# Data Management Monthly Report April 2017

## High-level Summary/Status

- The Pathfinder Integration Activity #3 was held at NCSA in May. This brought members of the Camera, Telescope and Site, Data Management, and Systems Engineering teams together to run all the system connecting various simulators of the summit facility.
- The Architecture Team completed tasks related to documenting DM designs (including a new LaTeX-based documentation workflow and draft product tree), deployment (including understanding requirements), and drafting design concepts for integrating production workflows).
- The prototype AP system can now process arbitrary DECam data through the generation of processed visit images (PVIs).
- Performance and usability upgrades were made to the Footprint system which is used to represent collections of pixels corresponding to astronomical sources. Improvements were made to the prototype NMF ("Non-negative Matrix Factorization") deblender, improving reliability, computational performance, and scientific results.
- Added the capability to model pupil obscuration to the DM camera geometry system.
- The Prototype Data Access Centre (PDAC) now has a new function for cone searches targeting multiple positions. Client side image performance improvements were made in the portal.
- Qserv was tested and shown to satisfy 20% DR1 KPMs and scaling tests on the IN2P3 cluster.
- The La Serena – Santiago fiber measurements report from Telefonica looks very good. A more detailed report  is being prepared by REUNA. The Spectrum subaward from FIU to Angola Cables (AC) was signed and fully executed at FIU.
- The Chile IT Hiring Selection Committee interviewed both Network Engineer candidates and made hiring recommendations for the open Network Engineer and IT Tech positions.
- Several DM team members attended the project MagicDraw training session in Tucson.
- A JupyterLab prototype was built to investigate architectural options for the Science Platform notebook service. A notebook was developed demonstrating verification metric framework features
- EUPS-based binary distribution of the DM stack is undergoing beta testing.

# Risk Management

The DM Risk Register was reviewed in the monthly process.  No new risks were added and no significant changes to existing risk exposure were made.

# Detailed Project Progress and Status

## LSST Program Office

**DM Project Management and Control**

Current accomplishments:

The DM Project Manager:
Officially commenced work for AURA on April 3. Immediately presented DM status to AURA Management Council (AMCL). Commenced updating the DM Management Charter to become the DM project management plan (LDM-294). Went to NCSA to meet management team there and understand role of NCSA in DM. Prepared draft charge for NSF/DOE DM review in July. Prepared draft agenda and document list to answer charge for the DM review.

Planned activities:

DM Project Manager will:
Go to SLAC to better understand QSERV and other activities there. Setup and run DMLT F2F in UW.  Continue to work on review preparations.  Gather inputs for next cycle plan and update PCMS.

**DM Subsystem Science**

Current accomplishments:

DM Subsystem Science staff has implemented comments to the study of impacts of heterogeneous focal plane on DM (LDM-523), with the conclusion of no additional impact unchanged (Slater). We have started the analysis of feasibility of Spark as a data analytics engine for LSST datasets (Slater). We have finished the technical note proposing options for computations of photometric redshifts and submitted it to SST review (Graham), and continued work on clarifying DM's requirements and capabilities for LSST Special Programs (Graham).

We continue to perform Science Validation tests on the PDAC, reporting issues to the PDAC team (Suberlak). Finally, we have organized participation at the LSST:UK Science Working Group workshop in Edinburgh, UK (Juric, Bellm and Lupton; Collection-5517 and Document-25798).

**Graham:** The journal manuscript "Photometric Redshifts with the LSST: Evaluating Survey Observing Strategies with a New Nearest-Neighbors Estimator" (Graham et al.) entered and remains in the LSST internal review process. The internal document evaluating the "LSST DRP Level 2 Catalog Photometric Redshifts" was circulated to the DESC-PZ working group and their feedback has been incorporated. Work on the internal document "Data Management and LSST Special Programs", which takes a close look at the DM requirements for processing images from special programs and the future needs of the science community, continued.

**Slater:** Finished edits of the heterogeneous focal plane report in response to comments. Continued work writing up the star-galaxy separation paper. Began investigations into using Spark on Amazon AWS for querying databases. This is initially aimed at understanding the mechanics of the system, with the longer term goal of assessing its performance and usability.

**Suberlak:** Completed single-object tests: detailed comparison of the S82 PDAC data to the UW-hosted clone of S82 data, evaluated the user experience of the Time Series View, analyzed the performance and accuracy of period detection with the periodogram tool, submitted specific recommendations for improvements to the PDAC team. Tested the user interface of External Images and External Catalogs, directly leading to fixing a bug of image cutouts misalignment (DM-10441).

Planned activities:

- Continue PDAC validation activities the goal of wrapping up Phase #1 validation report (Suberlak).
- Shepherd Photo-z paper and study through review and change control process (Graham).
- Circulate the "DM & Special Programs" document to the DM-SST team, incorporate feedback and continue to work on identifying/resolving potential issues (Graham).
- Continue work on star/galaxy separation (Slater).

**DM System Engineering**

Current accomplishments:

The entire team attended four days of MagicDraw training to prepare for the tool transition and increased use of model-based systems engineering.

System Architect:
- Helped interview stakeholders to understand deployment and provisioning needs for DM services.
- Delivered an initial product tree for LDM-294 along with some descriptive narrative in LDM-148.
- Answered several questions related to engineering trade-offs involving cost and sizing of bandwidth and storage.
- Reviewed Summit computer room specifications.
- Described potential interactions of workflow, Butler, and SuperTask components in production.

Deputy System Architect:
- Made first official release of the new LSST LaTeX classes and published associated documentation on https://lsst-texmf.lsst.io.

DM System Interfaces Scientist:
- Chaired SuperTask working group; main activity in April was exploring the requirements and design space around DataId-mapping required to support data grouping and parallelization changes for LSST workflows.
- Attended 3-day "early integration exercise #3" meeting at NCSA. Constructed proposal for the rest of the early integration timeline.
- Provided detailed functional input to design of "image header service" and "EFD reformatting" components.
- Attended 4-day MagicDraw training session at LSST-Tucson.
- Refined 2017 planning for PDAC and Science Platform development, in preparation for May DMLT and F17 planning.
- Continued revision process for LSE-72.

Planned activities:

DM System Architect and Deputy System Architect will:
- Complete product tree, architecture diagrams, and component descriptions.
- Trace LSE-61 Data Management requirements to components.
- Support visit to SLAC by new DM Project Manager.
- Analyze flow down of LSE-63 to Data Management requirements.
- Work on MagicDraw SysML requirements model.
- Attend face to face DMLT meeting.

