

Data Management Monthly Report

February 2017

High-level Summary

The DM Team prepared for the JTM in March, continued to prepare for the arrival of the DM Project Manager in Tucson, continued supporting LSST System Engineering and Operations Planning activities, added features deblending and spectral data processing and improved performance of the LSST Software Stack and completed the technical portion of R13.0, added all-sky catalog search, image cutout display features to the Prototype DAC (PDAC), completed the installation of the Mountain - Base fiber optic cable, prepared for large-scale pre-cursor data production runs at the Archive Center, and developed a draft Service Level Agreement and prototype SLA database.

Project Status

Selected technical accomplishments:

- The Architecture Team:
 - Prepared for the Joint Technical Meeting in March, worked on the DM Design, DM System Requirements, and EPO interface documents, and convened a new SuperTask/Butler Working Group.
- The AP Team:
 - Completed detailed comparison of image differencing algorithms on simulated data.
 - Implemented ability to use different photometric and astrometric catalogs in jointcal.
 - Demonstrated scaling of producers and consumers for the prototype alert distribution system.
- The DRP Team:
 - Demonstrated outstanding results from the prototype Non-negative Matrix Factorization (NMF) deblender.
 - Produced an early design sketch of “MultiFit”-style multi-epoch fitting system.
 - Tested a prototype spectral data reduction pipeline for the LSST Auxiliary Telescope.
- The SUIT Team:

- Continued to add new functions to PDAC deployed at NCSA, allsky catalog search, image cutout display.
- Bug fixes and improvement in Python API.
- The DAX Team:
 - Continued support of integration activities at the PDAC via problem investigations and bug fixes.
 - Completed ingest of 20% DR1 synthetic test dataset at IN2P3, to be used in gathering Qserv KPMs.
- The Net&BS Team:
 - All the fusion splices were completed on the Summits - AURA Gatehouse Network in February and it only remains to terminate the cable at the LSST telescope when we have occupancy of the computer room, which is expected to occur NLT September, 2017.
 - The Telefonica fiber installation from Highway D41 to Gatehouse is complete. There was a final problem with the fiber installation from D41 to the Gatehouse, which was solved by installing three more posts at the crossing point of D41 and the Observatory access road.
 - The first set of trenches and ducts that will be required to bring the new fibers into the compound in La Serena have been completed. There are now ducts available to bring fibers into the compound to the existing data center.
- The NCSA Team:
 - Held meetings with CC-IN2P3 to discuss plans for coordinated operations, including data movement between sites and a role in disaster recovery.
 - Completed the first round of operational planning discussions with FNAL.
 - Prepared for running HSC datasets through the existing batch production system pipeline.
 - Proposed a design for a header metadata client and discussed it with OCS/EFD staff.
 - Made significant progress detailing operational requirements for database use across the data backbone, including provenance and metadata catalogs.
 - Created a first draft Service Level Agreement in the prototype service management framework.
 - Tuned performance of the verification and compute clusters in response to user feedback.
 - Created a detailed design of the FY17 L1 test system.
- The SQuaRE Team:
 - Added HSC data to our verification harness, SQuaSH.
 - Completed the technical part of the 13.0 release.
 - Deployed the version dashboard for our LTD-hosted documents.

- Deployed a simple metrics monitoring microservice that delivers notifications of metric deviations via our chatbot.
- Deployed a new version of our git-lfs service.
- Extended our OSX build capacity.

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 Subsystem Lead and the DM Project Manager prepared for the March JTM meeting and continued to prepare for the arrival and official start of the DM Project Manager in Tucson.

Planned activities:

The DM Subsystem Lead and the DM Project Manager will run the DM portions of the March JTM meeting and continue to prepare for the arrival and official start of the DM Project Manager in Tucson.

DM Science

Current accomplishments:

DM Project Science staff has continued work on two ongoing studies (photometric redshifts, and star/galaxy separation), science validation of the Prototype DAC, definition of the LSST Science Platform, and organizational activities.

