/Daily

- Calibrations
 - Dome flats
 - Data cube ?
- Data pipeline products and resultant actions
- Facility data products and resultant actions
- Control system mode changes (*e.g.* for maintenance or other daytime activity)
- Bias frames
- WCS corrections
- Scatter light?
- Illumination correction calculations



Intermediate Time Scales (cont'd)



➤ Weekly

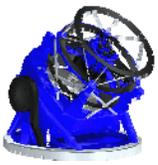
- Calibrations
 - WCS distortions
 - Photometric checkpoint fields (cadence ??)
- Amplitude, gain, read noise checks (cadence??)
- Fringe check data (cadence??)
- Facility trending

➤ Monthly

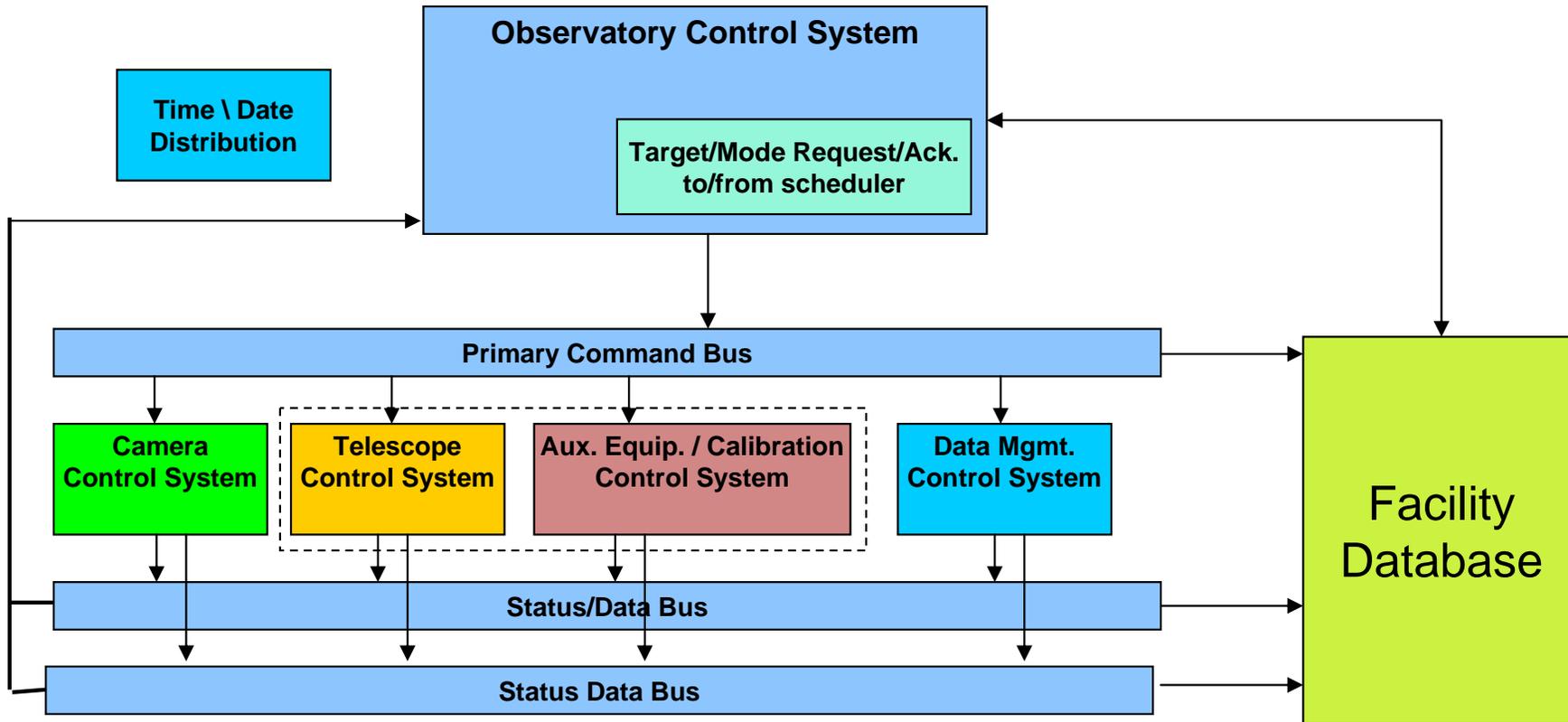
- Catalog Activity
- Science mission assessment
- calibrations

➤ Yearly (1-10 years)

- Data reprocessing
- Post servicing recalibration



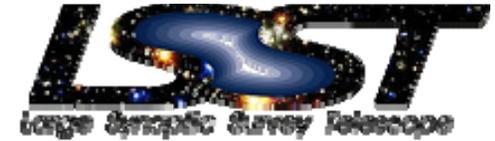
Diagrams – LSST System



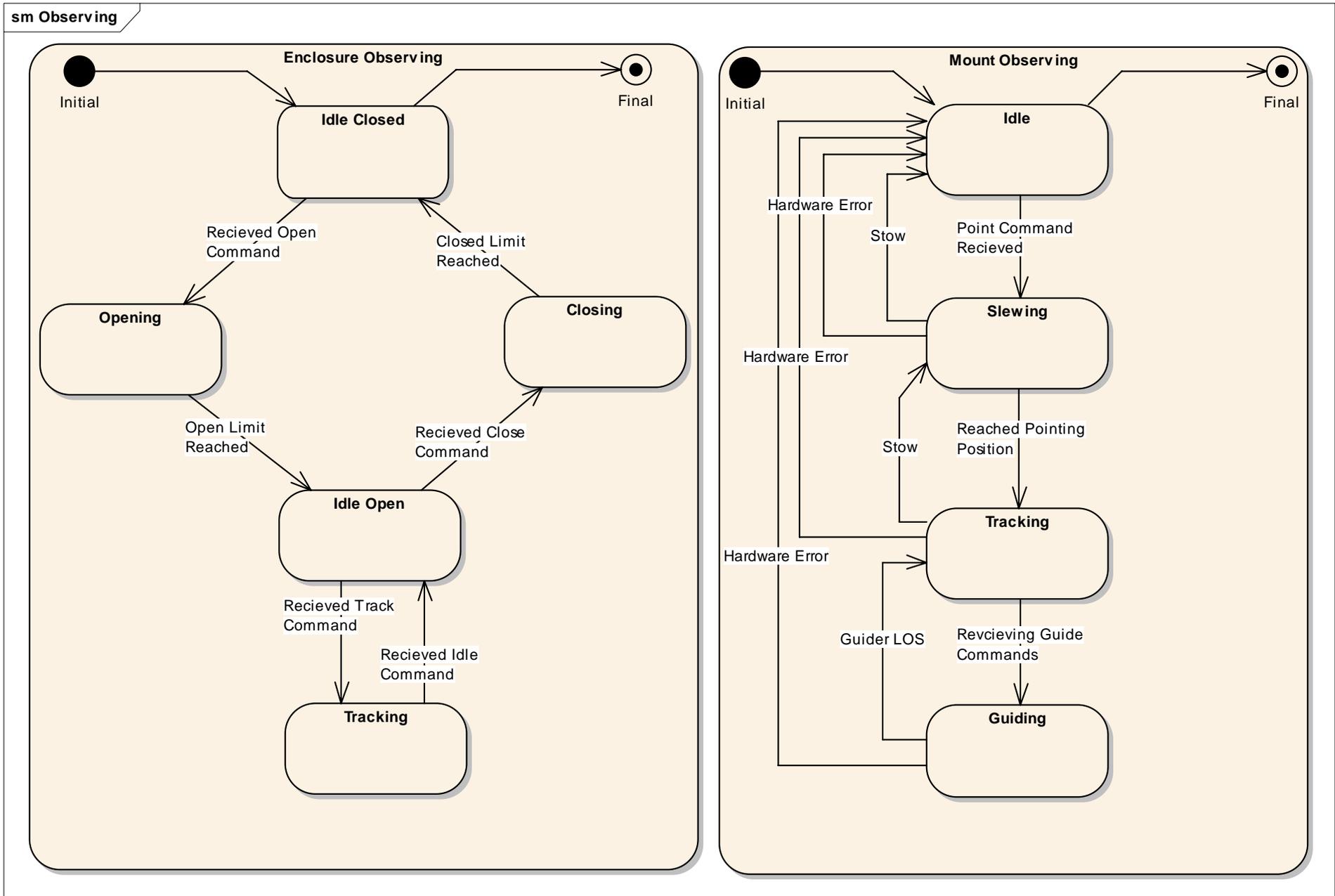
- Subgroups are assuming a Master/Slave arch