- Attend "Building the Infrastructure for Time-Domain Alert Science in the LSST Era" meeting in Tucson.
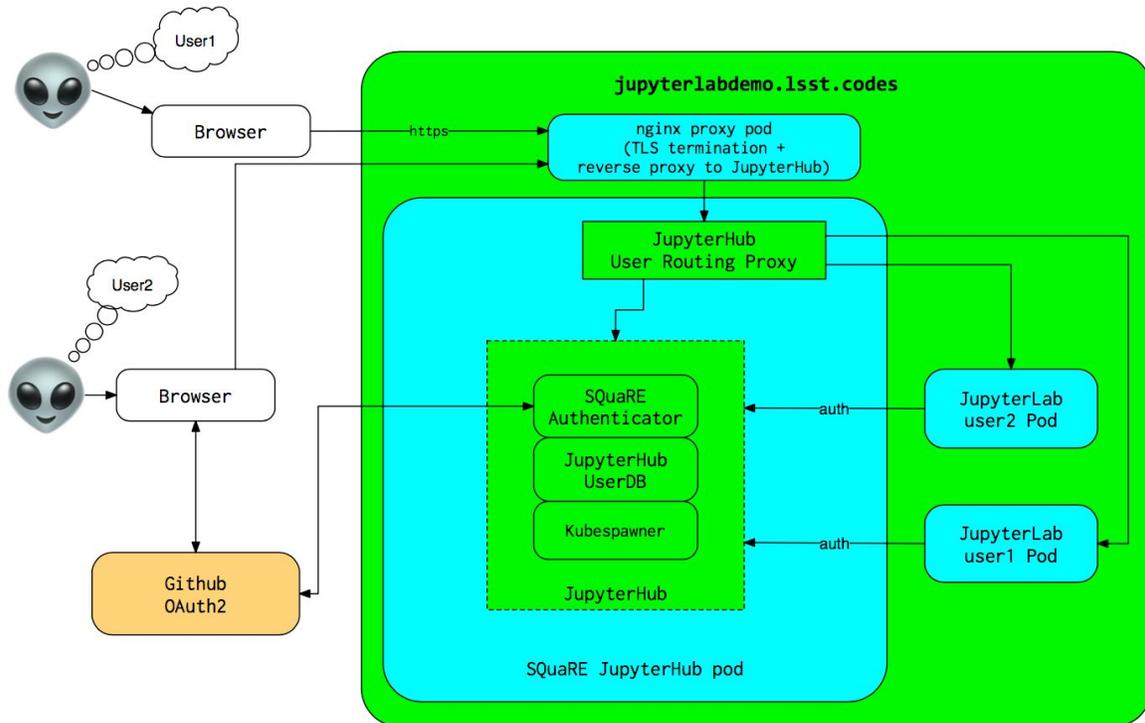
DM System Interfaces Scientist will:

- Attend face to face DMLT meeting.
- Prepare SuperTask design requirements document and a draft functional design, together with the SuperTask Working Group.
- Trace system-level ICDs to newly defined DM components.
- Refine early integration exercise timeline.

# DM Science Quality and Reliability Engineering (SQuaRE)

Current accomplishments:

- We started (and completed) a time-boxed epic to evaluate Jupyterlab via prototype activities with an eye to Science Platform capabilities. As a result we now have:
  - An experimental sandbox at jupyterlabdemo.lsst.codes (not a stable service; frequently redeployed with no notice; functionality subject to change).
  - A Dockerfile for installing JupyterHub and JupyterLab components onto our LSST stack container and exposing the stack kernel to Jupyter.
  - A Kubernetes configuration to deploy this service on the GKE cluster.
  - Our deployment involves JupyterHub spawning Jupyterlabs in individual pods based on a SQuaRE's CI-built Docker container distribution of the stack.
  - Authentication to this service via SQuaRE's usual "shim" authentication mechanism that uses Github organization membership for OAuth authentication
  - Consistent Unix uid/gid mapping for users using Github as a shim (your user id is your github id, your groups are the orgs you belong to).
- Our assessment is that JupyterLab provides a well-engineered, actively supported and scalable platform that is eminently suitable as the basis for the user notebook component of the science platform. We hope to discuss this in the wider DM Architecture setting.
- A technote describing our prototype has been published as SQR-018. It is being regularly updated with the latest progress. A representation of the architecture is shown below.

**jupyterlabdemo.lsst.codes**

nginx proxy pod
(TLS termination +
reverse proxy to JupyterHub)

JupyterHub
User Routing Proxy

SQuaRE
Authenticator

JupyterHub
UserDB

Kubespawner

JupyterHub

SQuaRE JupyterHub pod

JupyterLab
user2 Pod

JupyterLab
user1 Pod

Github
OAuth2

Browser

User1

User2

https

auth

auth

Work in Progress!
Does not represent architecture
of Science Platform

In green: SQuaRE deployment on GKE

- Opportunistically, Simon Krughoff (UW) alpha-tested our notebook service as part of generating demonstration videos for the LSST:UK Phase B Workshop. This was very useful to us and we thank Simon his feedback. His videos can be found here: http://ls.st/bgt and a partial screenshot of one of his notebooks executing on our service is shown below. Colin Slater (UW) also took the system for a test drive. Our thanks to both for this contributed effort.

```
In [5]:  import lsst.afw.geom as afw_geom
         bbox = afw_geom.Box2I(afw_geom.Point2I(1024, 1024), afw_geom.Extent2I(512,512))
         sources = butler.get('src', visit=410877, ccd=28, filter='r')
         overlay_masks(exp, bbox=bbox, sources=sources)
```
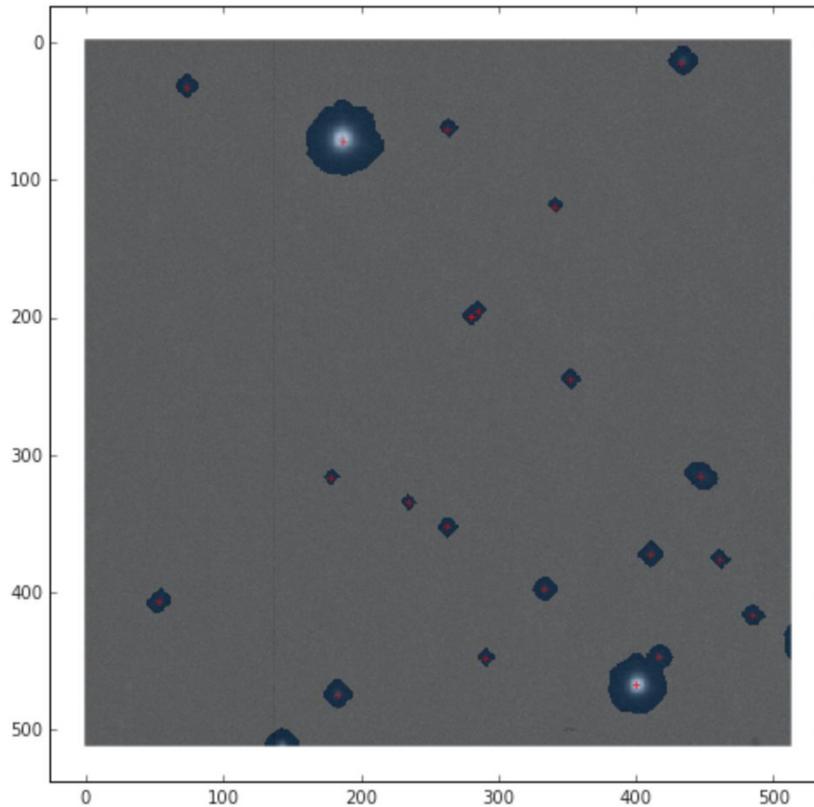


- Various improvements to SQuaSH including prefetch/caching to improve performance
- Work on the verification framework triggered by the work on in-task metric capture is now in an advanced state of design and implementation; see SQR-019 (work in progress, on master to allow easier circulation for comments) which is also a notebook demonstrating aspects of the design.
- The work on automated production of a binary distribution reached beta-testing phase. During testing we established that the eups table expansion slows down progressively so that a binary install of lsst_distrib takes 1-1.5 hours, nullifying one of the key advantages of binary distribution. However upon consultation with Science Pipelines we have agreed to deploy the new distribution server and reap the speed-up later when eups is fixed upstream.