The "Photometric Redshifts with the LSST: Evaluating Survey Observing Strategies with a New Nearest-Neighbors Estimator" (Graham et al.) manuscript is ready. Paper is back with the co-authors for final review, pre-submission. Submission is expected in March. We continued work on star-galaxy separation paper (Slater et al.). Modeling and verification against SDSS stripe 82 is complete, and finishing the writeup is the main focus now.

We are performing the science validation of the Prototype DAC (PDAC) environment (Suberlak et al.). A report on success of the PDAC for doing science with LSST will be delivered by the end of March.

The document with the overview of the LSST Science Platform has been delivered for inclusion in the Operations Plan, and a draft Science Validation Plan document has been delivered for consideration of internal DM organization of System Verification and Validation (Juric et al.).

A request was received from the LSST Project scientist to estimate the impact of hybrid (multiple CCD vendors) focal plane on image differencing false positive rates; the work is in progress and a report will be delivered by the end of March (Slater, Bellm, et al.).

Planned activities:

Complete the report on heterogeneous focal plane impact on image differencing.
Complete and submit the photo-Z paper.
Complete the first phase of PDAC science validation.
Complete the organization and establishment of the DM System Science Team.
Deliver the first version of the Science Platform document.

DM System Engineering

Current accomplishments:

DM System Architect and Deputy System Architect:

- Planned DM and cross-subsystem agenda for the Joint Technical Meeting.
- Completed a rough draft of a new version of the DM Design Document (LDM-148).
- Continued work on definition of Summit connectivity in the Summit/Base Tiger Team.
- Continued work on use cases and role definitions for Operations planning.
- Assisted with designs for databases, dataflow/workflow, data access services, and Data Butler.

- Developed a draft Statement of Work for investigating alternatives to the baseline infrastructure and middleware technologies.
- Reviewed and accepted changes to the DM Coding Standards.
- Requirements associated with calibration were firmed up and discussions continued on the flow down of performance metrics from LSE-29 to LSE-61.
- Work continued on the EPO interface requirements and verification (LSE-131).
- Progress was made integrating a new LaTeX document work flow into the existing documentation process.

DM System Interfaces Scientist:

- Continued to coordinate Prototype Data Access Center integration and development across the DM subsystems.
- Wrote a document describing the initial capabilities of the Prototype Data Access Center, to facilitate its review by a science team member:
<https://confluence.lsstcorp.org/display/DM/Guide+to+PDAC+version+1>.
- Developed the charge for the SuperTask/Butler Working Group and convened its first meeting.
- In collaboration with SUIT colleagues, prepared a more detailed conceptual design of the Science Platform as preparation for the March 2017 JTM.
- Wrote a note describing in detail the data-linking issues involved in either live Observatory metadata rendezvous or the ETL required for the creation of the “restructured EFD”:
<https://confluence.lsstcorp.org/display/~gpdf/Restructured+EFD+creation+and+the+auxiliary+telescope+spectrograph>.
- Wrote a draft of a 2018-era spectrograph operations concept and discussed it with interested parties.
- Participated in Summit-Base Tiger Team activities related to clarifying visualization and summit data quality analysis requirements.
- Pushed a (trivial) change request on LSE-69 (LCR-836) to completion.
- Began maintaining a DM Confluence page summarizing active change requests of interest to DM:
<https://confluence.lsstcorp.org/display/DM/Change+requests+of+interest+to+DM>.
- Reorganized and cleaned up the top level of the DM Confluence space.

Planned activities:

DM System Architect and Deputy System Architect will:

- Prepare for and attend the Joint Technical Meeting in Glendale.
- Consider new DM subsystem risks management and continue to prepare LSE-61 for submission to CCB.
- Complete the initial draft of LDM-148.
- Contribute to an updated sizing model.

DM System Interfaces Scientist will:

- Prepare for and attend the Joint Technical Meeting in Glendale.
- Continue coordination of PDAC activities.
- Continue leading the SuperTask / Butler working group.
- Work on cleaning up errors left behind in past change requests against the OSS, mostly relating to the move of Alert Production from the Base to the Archive.
- Develop documents reflecting decisions made at the JTM.