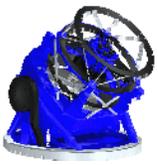


State Diagram: Observing

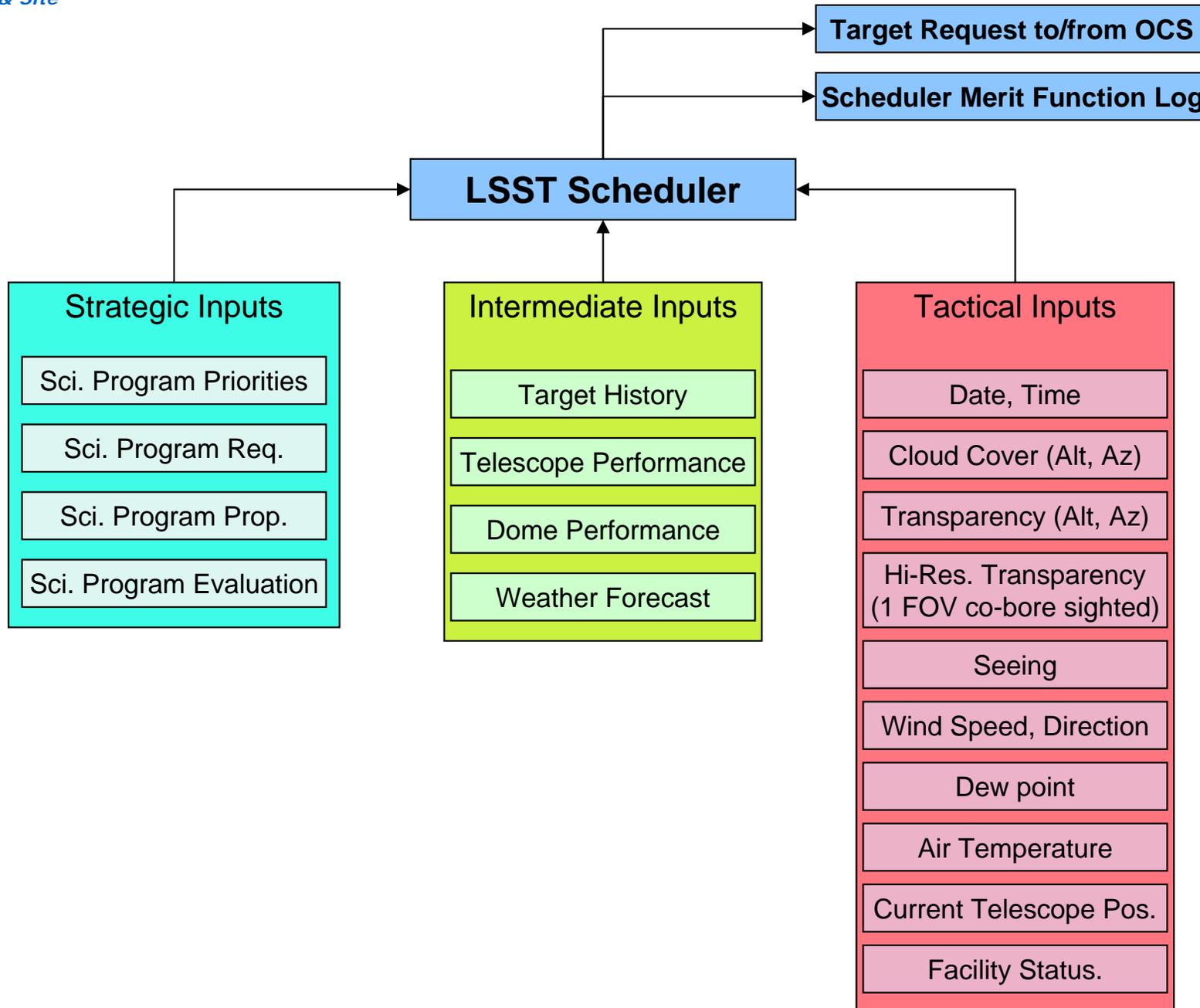
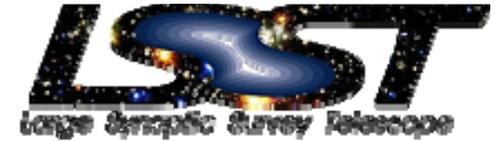


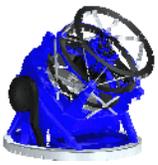
- Only 1 of many modes (calib develp/test obser idel) fleshed out here