Planned activities:
- Add small amount of persistent storage to our Hub/Lab demo to allow alpha-users to keep some notebooks around for testing.
- Tooling to enable Travis gatekeeping for flake8 compliance and branch protection.

- Verification plan work.

- None planned.

# University of Washington

Current accomplishments:

02C.03.00 - Alert Production Management Engineering and Integration
- Morrison went to the DESC hack week at Fermilab.
- Rawls worked on the AP prototype. This included finishing the prototype through the "calexp" step (DM-8800, DM-10298, DM-10297)

Hiring
- No activity.

02C.03.01 - Single Frame Processing Pipelines
- Findeisen worked on the system that will replace the current 2-D to 2-D coordinate transforms (DM-9599).

02C.03.02 - Association Pipelines
- No advancements in this area.

02C.03.03 - Alert Generation Pipelines
- Patterson researched technology for the alert filtering mechanism (DM-10025).

02C.03.04 - Image Differencing Pipeline
- Sullivan improved the DCR corrected template generation test suite (DM-10132).
- Reiss continued to work on the spatial correction for the image differencing algorithms.

02C.03.05 - Application Framework for Exposures
- Findeisen improved long term maintainability of the afw package (DM-4639).
- Along with pushing the prototype AP pipeline forward, Rawls fixed bugs uncovered in the process of doing the work (DM-10008, DM-10206, DM-8842).

- Owen focused on taking care of technical debt including improving unit tests and fixing issues left over from the pybind11 port (DM-10146, DM-9596, DM-10292, DM-10108, DM-10328, DM-10096, DM-9712, DM-10114).

02C.03.06 - Moving Object Pipelines
- No advancements in this area.

02C.03.07 - Photometric Calibration Pipeline
- Parejko implemented the spatially variable PhotoCalib model in jointcal (DM-9192).

02C.03.08 - Astrometric Calibration Pipeline
- Owen removed astrometry.net as a direct dependency of the stack, though the default is still astrometry.net (DM-2186).
- Morrison implemented the improved matching algorithm and began validating it.

Planned activities:

02C.03.00 - Alert Production Management Engineering and Integration
- Rawls will attend Python in Astronomy.  Patterson will attend IVOA in China and the broker workshop in Tucson.  Krughoff and Bellm will also attend the broker workshop. Krughoff and Bellm will attend the DMLT meeting.
- Rawls will complete the prototype system and begin looking at a refined design for the MVP.

02C.03.01 - Single Frame Processing Pipelines
- Owen will continue work on the WCS replacement

02C.03.02 - Association Pipelines
- No planned work.

02C.03.03 - Alert Generation Pipelines
- Patterson will implement a proof of concept filtering system.  She will also benchmark the current system.

02C.03.04 - Image Differencing Pipeline
- Reiss will get the image difference system to a point where he can take a break to help with other efforts.
- Sullivan will continue with the stackification process and documentation of the DCR correction algorithm.

02C.03.05 - Application Framework for Exposures
- Findeisen will look into the current status of the stack PSF estimation.

02C.03.06 - Moving Object Pipelines
- No planned work.

02C.03.07 - Photometric Calibration Pipeline
- Parejko will work on improving the spatially variable photometric model in jointcal.

02C.03.08 - Astrometric Calibration Pipeline
- Morrison will begin the verification process for the new matcher.

Recruitment update:  N/A

# Princeton University and University of California, Davis

Current accomplishments:

02C.04.00 - Data Release Production Management Engineering and Integration
- Travel & meetings:
  - Jim Bosch took part in the DESC Hack Week in Batava, IL during the week of 3–7 April.
  - Jim Bosch and Robert Lupton took part in the LSST UK Phase B Preparation Workshop in Edinburgh, UK during the week of 24–29 April.
- Management & planning:
  - A document describing plans for large-scale reprocessing of the Hyper Suprime-Cam Public Data Release 1 ("PDR1") on the LSST Verification Cluster

during the Fall 2017 cycle was produced and distributed to the DM Leadership Team for comments. [DM-10104]

- DMTN-044, a technical note suggesting approaches to software release and distribution policy within DM was written and distributed to the DM Leadership Team for comments. This will form the basis of a discussion session at the May 2017 DM Leadership Team meeting.

- Data Management replan [DM-8494]:
  - The outstanding changes to the Calibration Products Production section of LDM-151 — the Science Pipelines design document — have been submitted to the DM Subsystem Scientist for inclusion in the document. [DM-8066, DM-9131, DM-9132, DM-9136, DM-10197]
  - On request, a presentation was prepared and delivered to the LSST Project Science Team on DM's plans for processing crowded fields. [DM-9993]
  - A detailed proposal for storing "heavy footprints" — representing the regions of an image which correspond to particular sources, together with the deblended pixel values — as part of data releases has been drafted by the DRP team. This document is now available as LDM-513, and is now being considered by the DM Technical Control Team.

- Quality assurance [DM-8299]:
  - The DRP team has continued to cooperate with colleagues at NCSA to prototype large-scale processing of HSC PDR1 on LSST owned hardware.
  - The fix described last month to the way that corrections derived from the meas_mosaic calibration tool are applied to data has been validated and applied to the stack. [DM-9862]
  - The standard set of analysis plots produced by the DRP test suite have been enhanced to make it possible to highlight user-specified subsets (based, for example, on a particular flag being set) of the data. [DM-9381]

02C.04.01 - Application Framework for Catalogs

- Middleware evolution [DM-1109]:
  - The DRP team has continued to contribute to the SuperTask Working Group. During this month, a pseudocode implementation of a SuperTask-based system for performing coaddition was developed. A detailed description of the work is available on Confluence. [DM-10145]

- Implementation of new Footprint system [DM-3559]:
  - We use Footprints to represent contiguous regions of pixels on images, typically representing astronomical source detections. The Footprint system has been being overhauled during this cycle to provide a cleaner, more usable API coupled with a higher-performance implementation.

- A final review of the Footprint design as implemented was completed, and a few minor suggestions for improvements were incorporated. [DM-9996]
- All supported code in LSST repositories was modernized to make use of the new Footprint system. [DM-8108]
- Documentation for revised Footprints was completed and published at https://afw.lsst.io. This is a temporary site — ultimately, the material will be incorporated into the overall Science Pipelines documentation at https://pipelines.lsst.io — but it serves to illustrate the format and functionality that future Science Pipelines library documentation will take. [DM-7177]
- This work package is now complete.
- Emergent work and reduction of technical debt [DM-8136]:
  - A number of minor bugs and typos have been fixed across the codebase. These did not represent significant changes to available functionality.