DM Science Quality and Reliability Engineering (SQuaRE)

Current accomplishments:

- The technical work for the 13.0 stack release was completed and the release was pushed to the server, conda binaries and docker containers were produced and advertised internally. Documentation gathering from the contributors began and a community announcement will be made when it is complete. This release was the first time we minted the very first release candidate off a weekly as is; all tests passed as well as all portability builds under non-supported distros (such as Ubuntu). This is due to quality work by DM developers as well as the benefits of the tested weekly releases. We also continue to make releases without any developer interruption (such as a feature freeze) thanks to our weekly-based release process. The 13.0 candidate was minted off the 6th weekly release of 2017.
- We added HSC data to our existing precursor datasets (CFHT, DECam) that we verify against in `validate_drp`. HSC is now included on the verification runs that we perform automatically and publish through SQuaSH.





- We brought to a close work on an epic ([DM-5858](#)) involving a major development cycle on our documentation infrastructure. The main deliverable has been the build of version dashboards for documents supported in this platform such as DM technotes, the developer guide etc. For example here is the dashboard for the pipeline release documentation at pipelines.lsst.io with features including (1) links to the source repository and CI logs (2) a view of the source repository for that particular release/branch and (3) a view of the document at that particular release/branch. When a JIRA ticket is associated with a branch/pull-request, a link to that ticket is available.



LSST Science Pipelines







pipelines.lsst.io

 [lsst-sqre/pipelines_docs](#) ¹
 Travis

Releases

 [Current](#) 2017-03-15
 [View source](#) ²

Development editions

 u-ktl-v13-typos ³	2017-03-15	 View source
 DM-9815	2017-03-15	 DM-9815  View source
 13-0	2017-03-10	 View source

The dashboard is accessible through the “Change Edition” button on the document main site, and we have also added an “Edit on Github” button that takes one to the Github editor for that source. This is very low-barrier way for contributing quick fixes such as typos or information updates.

This epic also included some reliability engineering. The LTD keeper’s database was an sqlite DB in the prototype phase that resided on a Google Compute Engine persistent disk attached to the ltd-keeper pod. We wanted to do automated backups, but rather than developing a service to back up the GCE disk onto S3 (our initial plan) we migrated the database to the Google Cloud Platform managed SQL service. This provides the

desired automatic backups out of the box, and also allows us to scale the service in the future (were it to become necessary) by spinning up multiple ltd-keeper pods.

- We brought to a close work on an epic ([DM-8487](#)) for extending our status monitoring to metric values. Deliverables included a microservice that monitors the SQuaSH database for metric deviations, a chatbot interface to that microservice, a document on microservice creation, and a cookiecutter template to create microservices. Here's what a metric deviation notification looks from the user side:

February 13th



SQaRE Bot APP 8:31 AM

@adam: Metric **PA1** changed by more than **1.0%** in the last run.

Current value: **17.11** / Previous value: **17.347**.

Change was **1.37%**.

Dashboard: [https://bokeh.lsst.codes/metrics?](https://bokeh.lsst.codes/metrics?window=weeks&job__ci_dataset-cfht&metric=PA1)

[window=weeks&job__ci_dataset-cfht&metric=PA1](https://bokeh.lsst.codes/metrics?window=weeks&job__ci_dataset-cfht&metric=PA1) .