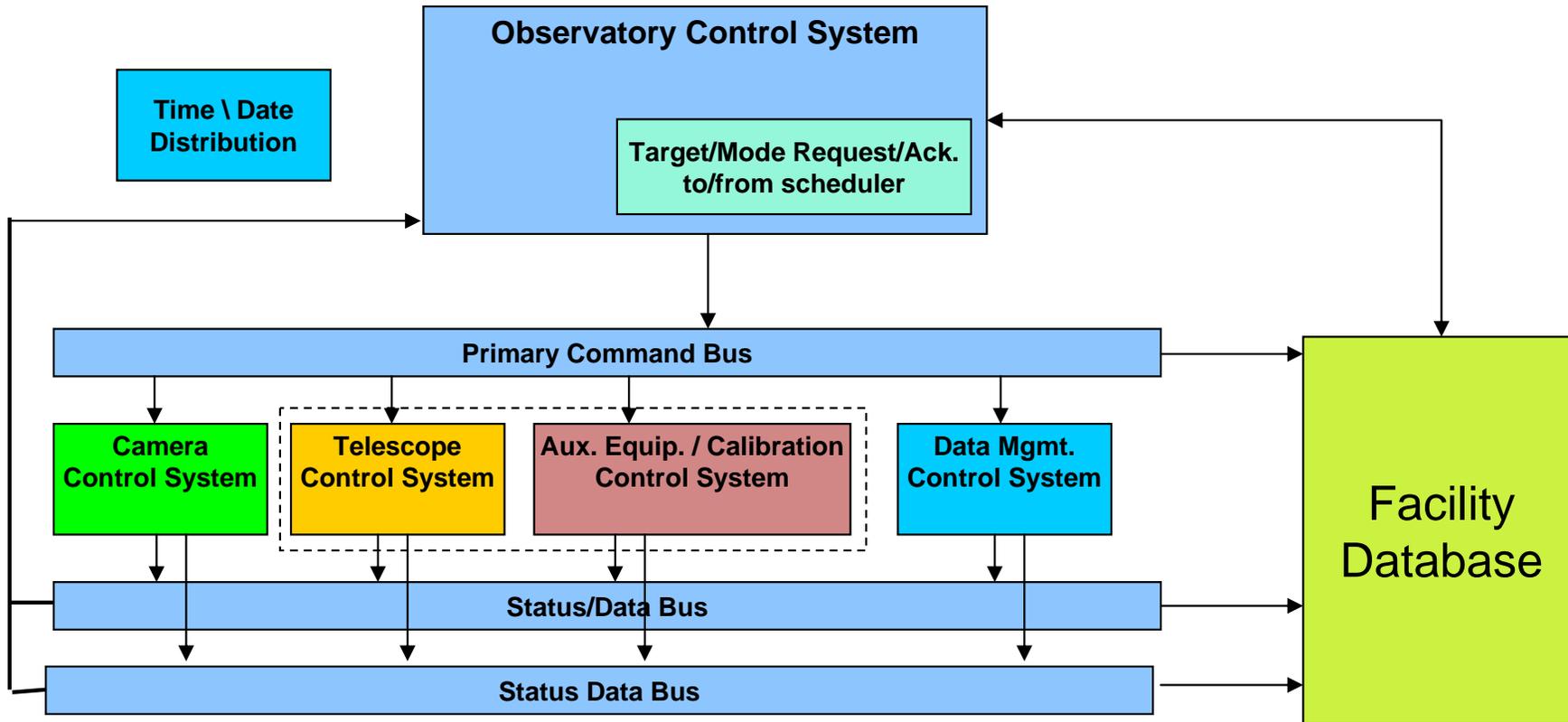
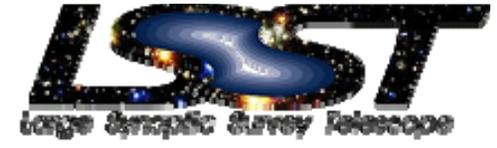


Diagrams – Scheduler I/O



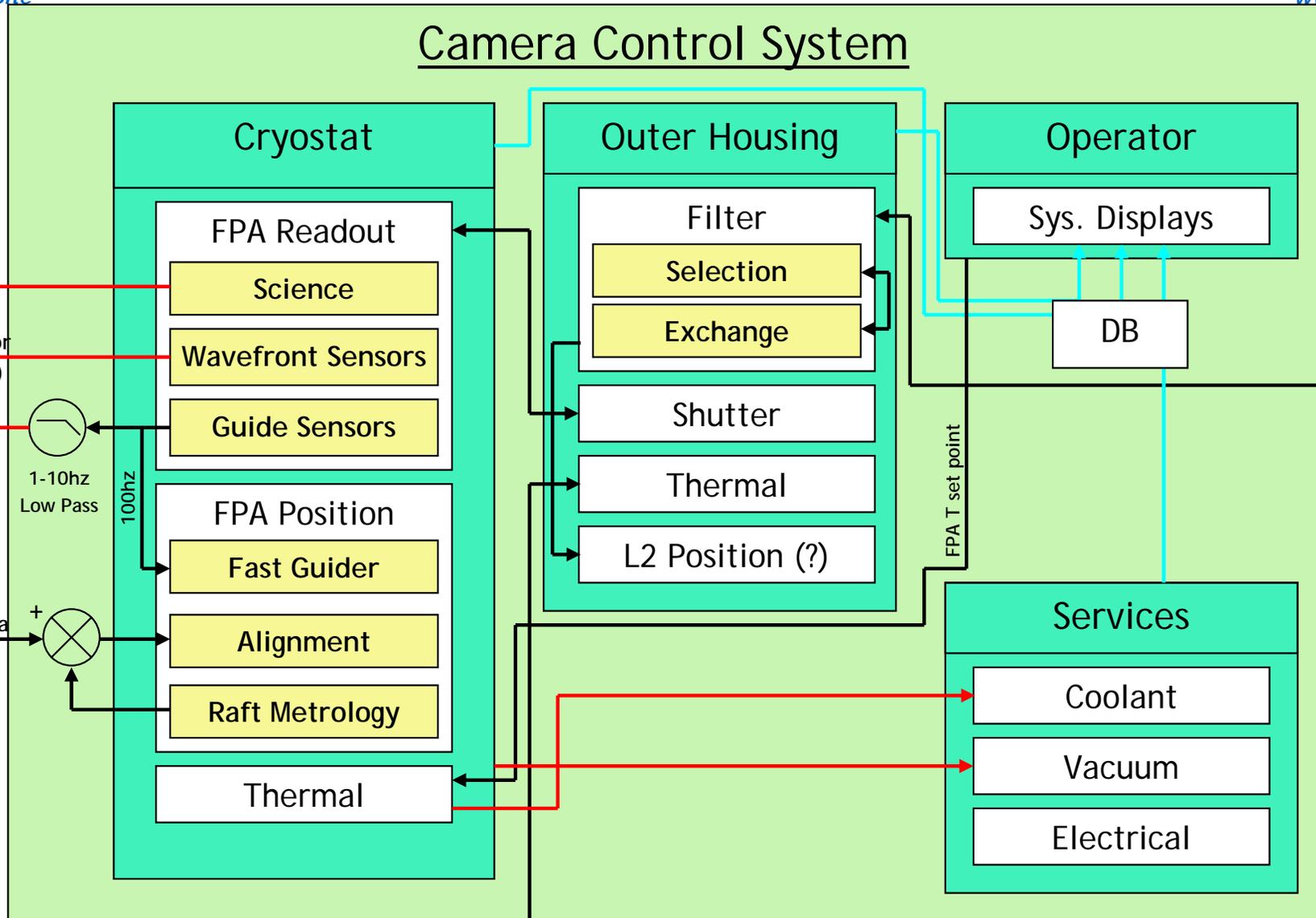
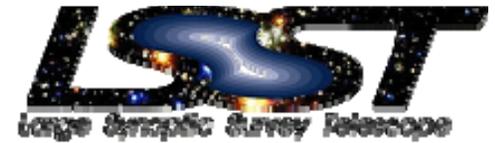