02C.04.02 - Calibration Products Pipeline
- Auxiliary telescope development [DM-8151]:
  - Work has continued through this month on the development of a camera ("obs") package which will enable us to ingest test data taken on the 0.9m telescope at CTIO into the LSST stack for processing. Providing all the required functionality to support CTIO 0.9m data processing has involved substantial changes and bug fixes across our codebase. [DM-9363, DM-9991, DM-9992, DM-10094, DM-10142, DM-10225, DM-10252, DM-10270]
- Access to camera test stand data [DM-8292]:
  - This epic has run in concert with the development of a camera package for the CTIO 0.9m, described above: a similar set of bugs have been fixed and tweaks made to our existing codebase. Much of the work applies to both work packages equally. [DM-9990, DM-10109, DM10221, DM-10233]
- Photometric Calibration [DM-8276]:
  - Work continues to adopt the Rykoff & Burke "Forward Global Calibration Method", as deployed on DES, to operate within the framework of the LSST stack. This will provide a powerful method of providing a "global" photometric calibration typing together photometry over large areas of sky. Although this approach may not be necessary in operations (our hope is tying LSST's photometry to Gaia will render it unnecessary), it will remain an essential tool for development and testing with precursor surveys. [DM-9283]

02C.04.03 - PSF Estimation
- Wavefront measurement and PSF reconstruction [DM-1909]:
  - The camera geometry framework ("camGeom") has been updated to provide all of the information about the instrument which is required to implement the "donut fitting" pipeline. Most notably, this involved adding the ability to model the pupil obscuration. This machinery is general purpose — it can be used for any camera — but, is currently only in use with Hyper Suprime-Cam. [DM-9572]

02C.04.04 - Image Coaddition Pipeline
- PSF homogenization [DM-8289]:
  - We require that the kernel being used to match PSFs is smaller than the PSF itself. However, this constraint sometimes leads to it being impossible to choose an appropriately sized kernel. It is now possible to "pad" the PSF being matched to arbitrary dimensions, thereby increasing the range of kernel sizes which can be used. [DM-9229]
  - Resolved an issue whereby the dimensions of the PSF on the coadd could be set incorrectly. [DM-9564]

02C.04.05 - Object Detection and Deblending
- Deblender development [DM-8140]:
  - Development work has continued through this month on the "Non-negative Matrix Factorization" deblender prototype. We are optimistic that this work will address many of the shortcomings of our existing codebase and provide a deblender which is suitable for use during operations. However, it is still very much a work in progress. We expect development and testing of the prototype to continue ovr the next several months in order to establish whether this approach will ultimately meet our requirements.
  - During this month, a major advance was made in the NMF prototype by enabling it to apply multiple constraints (for example, "the flux of the object must monotonically decrease away from it center", or "the object must be symmetric about it center") to a single object. This new technique substantially enhances the capability of the deblender. [DM-9997]
  - The fitting algorithm in use has been switched to another which converges both faster and more reliably. [DM-10090, DM-10138]
  - The symmetry constraint imposed by the deblender has been enhanced to force the solution to use the minimum of each pixel and its symmetric partner. This reduces flux "leakage" from brighter sources into their fainter neighbours. [DM-10151]

○ The deblender can now account for the estimated position of the peak value in each source being slightly offset from its true value (due to, e.g., rounding to pixel boundaries). [DM-10189]
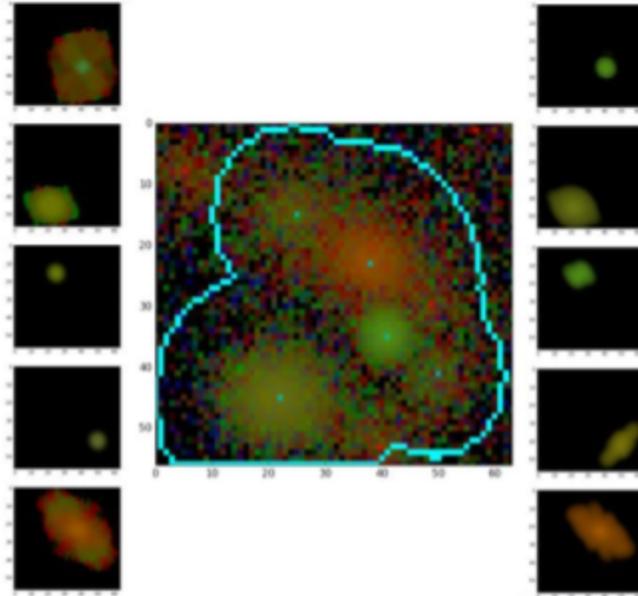


*A comparison of the results of processing a simulated blend (center) with the SDSS-style deblender, as currently used in the DM stack (left) and thew new, NMF deblender (right). The outline shows the detected footprint of the blend; the thumbnail images show the deblended components. Note that the new deblender shows much cleaner separation of components by both shape and color.*

02C.04.06 - Object Characterization Pipeline
- Enhancements and upgrades to CModel flux measurement [DM-1111]:
  ○ Work to enable simulated source injection on coadds was started this month. It is expected to be finished during May. This will be an essential technique in debugging CModel code. [DM-9998]
- Emergent work and reduction of technical debt [DM-8306]:
  ○ A series of upgrades were made to the "shared stack" installation of the LSST DM codebase on the lsst-dev01 developer hardware. This resolved persistent issues with intermittent errors due to compiler incompatibilities, and provided a series of minor usability enhancements. [DM-8872, DM-10070, DM-10102, DM-10103, DM-10320]
  ○ The section of the Developer Guide describing the LSST Debugging Framework (lsstDebug) was overhauled and updated. [DM-10234]
  ○ An issue whereby data repositories were being created with incorrect filesystem permissions was corrected. [DM-10231]

Planned activities:

02C.04.00 - Data Release Production Management Engineering and Integration
- Attend the DM Leadership Team face-to-face meeting in Seattle, WA.
- Deliver all outstanding sections of [LDM-151](#) to the DM Subsystem Scientist.
- Finalize the plan for the Fall 2017 development cycle.
- Continue QA work based on reprocessing HSC PDR1.

02C.04.01 - Application Framework for Catalogs
- Complete our contribution to the SuperTask Working Group.
- Produce a design for reworking the statistics library within the DM codebase.

02C.04.02 - Calibration Products Pipeline
- Provide a fully-functional camera package in support of the CTIO 0.9m.
- Begin implementation of FCGM within the framework of the LSST stack.

02C.04.03 - PSF Estimation
- Deploy the complete "donut" fitting pipeline at scale over the full focal plane.

02C.04.04 - Image Coaddition Pipeline
- Complete all remaining clean-ups of the PSF-matched coaddition codebase.
- Begin implementation of "warped image comparison" — that is, of automatically identifying and rejecting artefacts during coaddition.

02C.04.05 - Object Detection and Deblending

- Continue prototyping and development of the NMF deblender.

02C.04.06 - Object Characterization Pipeline
- Complete implementation of the simulated source injection framework.

Recruitment update:
- John Swinbank, Data Release Production T/CAM, has accepted a new position at the University of Washington starting November 2017. He will as as T/CAM for both the Data Release Production and Alert Production groups, as well as Deputy Project Manager for LSST Data Management.

# IPAC / California Institute of Technology

Current accomplishments:

02C.05.00
- Continued to work with IPAC IRSA group on collaboration in Firefly development, plan and schedule coordination.  IRSA started the time series tool testing and gave good feedback.
- Continued to work on SUIT requirements.
- Provide input for NCSA regarding applications needs in operations.

02C.05.01   Basic Archive Access Tools
- PDAC:
  - Enabled multiple-target cone search.
  - Deployed updated version.  Please see access guide here: https://confluence.lsstcorp.org/display/DM/Guide+to+PDAC+version+1
- Java code refactoring and adding unit tests.
- First draft version of Science Platform vision document.

02C.05.02   Data Analysis and Visualization Tools
- JS API improvement for histogram display.
- Histogram options(bin size and width relation) improvement.
- Plotting library used in Firefly
  - Finished evaluation of using plotly.js for charting in Firefly, report is here https://confluence.lsstcorp.org/display/DM/Plotly+evaluation
  - Finished replacing Highcharts library with plotly.js in Firefly 2D plotting functions.
  - Plotly also has API in Python, MATLAB, and R.
- Updated firefly_widgets to work with different Firefly based servers, syntax changes to work with ipwidgets 6.0.
- Image rotation and flip is now done in client side to keep pixel readout  scientific fidelity.
- Improvements in compass and other overlay layers on image.