- We brought to a close an epic ([DM-8483](#)) to extend our OSX build capacity. OSX builds are slower than the Linux builds in a virtualised environment and due to the OSX licensing model not available through standard commodity providers, so we support our own. The new hardware was configured and the extra CI nodes added to the Jenkins pool.
- We brought to close an epic ([DM-6211](#)) that covered a number of improvements to our git-lfs service. Git-lfs is a new service and has been moving quite rapidly; since we self-host due to our large data repositories, we maintain our own fork of an S3-backed LFS server. This epic involved upgrading the protocol to support newer clients and keep us current enough to receive support for the git-lfs core team. The new server is now in production.
- The new version of SQuaSH was deployed as a production test deployment. Some issues were noted that were not apparent in the developer's local machine deployment that require further investigation.
- The issues preventing us from moving forward with the eups tarball stack binary release method were resolved and testing shows that automatic production via this method is less fragile than conda binaries.
- We hosted a very successful 4-day visit with John Parejko. John has recently completed the first iteration of jointcal and we are using jointcal as the focus for the extension of SQuaSH to metrics harvested from stack tasks instead of just afterburners. John agreed to

serve as the product owner of that sprint. During his visit we did preliminary design work on the API between the task and SQuaSH, mocked jointcal metric specifications and protoyped supporting python classes. We thank the UW team for his time.

- We hosted a very interesting day-visit from Brian Granger, co-founder of Project Jupyter and explored topics of mutual interest. Brian also gave a Tech Talk on the extensive improvements in the upcoming JupyterLab first release, which with the speaker's permission we made available at youtu.be/rpWufDHIKNw. Our thanks to all the DM folks who dialled in for the presentation and enriched Q&A by their participation.

Planned activities:

- Prepare for and attend JTM meeting.
- Complete 13.0 release documentation.
- Plan out and ramp up S17-B epics.
- SQuaSH production deployment.

Recruitment update:

- We're excited to announce that Simon Krughoff will be moving to Tucson through a project transfer to join the SQuaRE team in a scientific lead capacity. Simon is expected to start August 1st. Simon will bring a wealth of expertise on pipelines in general and Alert Production verification in particular.

University of Washington

Current accomplishments:

02C.03.00 - Alert Production Management Engineering and Integration

Krughoff, Morrison and Connolly attended the DESC meeting at SLAC.

Rawls continued work on the prototype alert production system including dealing with some technical debt in the DECam definition package.

Hiring

No activity.

02C.03.01 - Single Frame Processing Pipelines

No advancements in this area.

02C.03.02 - Association Pipelines

No advancements in this area.

02C.03.03 - Alert Generation Pipelines

Patterson scaled up the producers and consumers and also researched tools for monitoring performance of the system: e.g. CPU usage, latency, throughput. (DM-8819, DM-7456, DM-7455)

02C.03.04 - Image Differencing Pipeline

Reiss finished off the testing and comparison of image differencing techniques (DM-8796). He began implementing the classes necessary for implementing the spatially varying components of the image differencing algorithms. (DM-8796)

Sullivan finished off the prototype implementation of the DCR algorithms (DM-5699 and DM-8801 to come). He is now ready to port the algorithm to the stack and to write up the algorithm in a tech note.

02C.03.05 - Application Framework for Exposures

Findeisen implemented the Point2DList class which is needed for the new transform framework. (DM-7888).

Though we had predicted that the pybind11 work would be largely finished in January, there was still a significant amount of work for Owen and Findeisen in February. This included relatively

small changes to a large number of packages (DM-8464, DM-8454, DM-8452, DM-9384, DM-9276, DM-9279, DM-9258, DM-8874, DM-8462, DM-8463, DM-9277, DM-9275, DM-9462, DM-9429, DM-8096, DM-9280, DM-9432).

Owen and Findeisen also worked on general bugs and other emergent work (DM-8105, DM-7891, DM-9049, DM-9502, DM-9313, DM-8355, DM-9433, DM-9298).

02C.03.06 - Moving Object Pipelines

No advancements in this area.

02C.03.07 - Photometric Calibration Pipeline

Parejko worked on cleanup of jointcal by replacing standard print statements with configurable log statements (DM-8547) and to clean up dead I/O code (DM-9416). Parejko also re-worked jointcal to be able to make use of the new reference catalog system by being able to take a different astrometric and photometric catalog (DM-8552). He also began prep work for improving the photometric fitting by designing a new spatially varying photometric calibration object as well as investigating the photometric model of the existing meas_mosaic package (DM-9193, DM-9194).