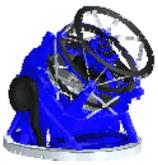
Diagrams – LSST System



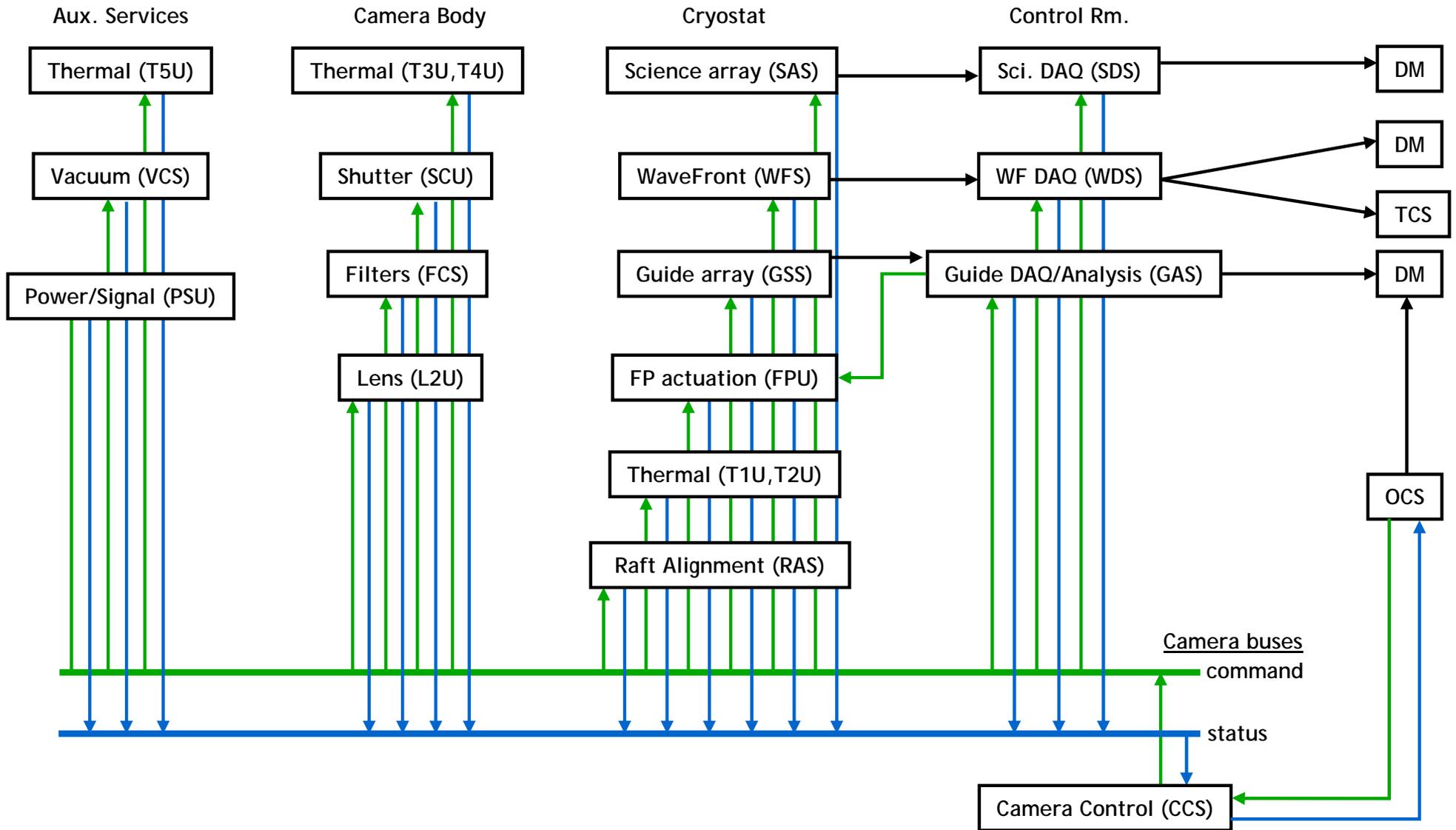
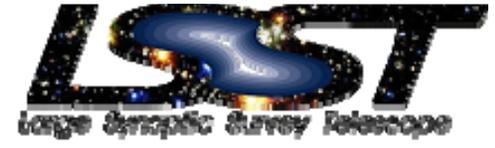