02C.05.03 Alert/Notification Toolkit
- No new work done.

02C.05.05 User workspace
- No new work done.

Planned activities: (for May 2017)

02C.05.00
- Continue to work with IPAC IRSA group on collaboration in Firefly development, plan and schedule coordination.
- Xiuqin, Gregory, and David C. attend DMLT face to face meeting at UW, 5/9-5/12, 2017.
- David Shupe will give a talk at Python in Astronomy 2017, May 8-12, Leiden, NL. Please see slides here: https://confluence.lsstcorp.org/display/DM/SUIT+presentations

02C.05.01   Basic Archive Access Tools
- Continue working on science platform vision as part of SUIT design.
- Junit tests for Java classes.
- PDAC development:
  - Improvement in time series data display UI with user feedback.
  - Search and display WISE data in PDAC.

02C.05.02   Data Analysis and Visualization Tools
- Improvement and bug fixes in UI due to feedback from users
  - Grid overlay and better placement of labels.
  - Catalog searches bugs DM-9824, DM-10379.
- New functions
  - Provide PNG download for 2D charts.
  - Change Firefly logarithm definition to be in sync with other languages DM-10349.
  - 2D plotting enhancement to enable multiple data traces in one chart space.
- Support Camera visualization work by attend the weekly meeting

02C.05.03 Alert/Notification Toolkit
- No work planned

02C.05.05 User workspace
- Some work as part of the Science Platform vision document.

Recruitment update:
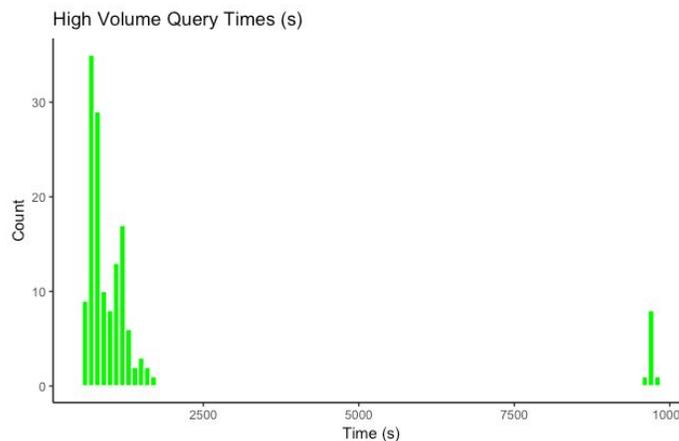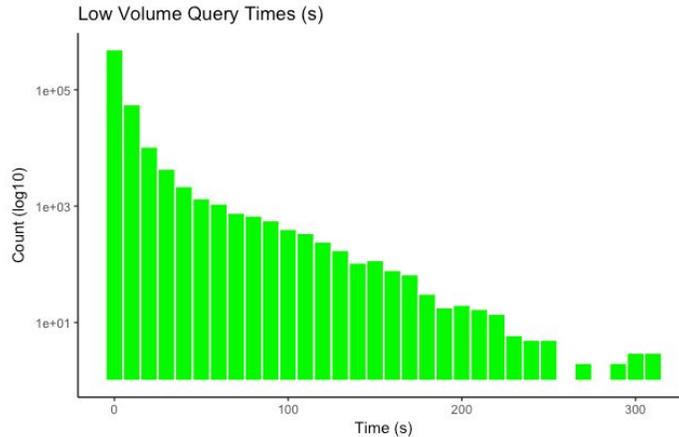- No activities.

# SLAC / Stanford University

Current accomplishments:

02C.06.00 Science Data Archive and Application Services Management Engineering and Integration

- Team continued improving robustness of DAX services and otherwise supported SUIT integration efforts in the PDAC as necessary.
- Thukral completed the 20% DR1 Qserv KPMs and scaling tests. All metrics are on track, meeting or exceeding correspondingly scaled targets. Complete writeup of results: https://confluence.lsstcorp.org/pages/viewpage.action?pageId=54854103



Low Volume Query Times (s)



High Volume Query Times (s)

- Gates had vacation during this month.

02C.06.01.01 Catalogs, Alerts and Metadata

- Salnikov conducted delayed-indexing tests on the L1/AP DB prototype (write to non-indexed table during the night, then merge to indexed table during the day). Non-indexed writes are indeed faster, but the overall effect is not that large. [DM-10092]

02C.06.01.02 Image and File Archive
- Lo implemented configuration and logging fixes for imgserv. [DM-9228, DM-9027]

02C.06.02.01 Data Access Client Framework
- Pease enhanced Data Butler with framework for pluggable serialization. [DM-4542, DM-9754]
- Pease implemented parent discovery feature for new-style Data Butler repositories. [DM-8687]
- Pease and Salnikov participated in ongoing SuperTask Working Group activities.

02C.06.02.02 Web Services
- Van Klaveren reimplemented table listing in metaserv in terms of DbRepo and DDT_Table. [DM-10295]
- Van Klaveren addressed fixed precision decimal issues in dbserv. [DM-10187]
- Van Klaveren implemented an ADQL parser to be used in dbserv for column/table name extraction. [DM-8665]

02C.06.02.03 Query Services
- Gates corrected a bug discovered during KPMs where some interactive queries were being miscategorized and misplaced onto shared scans [DM-9974]
- Gates began investigations into some cross-database spatial join query issues uncovered in the PDAC. [DM-10283]
- Thukral added column and table statistics MariaDB configuration options to the Qserv deployments, to enable improved query plans. [DM-9757]
- Mueller removed obsolete boost_thread Qserv dependency. [DM-10069]
- Mueller packaged libcurl for eups to be used in Qserv unit tests. [DM-9413, DM-10263, DM-10286]
- Gaponenko continued work on design for Qserv data distribution / replication subsystem [DM-10423]

02C.06.02.04 Image Services
- No work was carried out in this WBS element this month.

02C.06.02.05 Catalog Services
- No work was carried out in this WBS element this month.

Planned activities:

02C.06.00 Science Data Archive and Application Services Management Engineering and Integration

- Team to continue improving robustness of DAX services and otherwise support SUIT. integration efforts in the PDAC as necessary.
- Mueller to work with team to complete F17 cycle planning.
- Mueller to attend DMLT Face to Face meeting at UW.
- Van Klaveren and Lo to attend IVOA Interop meeting in Shanghai

02C.06.01.01 Catalogs, Alerts and Metadata
- No work is scheduled for this WBS element this month.

02C.06.01.02 Image and File Archive
- Lo and Van Klaveren to work with SUIT team to revise/refine v1 DAX service APIs (moving towards VO standards-based APIs).

02C.06.02.01 Data Access Client Framework
- Pease to complete Data Butler storage and format refactor, including Swift storage implementation.
- Pease and Salnikov to continue participation in SuperTask Working Group activities, including upcoming "hack week".

02C.06.02.02 Web Services
- Van Klaveren to cleanup and republish SDSS metadata via metaserv in the PDAC

02C.06.02.03 Query Services
- Gates to continue investigations into cross-database spatial join queries.
- Gaponenko to continue work on data distribution / replication design, including prototype service skeletons.

02C.06.02.04 Image Services
- No work is scheduled for this WBS element this month.

02C.06.02.05 Catalog Services
- No work is scheduled for this WBS element this month.

Recruitment update:
- No recruitment activity this month.