02C.03.08 - Astrometric Calibration Pipeline

Morrison refined his pattern matching implementation. It is clear that the Optimistic algorithm presented in Tabur (2007) is not sufficient in reasonably crowded regions. By relaxing the optimism (that the first pattern that matches is the correct one), it's possible to do much better in crowded regions at the expense of longer runtime. It's possible to gracefully failover from one regime to the other.

Planned activities:

02C.03.00 - Alert Production Management Engineering and Integration

All members will attend the JTM in Glendale CA.

Rawls will continue working on the prototype AP system. She will work with Eric Bellm to define metrics and analyze the current system.

02C.03.01 - Single Frame Processing Pipelines

Owen and Findeisen will continue work on the new transform framework.

02C.03.02 - Association Pipelines

No planned work.

02C.03.03 - Alert Generation Pipelines

Patterson will work on a monitoring suite for the alert distribution system.

02C.03.04 - Image Differencing Pipeline

Reiss will implement spatially varying ZOGY to test against the current stack baseline algorithm.

Sullivan will finish writing up the proposed DCR correction algorithm.

02C.03.05 - Application Framework for Exposures

Bug fixes and technical debt.

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 port his improved matcher into the stack and write it up in a DMTN describing the new algorithm and showing its performance on a variety of images.

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:
 - Bosch & Meyers attended the Dark Energy Science Collaboration meeting in California for the week of 13 February.
 - Guyonnet visited Princeton for the week of 6 February to collaborate on pipeline design and planning with the team there (see 02C.04.02, below).
 - Meyers visited Princeton for the week of 20 February to begin work of integrating his “donut finding” code with the LSST pipeline framework (see 02C.04.03, below).
- Quality assurance [[DM-8299](#)]:
 - A bimodal distribution of Footprint sizes of sources used for PSF modeling was identified. It was traced to a difference in the handling of blended and isolated sources. The use of blended sources for PSF modeling is likely inappropriate, and will be further investigated. [[DM-9252](#)]
 - The QA team has observed that the “trace radius” of sources processed through the LSST stack is systematically different to that of sources processed, nominally identically, through the Hyper Suprime-Cam (HSC) equivalent. Investigation of this effect is ongoing. [[DM-9411](#)]
- Task documentation prototype [[DM-8559](#)]:
 - Effort has been ongoing to produce example Task documentation in the new ([DMTN-030](#)-based) framework. It is expected that this documentation will be

made available to pipeline developers for comment early in March. [[DM-8717](#), [DM-8723](#)]

02C.04.01 - Application Framework for Catalogs

- Middleware evolution [[DM-1109](#)]:
 - Jim Bosch, DRP Science Lead, will serve as representative of the Science Pipelines on the “SuperTask Working Group”, which convened this month.
 - An initial design sketch for the interface for multi-epoch fitting (“MultiFit”) has been developed. This provides a useful basis for discussion, but is far from a mature or usable system. [[DM-9602](#)]
- Implementation of new Footprint system [[DM-3559](#)]:
 - Work has continued through this month to convert all existing Science Pipelines code to use the new Footprint system. [[DM-8108](#)]
 - This work will not be merged to master until the pybind11 conversion — see below — is complete.
- Enhancements and upgrades to CModel flux measurement [[DM-1111](#)]:
 - In preparation for work on upgrades to the CModel algorithms, the existing codebase has been audited for obsolete and unwanted code, which has now been removed. [[DM-9045](#)]
- Conversion from [SWIG](#) to [pybind11](#) [[DM-7717](#)]:
 - This work has proceeded apace through February, with a total of 34 separate tickets closed.
 - The Science Pipelines codebase is now fully functional using pybind11.
 - Some refinements to the approach taken and some performance enhancements will be added before this work merges to master.
 - The merge is expected in early March.
- Emergent work and reduction of technical debt [[DM-8136](#)]:
 - An error in the package provenance system, which could lead to inconsistent results and, in turn, pipeline failures, in some circumstances, was discovered and fixed. [[DM-9439](#)]
 - The code used to catch errors and set appropriate flags in measurement algorithms has been overhauled to be more robust against programmer error. [[DM-6723](#)]
 - The pipe_drivers package of high-level pipeline orchestration scripts now runs under Python 3. [[DM-7756](#)]
 - The mechanism used for compiling against external packages (notably [Boost](#)) has been modified to eliminate spurious warning messages. [[RFC-246](#), [DM-8169](#)]