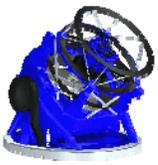
Camera Diagram



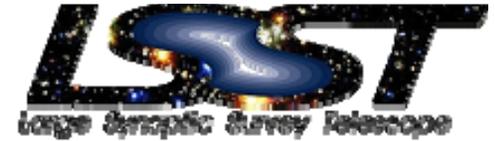


Camera Control



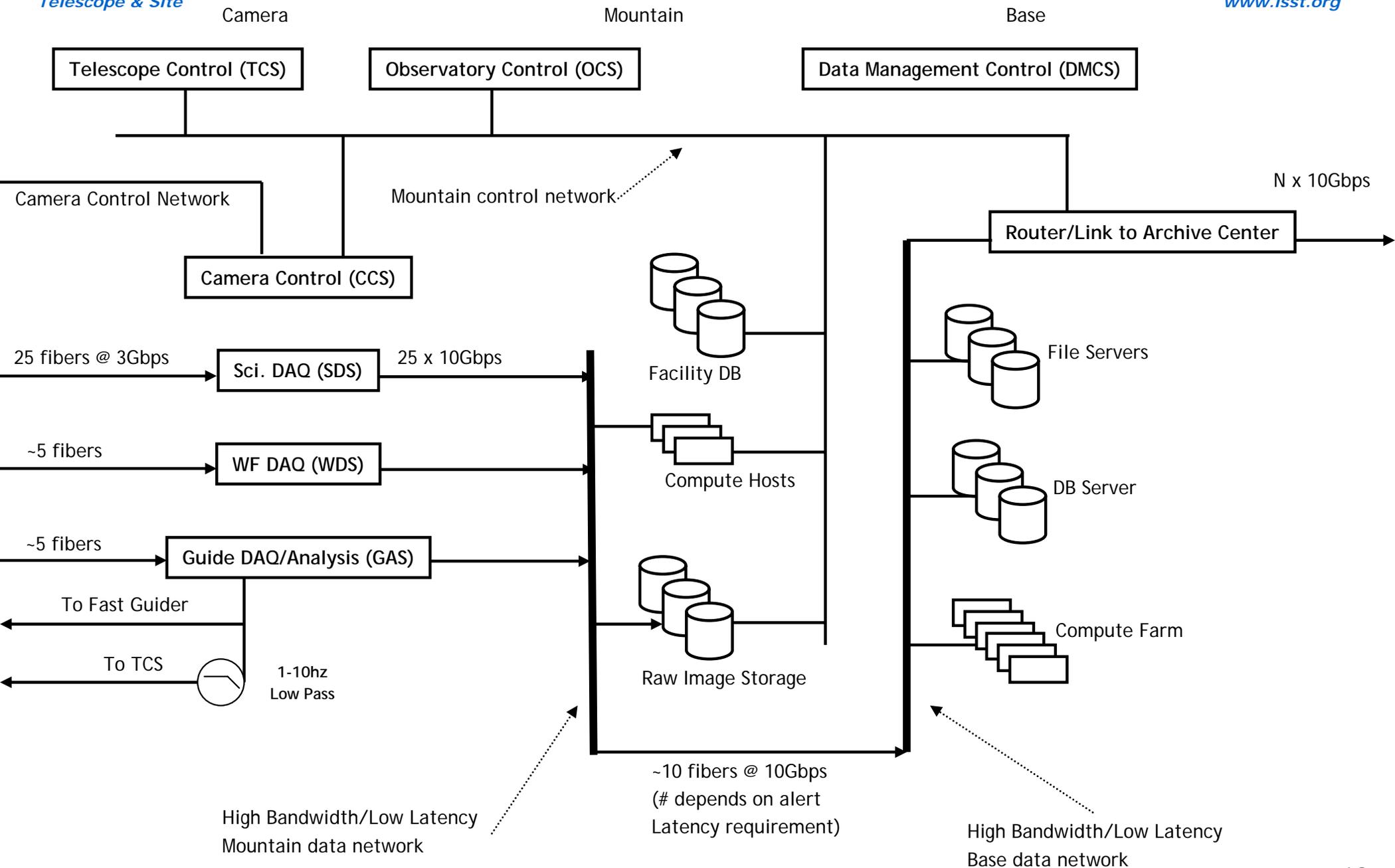


• Network centric view with some speeds and feeds



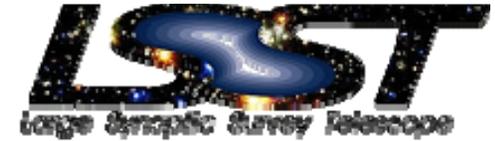
Telescope & Site

www.lsst.org

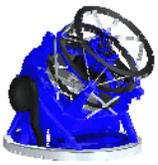




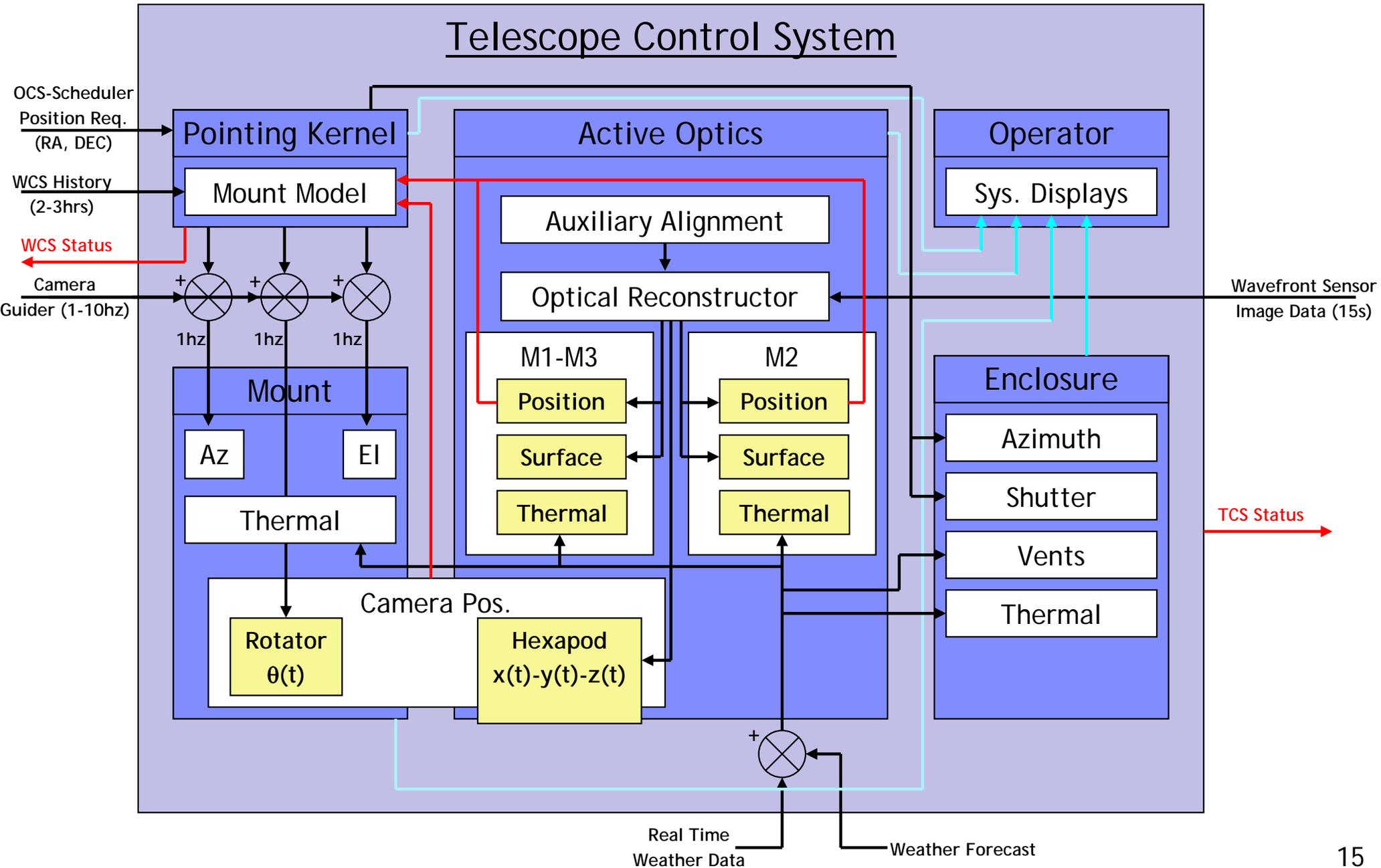
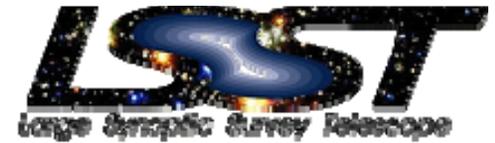
Camera Subsystems Nomenclature

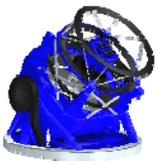


- Science array subsystem (SAS)
- Science array Data Acquisition Subsystem (SDS)
- Wavefront Sensor Subsystem (WFS)
- Wavefront Sensor Data Acquisition Subsystem (WDS)
- Guide Sensor Subsystem (GSS)
- Guide Sensor Analysis Subsystem (GAS)
- Focal Plane Actuation Unit (FPU)
- Thermal Zone 1 Subsystem (T1S)
- Thermal Zone 2 Subsystem (T2S)
- Thermal Zone 3 Unit (T3U)
- Thermal Zone 4 Unit (T4U)
- Thermal Zone 5 Unit (T5U)
- Raft Alignment Subsystem (RAS)
- Shutter Controller Unit (SCU)
- Filter Controller Unit (FCS)
- Vacuum Control Subsystem (VCS)
- L2 Controller Unit (L2U)
- Power and Signal Controller Unit (PSU)

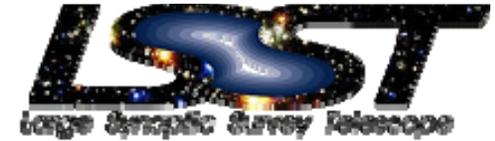


Telescope Diagram





Aux/Calibration Diagram



Auxiliary / Calibration Control

Calibration

2m Calibration Tel.

TCS

Spectrometer

Camera

Laser Illumination

Wavelength

Intensity / Flux

Auxiliary

Cloud Cover

IR All Sky Camera

Vis All Sky Camera

Weather

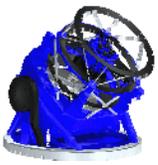
Current Conditions

Forecast

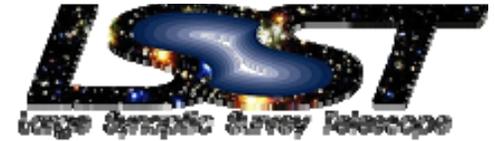
Atmosphere

Seeing (DIMM)