# NCSA / University of Illinois

Current accomplishments:

02C.07.00 Processing Control and Site Infrastructure Management, Engineering and Integration

**Planning and Management**

These activities involve the creation of project plans for the construction phase for the DM-wide replan, high-level engineering and design specification, and planning for Data Facility operations during the commissioning and operations phases. NCSA leads planning for operations of the Data Products Production (DPP) department.

- Assisted project with replan status presentation for AMCL meeting. Reviewed ITC staffing profile with ICI management.
- Reviewed current ITC and planned deployments, including FY17 network-based security in Chile with storage and systems groups. Coordinated staff transition.
- Resource provisioning and management — Conducted "interviews" with each DM development group to gather resource management needs. Held discussions about elastic provisioning for master provisioning enclave.
- Worked with network group to identify UIUC to Chicago network architecture, and infrastructure costs and peering fees associated with each PoP in Chicago.
- Held two-day face-to-face meeting with new DM project manager to review replan, discuss documentation and prepare for the DM review.
- Began preparing plan for the first half of the Fall 2017 DM construction cycle.

DM-9656 Replanning, Commissioning, Operations Planning (S17b)

### Service Management and Monitoring
The Service Manager develops and maintains the service catalog, including service-level targets, service-level agreements, and principal technical and managerial liaisons. This includes monitoring and managing availability, capacity, and IT continuity of services, and other operational matters, as well as forming a definitive opinion about the satisfaction of each customer for the services provided. The service manager supports deployment of services to operation and service transitions.

Development of the DPP services model within the LSST Enterprise Architect framework continued, with refinement of the mapping of high-level services to the internal service architecture; the service catalog now contains all known LSST service components and software and will continue to evolve as component-level details of services are specified. We also further developed internal workflows for Change management and Incident Response based on standard ITSM processes. Work on service monitoring continued with configuring performance thresholds on the prototype dashboard, and beginning to investigate and integrate prototype real-time service metrics about availability and incident and request response.

DM-8515 Service Management Definition and Refinement
DM-9657 Service Management Definition & Refinement (S17b)

DM-8516 Enterprise Monitoring Integration - Phase 1
DM-9658 Enterprise Monitoring Design - Phase 2

**Hardware acquisition and provisioning planning**
These activities involve high-level planning and design of physical systems related to computation, storage, networking, administration, and IT security on which DPP services are running or will be deployed. This includes consideration of near-term construction phase needs, as well as preparation for commissioning and operational needs.

We continued planning for deployment of the AA and network-based security services endpoints in Chile that will occur later this year, coordinating with Chilean staff and beginning the procurement process. Configuration of physical systems will occur at NCSA before being shipped to La Serena and installed at the NOAO facility. This is the first of several service endpoints that will be deployed, and will lead to the deployment of project-wide network-based security services. Further, it provides for early testing of remote administration of systems in Chile from NCSA.

We continued to rework the sizing model to derive pre-operations capacity needs, working from use cases of engineering data plans (e.g., early test stand data), calibration plans, commissioning observing programs, storage to support ongoing pipeline development (e.g., external datasets such as HSC) and expected processing campaigns, to calculate both raw data to be archived, as well as derived data to be produced and archived. This work is ongoing and will be extended to cover the entire survey operations and post-operations.

DM-8512 Planning Deployment in Chile
DM-8506 Costing Model Redesign

<u>02C.07.01 Processing Control</u>

**Batch Production Services**
These activities support the construction of services that enable the production of data products in a batch environment (e.g., Level 2 data products). The batch production services will execute processing campaigns on computing resources to produce the desired LSST data products, where campaigns are defined as sets of pipelines (ordered ensembles of computational steps), inputs they are being run against, and methods handling their outputs.

In April, we continued to enhance this service façade with the ability to orchestrate and run more complex pipelines in the planned workload management framework using Pegasus and HTCondor. This included evaluating the new Butler API, implementing support for importing

graphs into the generic DAX generator, and creating representations of selected workflows in graph form.

We continued preparations for reprocessing HSC data, staging complete and RC (test-sized) datasets, processing a portion of the data to test fixes to the selected Stack version, and planning for processing campaigns with the pipeline developers.

We also spent substantial time participating in the SuperTask Working Group, providing input on technical and operational requirements of the production processing services and discussing technical aspects of the application interface between the production workload management system, the Supertask workflow system, and the Butler.

DM-8333 Run selected existing science codes with initial Batch Production Service façade
DM-9662 Workflow creation improvements and expansion
DM-9664 SuperTask Working Group Activities

### Level 1 Services
These activities support the construction of services that will support Observatory Operations and enable the production, transport, and archiving of Level 1 data, including the nightly stream of images and events collected and processed in near real time.

We continued integrating the existing prompt processing system orchestration code with the newly developed common front end elements for Level 1 services that interface with observatory systems, and continued work on the OCS Bridge system, refactoring existing code and supporting new OCS functionality. We continued working with Telescope & Site developers to integrate SAL/OCS code to produce mock telemetry streams and digest updated images and header information.

We hosted and participated in Pathfinder Integration Activity #3 with members of the Camera, Telescope and Site, Data Management, and Systems Engineering teams, part a series of cross-subsystem software early integration activities coordinated by LSST Systems Engineering. The activity focused on executing basic events, exercising OCS-commandable device state transitions and proper responses to valid and invalid commands, and capturing events in the EFD.

DM-8317 Enhancements for OCS Bridge components
DM-9659 Header construction and distribution architecture
DM-9661 Reintegration of archiving and prompt processing

**Common Middleware and Other Tasks**

These activities consist of developing and maintaining general processing control software components, including common software used in production processing and by DM developers, as well as emergent unplanned support tasks.

Emergent work for April involved migrating the orchestration (ctrl_*) user guide to the DM developer documentation framework, and adding tests to the ctrl_* code base.

DM-9663 Emergent Middleware Work (S17b)

02C.07.02 Infrastructure Services

**Data Backbone**

These activities support the construction of services which archive, catalog, and distribute data to compute resources and data access endpoints across all sites—ingestion, file management, database hosting, etc.

We finished work with SLAC and the DM architect to gather requirements about the operational considerations of hosting the identified databases, including estimated query loads, capacity, and other administrative concerns. We completed prototyping a data backbone façade to determine the feasibility of an interface sufficient to meet the needs of near-term DM and project data archiving and processing activities and milestones. We began investigating methods for data movement over a WAN supporting the spectrograph test stand in January 2018, as well as long-term solutions for data distribution in the Data Backbone.

DM-7645 Prototype bookkeeping and interfaces for the data backbone
DM-9665 Prototype Data Backbone Façade

02C.07.03 Environment and Tools

**QA Environment**

These activities provide environments and tools to support general DM developer activities.

Work to provide a Jupyter hub instance and access to datasets to support upcoming QA activities continued with working toward persistent access to shared file systems on our GPFS storage cluster, application containerization using Kubernetes, and use of a persistent URL and file system. This environment was provisioned on the NCSA OpenStack, Nebula.

DM-8330 Instantiate VM with Jupyter Hub and GPFS access

02C.07.04 Site Infrastructure

**Hardware Acquisition, Deployment and Provisioning**
These activities consist of the acquisition, provisioning, configuration, maintenance, and decommissioning of physical capabilities and associated systems which support LSST services running at NCSA.

Hardware acquisition for the L1 Test system continued with an agreement for delivery of a small loaner system while awaiting availability of the full test system, as well as installation of a network interface for the DAQ simulator hardware. We began the final activities for the migration from NFS to GPFS file systems, continuing migration of services, and beginning the decommissioning of the NFS file system and related hardware. Work on implementing disaster recovery procedures for datasets continued, with successful backup and recovery of managed datasets.