02C.04.02 - Calibration Products Pipeline

- Auxiliary telescope development [[DM-8151](#)]:

- A functional, albeit not yet algorithmically sophisticated, prototype spectral data reduction pipeline for the Auxiliary Telescope has been demonstrated, based on test data taken on the 0.9m telescope at CTIO.
- Work is now underway to convert this prototype to work within the framework of the LSST Science Pipelines. [[DM-9363](#), [DM-9365](#)]
- Guyonnet, who is leading the development of this pipeline at Harvard, visited Princeton for the week of 6 February to collaborate with the team there on the details of pipeline integration.
- Access to camera test stand data [[DM-8292](#)]:
 - Work has commenced on “camera package” which will provide integration of data from the single chip camera test stand (“TS3”) into the LSST Science Pipelines. [[DM-9400](#)]
 - Complete delivery of this work will require discussions between the DM and Camera teams, scheduled to take place at the LSST Joint Technical Meeting in March.

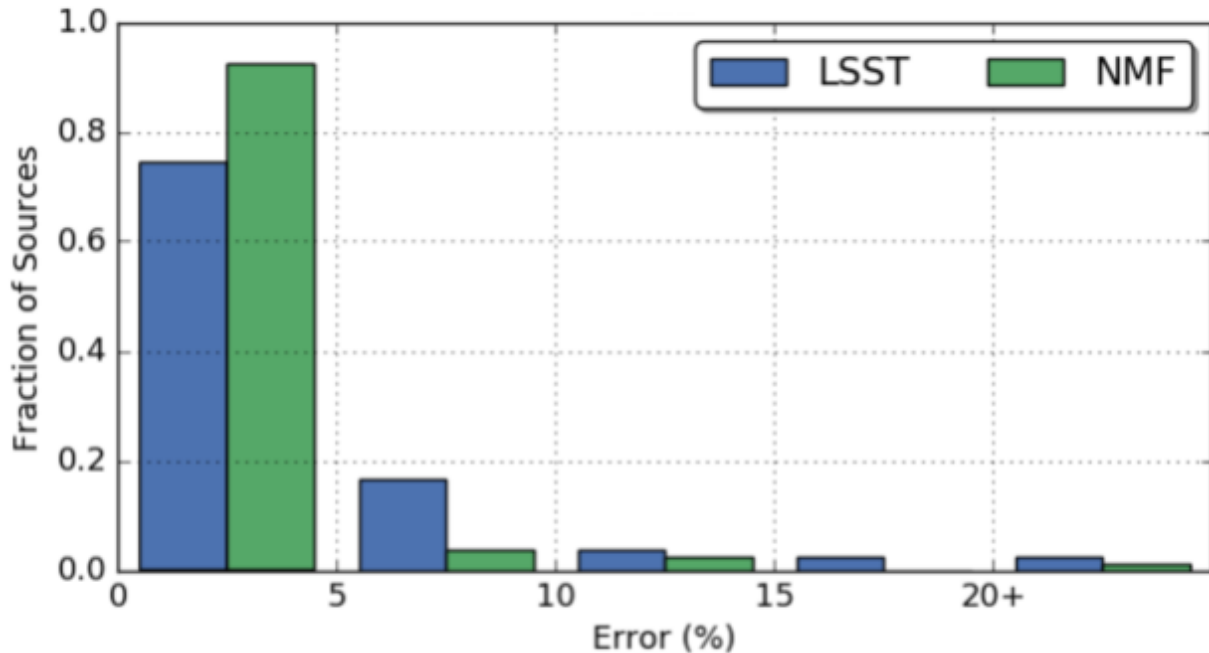
02C.04.03 - PSF Estimation

- Wavefront measurement and PSF reconstruction [[DM-1909](#)]:
 - Development and testing of a wavefront measurement system using out-of-focus data from HSC is underway. Meyers visited Princeton during the week of 20 February to collaborate with the team there on the details of integrating his algorithmic code with the LSST pipeline framework. [[DM-8565](#), [DM-8589](#), [DM-9567](#)]
 - In order to facilitate PSF estimation prototyping with HSC data, it is necessary to perform instrument signature removal without invoking the regular LSST single frame measurement pipeline. A simple interface to perform just this task has therefore been developed. [[DM-9186](#)]

02C.04.04 - Image Coaddition Pipeline

- Research properties of covariance under coaddition [[DM-6176](#)]:
 - A basic test codebase capable of tracking covariance through the image warping and coaddition process over a full is now available. [[DM-7901](#), [DM-7902](#)]
- PSF homogenization [[DM-8289](#)]:
 - The work has now been performed to add PSF-matched coadds as a standard data product in LSST processing. This behaviour is expected to be added to the default pipeline in early March. [[RFC-272](#), [RFC-283](#), [DM-8491](#)]
- Warped image comparison [[DM-8290](#)]:

- A document describing the approach being taken to coadd artefact removal using warped image comparison has been published. Work to implement this approach is expected to begin in March. [[DM-8953](#)]