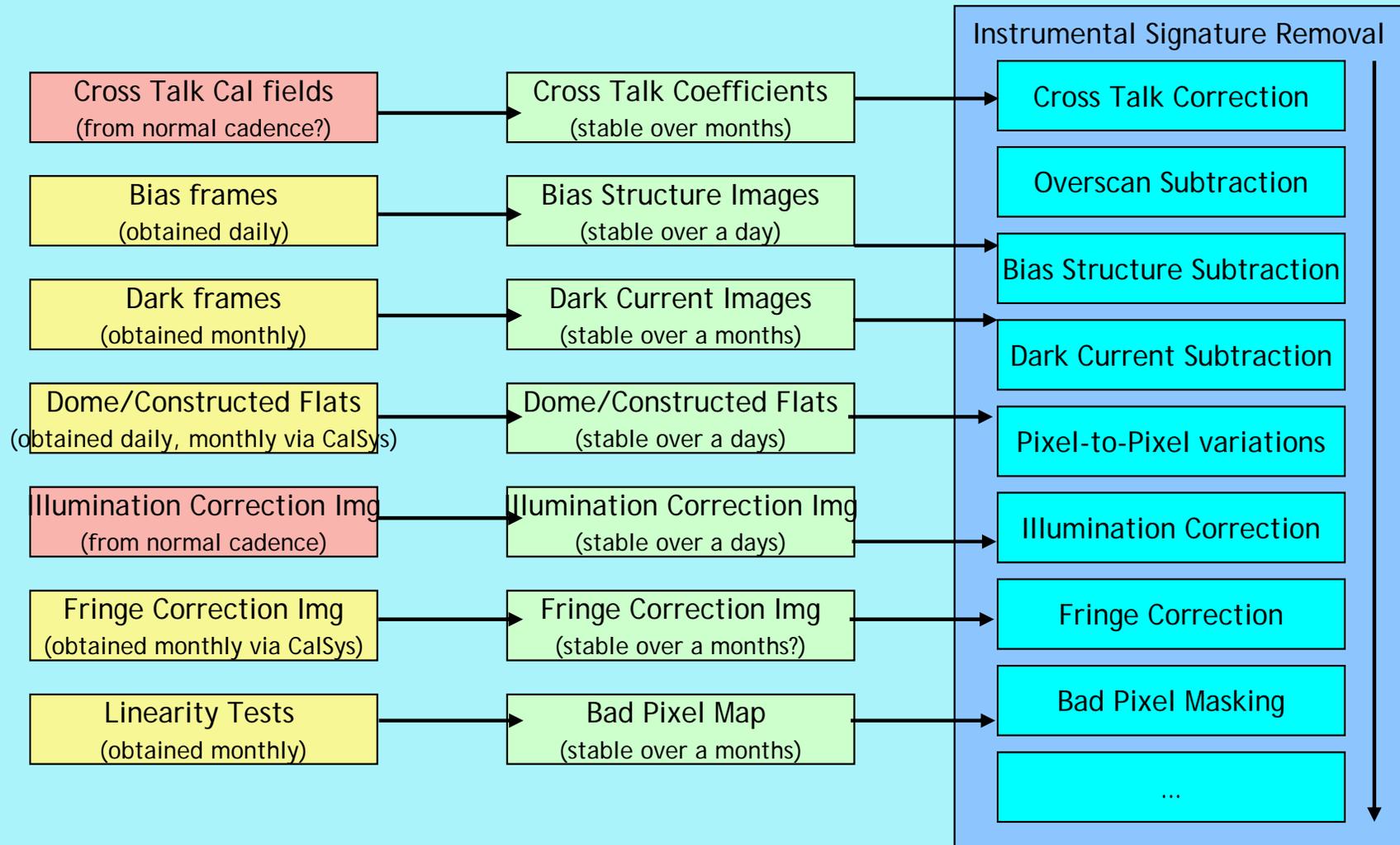
Vert. Struct. (MASS)



Calibration Processes 1

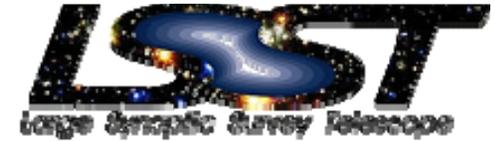


Calibration Processes: Instrumental Signature Removal





A Calibration “laundry” list



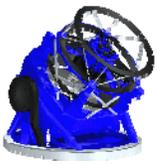
Instrumental Signature Removal

- cross talk correction
 - need calibration map done ~monthly/quarterly
- overscan (both x and y?)
- bias frame subtraction
 - Nightly/weekly
- dark frame subtraction
 - Weekly/monthly
- initial (dome) flats
 - Nightly weekly
- illumination correction
- fringe correction
- Stray and scattered light correction (if needed)
- Gain, noise and linearity knowledge
- Bad pixel map

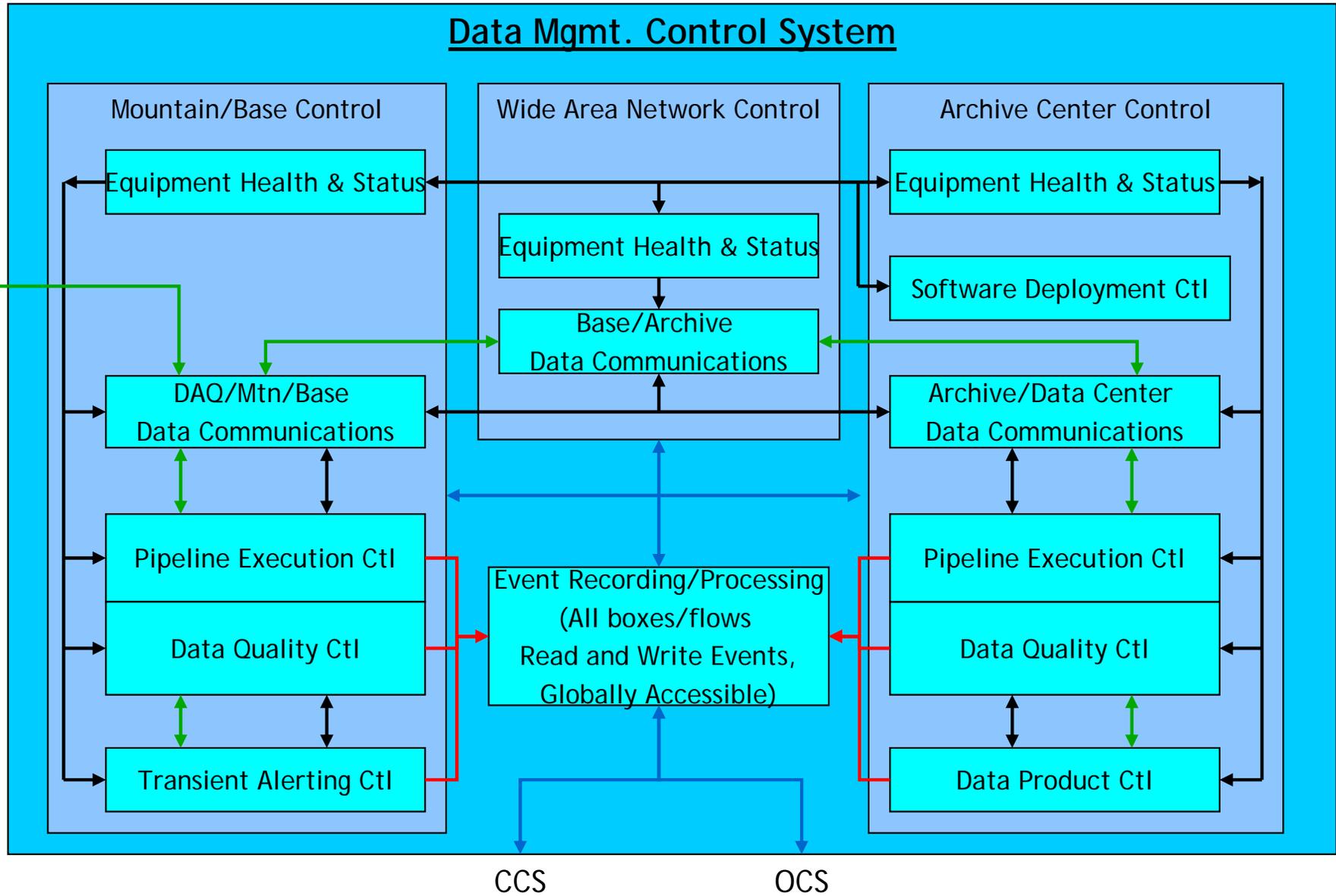
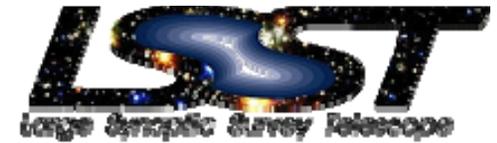
Image Calibrations

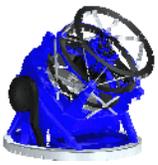
- World Coordinate System (WCS)
- System Transmission (end-to-end)
- “Natural System” photometric calibration
 - PSF measurement
 - Detector-to-Detector
- Transformation to other (“standard”) photometric systems
 - Zero point offsets
 - Color terms

- Others???