DM-8502 Disaster Recovery for Science Datasets
DM-8503 Migrate Users from NFS
DM-8504 Migrate Services from NFS
DM-8505 Decommissioning Hardware
DM-8510 DAQ Teststand Single Raft Deployment
DM-9685 Procurement Activities for L1 Test Systems

**Service Management for LSST development resources, Emergent and Miscellaneous Work**
These activities consist of supporting and communicating with users of the current services provided by NCSA to LSST DM developers.

We continued refining and extending system-level monitoring of cluster hardware-- definition of additional metrics as well as deployment of data storage and visualization components of the monitoring system. We also addressed further user- and developer-driven requests and issues with migration from and retirement of the NFS file system.

DM-9666 Service Management & Emergent Work (S17b)
DM-9667 Cluster Service Monitoring Development

<u>Planned activities:</u>

<u>02C.07.00 Processing Control and Site Infrastructure Management, Engineering and Integration</u>

**<u>Planning and Management</u>**
We will continue preparations for the DM review, including organizing the WBS into planning packages and milestones. The WBS is also a complete list of services and a high-level list of software and hardware components, and a mapping of service dependencies will begin next month. This provides a basis for phasing of service integration, sizing of physical system components, supporting documentation of DM architecture and enumeration of the product tree, and enumerating the documentation and verification tests for incorporation into the overall DM and commissioning integration, test, verification, and validation plans.

We will continue work on a capacity model for the pre-operations phase of the project based on use cases of archiving raw data from test stands and from instruments as they are commissioned, as well as processing use cases for continued development support, service integration, and production. Requirements from DM, the commissioning team, pre-operations plan, and EPO will be gathered and synthesized.

We will begin a high-level specification of the master provisioning resource management framework, which deploys compute resources to production enclaves as needed. This includes batch processing for all use cases, containerized application operations, and possibly prompt processing.

We will attend the DM Leadership Team meeting in Seattle, begin preparations for the DM review in July, begin porting concept of operations service documentation to the new DM document framework, participate in the DM subsystem science team and DM subsystem engineering team and associated activities, and prepare the detailed cycle plans for F17 and submit to PMCS.

DM-9656 Replanning, Commissioning, Operations Planning (S17b)
DM-7632 Develop planning packages from DM replanning deliverables

**<u>Service Management and Monitoring</u>**
We will finish planned work with the development of the DPP services model within the LSST framework, integrating the mapping of dependencies in the service catalog described above.

Work on service monitoring will continue with investigating/integrating prototype real-time metrics for availability, capacity, and continuity management. We will attend the ServiceNow conference for evaluating an industry-standard a service management framework and schema.

DM-8515 Service Management Definition and Refinement
DM-8516 Enterprise Monitoring Integration – Phase 1

**Hardware acquisition and provisioning planning**
We will continue planning for procurement of the full-scale L1 test system, as well as updating plans for expected remaining FY17 hardware expansion as described in the FY17 Annual Acquisition Strategy Document, verifying needs against planned procurements.

02C.07.01 Processing Control

**Batch Production Services**
In May, we will continue to enhance this service façade with the ability to orchestrate and run more complex pipelines in the planned workload management framework using Pegasus and HTCondor. We expect to begin processing of the full HSC reprocessing with Strategic Survey Program (SSP) Public Data Release 1 (PDR1) data, implemented using the legacy ctrl_pool processing framework as development of components of the planned workload management system continues. We will also continue our involvement in the SuperTask/Butler Working Group, including contributions to requirements and design documentation.

DM-8333 Run selected existing science codes with initial Batch Production Service façade
DM-9662 Workflow creation improvements & expansion
DM-9664 SuperTask Working Group Activities

**Level 1 Services**
We will continue integrating the archiving and prompt processing Level 1 services, and continue work on our interface to the OCS system to continue support of the series of Early Pathfinder software Integration Activities. A detailed schedule of integration milestones is being developed by LSST Systems Engineering. We will also continue working with Camera and Telescope & Site developers to identify sources and contents of the EFD, OCS metadata available to build headers, and contents of headers required by CCS developers and downstream DM processing.

We have proposed work on a design for acquiring header information from OCS and recording it in the EFD. This design supports both real-time archiving and processing, as well as archiving and processing in "catch-up" mode, in which retrieval of pixel data from the camera buffer

occurs asynchronously from data acquisition by the camera; if accepted, work will begin on this task.

DM-8317 Enhancements for OCS Bridge components
DM-8575 Deploy Mock for OCS with monitoring info
DM-9659 Header construction and distribution architecture
DM-9661 Reintegration of archiving and prompt processing

**Common Middleware and Other Tasks**
Work for May is anticipated to include changes to common library functions necessary to support Batch Production and Level 1 Services, and addressing further user- and developer-driven issues as they arise.

DM-9663 Emergent Middleware Work (S17b)

02C.07.02 Infrastructure Services

**Data Backbone**
We will report on completed work prototyping a data backbone façade to determine the feasibility of an interface sufficient to meet the needs of near-term DM activities and milestones. We will continue investigating methods for data movement over a WAN supporting the spectrograph test stand in January 2018, as well as long-term solutions for data distribution in the Data Backbone. We are evaluating the Rucio data distribution package, used by the ATLAS experiment, distributing data within the Data Backbone to service access points (between the Base Facility, NCSA, CC-IN2P3, and other sites, including camera test stands at SLAC and Tucson).

DM-9665 Prototype Data Backbone Façade

02C.07.03 Environment and Tools

**QA Environment**
Work to provide a Jupyter hub instance and access to datasets to support upcoming QA activities will continue with access to common datasets one the GPFS filesystem, and documenting configuration and use of the service.

DM-8330 Instantiate VM with Jupyter Hub and GPFS access.

<u>02C.07.04 Site Infrastructure</u>

**Hardware Acquisition, Deployment and Provisioning**
Planned work includes finalizing the migration from NFS to GPFS file systems, continuing migration of services, and continuing the decommissioning of the NFS file system and related resources. Work on implementing disaster recovery procedures for datasets will be completed. We will begin procurement activities for the systems to be used in raft-scale testing of the L1 Services and begin acquisition and provisioning activities for the AA deployment in Chile.

DM-8503 Migrate Users from NFS
DM-8504 Migrate Services from NFS
DM-8505 Decommissioning NFS
DM-8502 Implementation of disaster recovery for /datasets (Phase 2)
DM-9685 Procurement Activities for L1 Test Systems

**Service Management for LSST development resources, Emergent and Miscellaneous Work**
Work for May is anticipated to include addressing further user- and developer-driven requests and issues with migration from and retirement of the NFS file system, and related system needs. We will continue to investigate and prototype additional means to monitor the services provided on the development cluster. We will also address technical debt related to system administration.

DM-9666 Service Management & Emergent Work (S17b)
DM-9660 System Administration Technical Debt (S17)
DM-9667 Cluster Service Monitoring Development

<u>Recruitment update:</u>
Scott Harden was hired in NCSA's Integrated Data and Database Services. Scott will be responsible for architectural and operational design, integration of schema from SLAC, and administration of the databases used by LSST Project services hosted at NCSA.


# AURA

This section covers accomplishments and planned activities in WBS 02C.08 International Communications and Base Site.