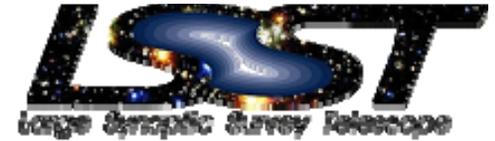


Data Management Diagram

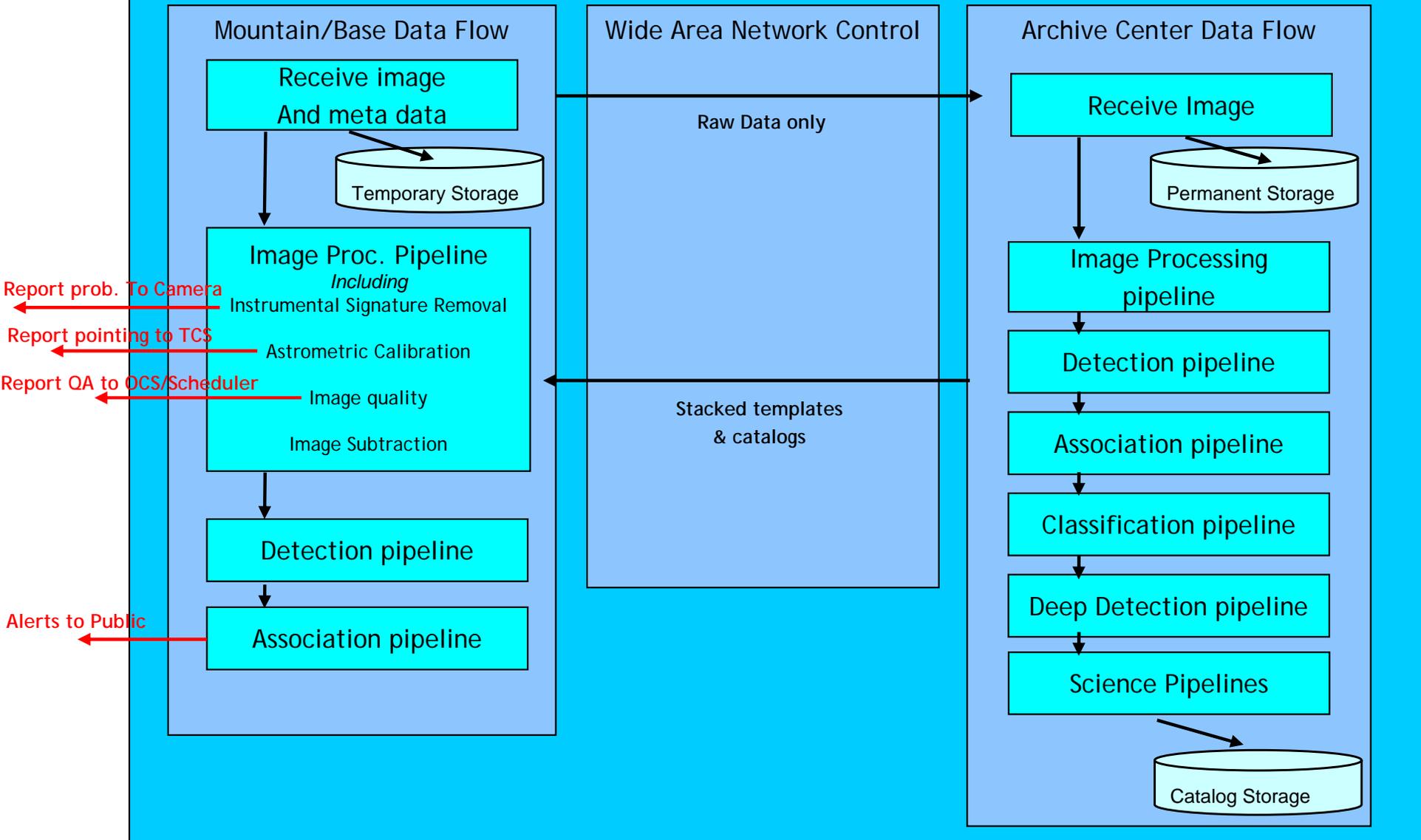




LSST Pipeline Data Flow

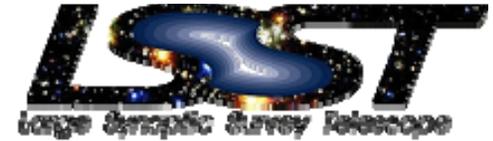


Data Mgmt. Pipeline Data Flow





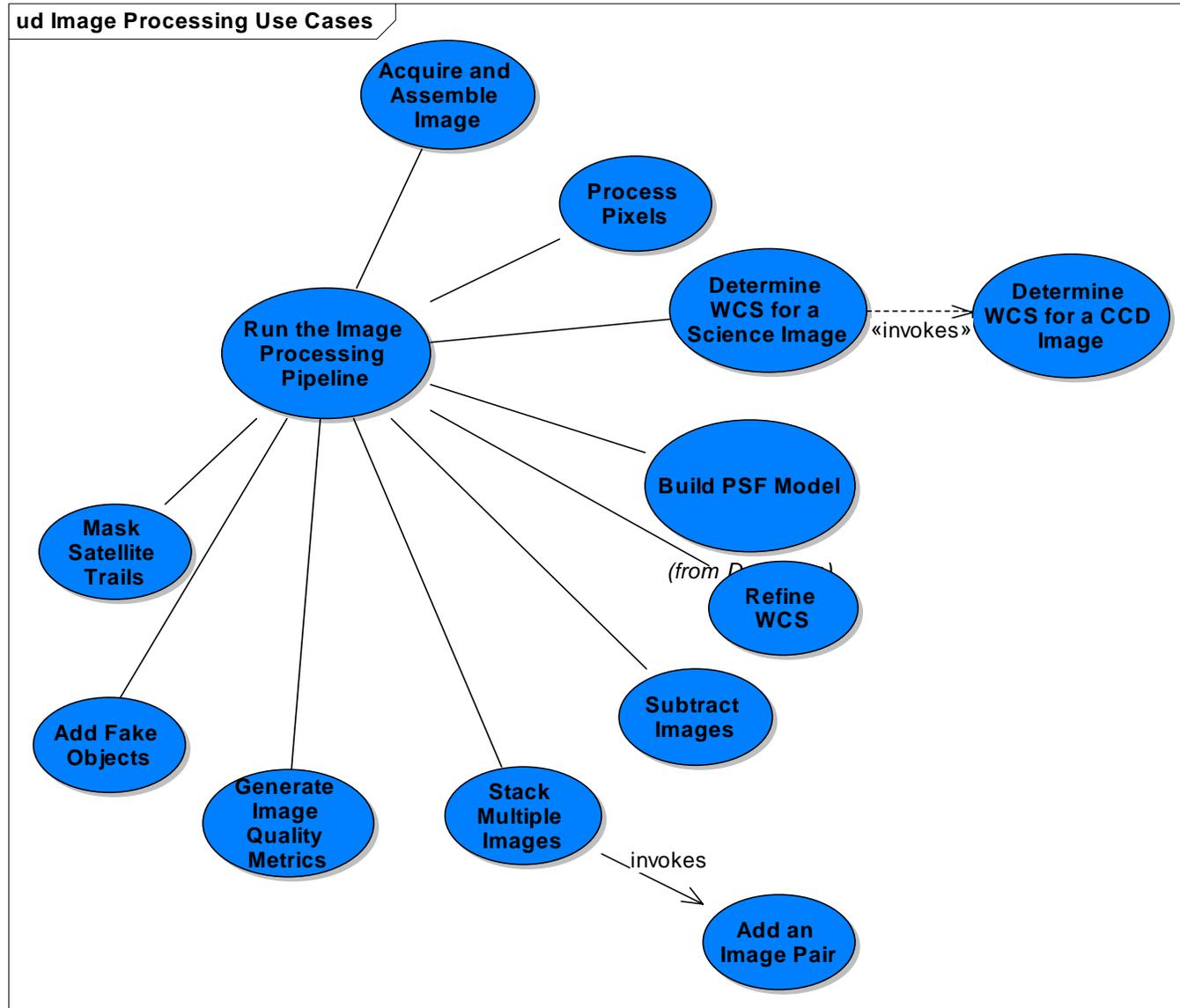
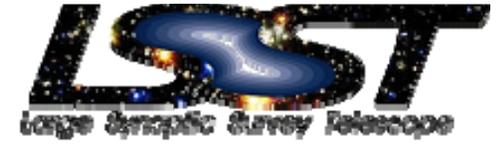
Nightly DM Products



- **Data Quality Report (t, λ) / filter human and machine readable**
 - Photometric zero point
 - Sky brightness versus time
 - PSF parameters
 - Detection efficiency of point sources as a function of magnitude
- **Calibration report**
 - Super-flat(λ) from all data taken
 - Bias image combined from all individual biases taken that night.
 - Compile statistics of comparison of these two images against “official” images in the calibration archive. (Indicators of telescope and camera problems)
- **Data Management System Performance Report**
 - # images successfully processed through each pipeline
 - # images for each pipeline that had recoverable failures -group by failure type (eg hardware or cpu / software failure cleared by automated intervention)
 - # images for each pipeline that had unrecoverable failures - similar grouping
 - # images archived at base camp
 - # images archived at archive center
 - # images satisfying the science criteria for each active science program

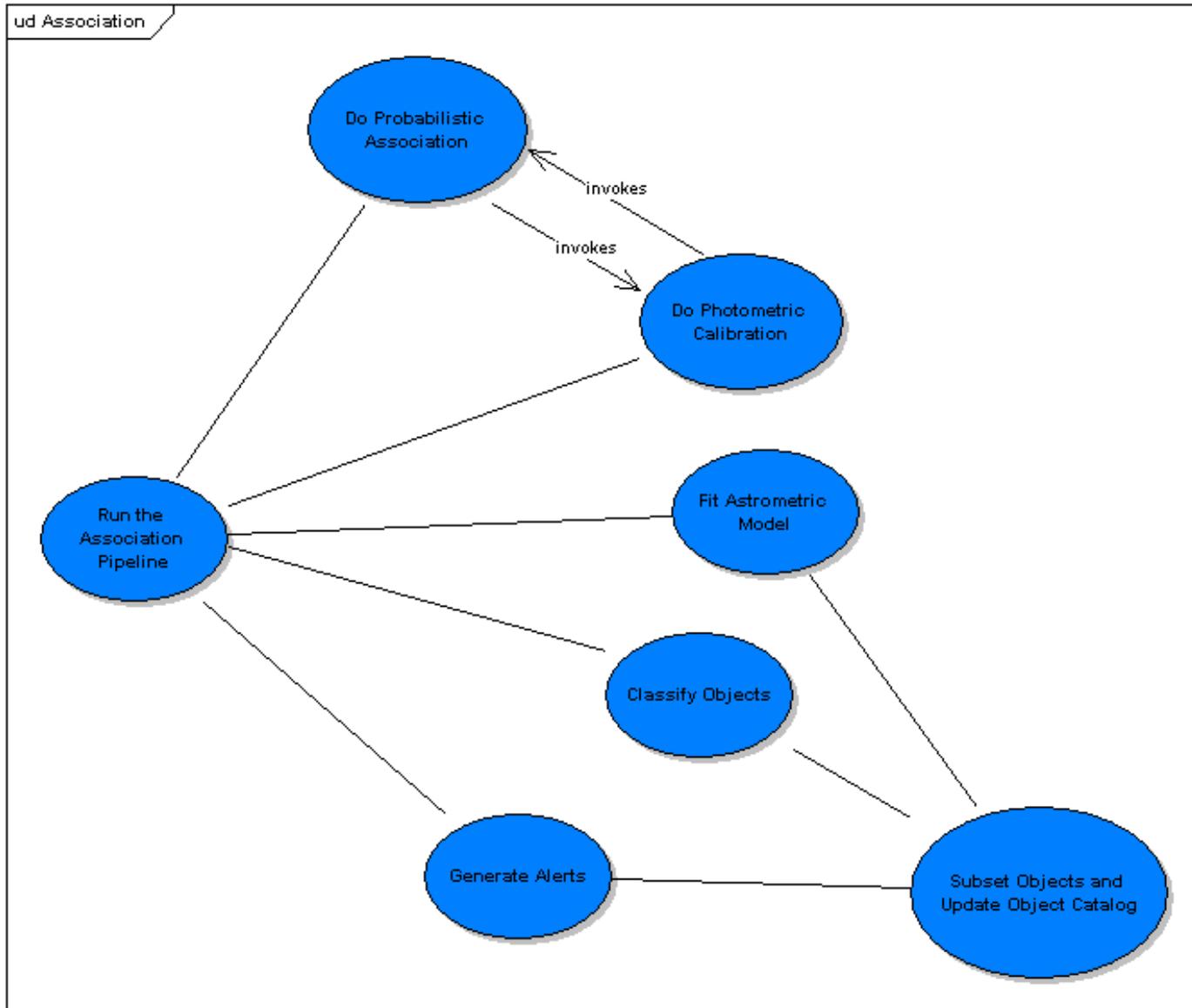
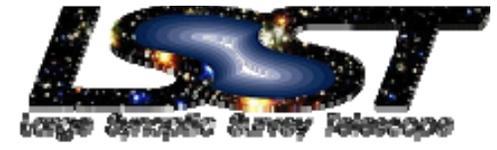


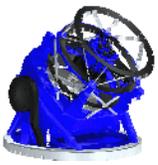
Sample Use Case Diagram: Image Proc. Pipeline



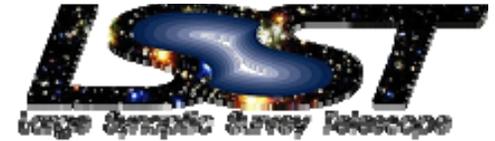


Association Pipeline Use Case





Next steps



- This is still work in progress
 - We intend to complete the highest 2 levels of system state diagrams and believe the subsystems need to complete theirs
 - The other data flow pipelines are being worked on

- Related work done by other subgroups should be referenced or pointed to

- Include Feedback