Current accomplishments:

## 02C.08.00 International Communications and Base Site Management Engineering and Integration

## 02C.08.01 Base Center

- Summit Base ITC Tiger Team:  Completed work on the Summit Base ITC Design Document (SBIDD) that will be proposed to the LSST CCB to become a baselined LSE document. [https://confluence.lsstcorp.org/display/SYSENG/LSST+Summit+-+Base+ITC+Design](https://confluence.lsstcorp.org/display/SYSENG/LSST+Summit+-+Base+ITC+Design). The draft document is ready for comments by the broader project outside the Tiger Team, and a Request for Comment will be issued.  As previously reported, an LCR will be created to submit the document to CCB for baselining.  The initial baseline, while complete for the Summit and Summit - Base, will still be incomplete for the Base.  This is unavoidable due to the more advanced schedule for Summit Facility and Network and Summit - Base Networks, which are already being procured/constructed.  To complete the Base section, we will need to have a complete Control Room design, expected after an 8-month INRIA design contract. When the Tiger Team disbands in August, 2017 SBIDD responsibility will migrate to "regular" System Engineering team.   The draft LSE-299 Summit Computer Room Requirements Document (parallel to the LSE-239 Base Data Center Requirements) has been reviewed by the Tiger Team and the LSST Architect.  An LCR will be prepared to submit it to the CCB for baselining.
- Summit and Base Networking and Computing:  Considerable work was done regarding the Summit LAN RFP answering vendor questions and providing clarifications. We received 5 bids for the Summit LAN RFP.   Owing to the RFP proposals containing only full maintenance prices for the equipment, Ron Lambert visited the vendors in Santiago to clarify that we required the option of warranty plus 8x5 maintenance (TAC+NBD 8x5). Those numbers are due to come in May 5. There are now 4 vendors as EGS/Brocade was disqualified owing to not fulfilling the bond guarantee. The selection committee will rank the bids and make a selection by May 15.
  Completed support for planning and overseeing for the arrival of EIE dome team and installation of phones and internet in their containers on Pachon.

## 02C.08.02 Chilean Data Access Center
- No activity this month.

## 02C.08.03 Long-Haul Networks

02C.08.03.01 Chile National WAN

- Summits - AURA Gatehouse Network:  No change from last month.  We are still waiting for the final measurements for the fibers from Gatehouse to Summits.
- DWDM Equipment:   The AURA requisition went out to Coriant for the DWDM equipment last month. Expect arrival of the equipment at the end of May, when we will have 30 days to inspect the equipment before payment. REUNA Annex IV Contract 1, which defines the activation of the 1st optical channel from AURA/LSST to Santiago, was signed between AURA and REUNA.  The DWDM contract between REUNA-CORIANT/Raylex is agreed and in the signature process.
- Santiago-La Serena:  REUNA conducted a site survey from 24th-28th may, in preparation for deploying the DWDM equipment; all the sites except Los Andes were visited.  In general the cable housing conditions are met, a detailed revision of the information is being done.
- La Serena – AURA Gatehouse:  Telefonica sent the fiber measurements which look very good. The report detailing this information is being prepared, REUNA deliverable #2 Contract 1A Annex III-B.  The new ducts into the AURA compound are now ready and waiting for Telefonica to reinstall the existing fiber cable and the new fibers coming from the LSST/AURA contracts.  We arranged with Telefonica that when the fibers are installed in La Serena we will the terminate the fibers at LSST in order to make the measurements again to La Serena.

02C.08.03.02 International Chile - US WAN

- 100 Gbps Managed Ring:  No planned activity in this period.  The ring is performing as expected.
- Management and Coordination Contract:
  Conducted the regular monthly meeting of the LSST Network Engineering Team (NET), which is the cross-institution team of network management and technical staff responsible for designing, engineering, deployment, and supporting operations of the LSST long-haul networks. The early focus of the NET is on the Network Verification Plan and Matrix.  This plan covers the final verification tests to be performed on the network segments to confirm that they are meeting the LSST requirements. Members of FIU attended several network conferences and symposia relevant to LSST networking: Western and Central Africa (WARCREN) Conference; ACM Symposium on SDN Research 2017; NSF CENTRA meeting; Internet2 2017 Global Summit; IRNC AMIS meeting.
- Spectrum Contract:  The subaward from FIU to Angola Cables (AC) was signed and fully executed at FIU.  The commitment form from AC to FIU was received and AC is now

registered correctly in sam.gov with an active DUNS number.  Co-PI Chip Cox met with AC to review the subaward and facilitate this progress.  AmLight engineers had remote meetings with two optical equipment vendors (Infinera and Coriant). The goals of these meetings were to learn more about their equipment capabilities and collect recommendations regarding the essential optical submarine subsystem attributes that should be specified in the Spectrum equipment Request For Proposal (RFP) phase. The suggestions were added to a technical questionnaire which AmLight engineers are working on, and in May, the final document will be presented to AC by Co-PI.

- US National WAN:  AmLight Co-PI Ibarra and Jeff Kantor and Don Petravick met to firm up strategy to refine proposal to ESNet, including message to DOE LSST "advocate".

Planned activities:

02C.08.01 Base Center

- Summit Base ITC Tiger Team: Complete review of draft of Summit - Base ITC Design Document and prepare LCR for submission to CCB.   Create LCR to submit LSE-299 Summit Computer Room Requirements Document to CCB.
- Summit and Base Networking and Computing: Planning of racks and network equipment will continue to be completed by end of May.  Score the Summit LAN RFP proposals and select vendor.

02C.08.03 Long-Haul Networks

02C.08.03.01 Chile National WAN

- Summits - AURA Gatehouse Network:  Complete measurements of the fibers between the Summits and Gatehouse.
- DWDM Equipment:  Waiting to receive Coriant AURA/LSST DWDM equipment. REUNA will have a face-to-face meeting with CORIANT/Raylex the week of May 11 to finish signing the contract REUNA-CORIANT/RAYLEX and agree on the deployment plan, including training activities.
- Santiago-La Serena:  REUNA to do the site survey in Los Andes site, planned for May 17.  Make a detailed revision of the site survey information, then supervise corrections if necessary.
- La Serena - AURA Gatehouse: Complete installation of Telefonica fiber cable in the existing NOAO computer room, planned for May 13 or 20 depending on weather.  Send report #2 Contract 1A Annex III-B to AURA.  Plan the details of the equipment deployment.

02C.08.03.02 International Chile - US WAN
- 100 Gbps Managed Ring:  Next planned activities are scheduled for June 2017, when the Pacific 100G circuit will be opened in Chile.
- Management and Coordination Contract: Complete updates by LSST Network Engineering Team (NET) to resolve issues/comments on Network Verification Plan and Matrix.  Complete a revision to the Network End to End Test Plan.  Submit DM change request to adjust bandwidth allocations in LDM-142 based on NET comments.
- Spectrum Contract: FIU and Angola Cable to work out operations and maintenance payment timing.
- US National WAN: Negotiations to refine and improve the ESNet service and costs will continue during May, including contacting the DOE LSST Program Officer.

Recruitment update:
- The Chile IT Hiring Selection Committee interviewed both candidates and made the following recommendation with respect to the open Network Engineer and IT Tech positions:
    - (Candidate 1 Name Redacted) Assuming references check, we recommend that he be offered the open Network Engineer position, but at a Sr. Network Engineer grade.
    - (Candidate 2 Name Redacted) Assuming references check,  we recommend that he be offered a position at a Network Engineer grade.  We recommend that we change the open IT Tech position to a Network Engineer position with IT support duties.