A comparison of the accuracy of SED recovery with the new (“NMF”) vs the old (“LSST”) deblending algorithms. Note the substantially improved fraction of sources with a small (0-5%) error in the NMF case.

02C.04.05 - Object Detection and Deblending

- Deblender development [[DM-8140](#)]:
 - Development of the Non-negative Matrix Factorization (NMF) deblender has continued, including algorithmic refinements and closer integration with the LSST stack. [[DM-8959](#), [DM-9143](#), [DM-9173](#), [DM-9186](#)]
 - Tests show a substantial improvement in accuracy over the older algorithm.

02C.04.06 - Object Characterization Pipeline

- Emergent work and reduction of technical debt [[DM-8306](#)]:
 - Several minor bugs were fixed and documentation improvements made during the course of this month. [[DM-903](#), [DM-3804](#), [DM-9316](#), [DM-9431](#), [DM-9504](#), [DM-9519](#), [DM-9520](#), [DM-9521](#)]
 - An error in the PcaPsf PSF estimation algorithm, which would lead to different results depending on the version of Python in used, was discovered and fixed. This results in the Science Pipelines code being numerically identical between Python 2 and Python 3. [[DM-8030](#)]

- The DRP team collaborated with the SUIT team in prototyping an interface between the Science Pipelines code and the Firefly visualization system. [[DM-9420](#)]
- A new measurement algorithm which provides aperture fluxes on sources convolved to a nominal PSF has been added to the Science Pipelines. This functionality is useful for, for example, measuring the color of galaxies in variable seeing (by using a common aperture and target seeing in each band). [[RFC-294](#), [DM-9394](#)]

Planned activities:

02C.04.00 - Data Release Production Management Engineering and Integration

- All members of the team will attend the LSST Joint Technical Meeting (JTM) in Glendale, CA in the week of 6 March.
- Following the JTM, we expect a renewed focus on completion of the DM Replan.

02C.04.01 - Application Framework for Catalogs

- Participation in the SuperTask Working Group will continue.
- Both the pybind11 port, and then the new Footprint implementation, are expected to merge to master and become generally available during this month.

02C.04.02 - Calibration Products Pipeline

- Continue to work on making the prototype Auxiliary Telescope pipeline available in the LSST framework.
- At the JTM and beyond, work on integration of camera test stand data with the Science Pipelines.

02C.04.03 - PSF Estimation

- Continue development of “donut” fitting pipeline within the Science Pipelines framework.

02C.04.04 - Image Coaddition Pipeline

- Complete work on PSF homogenization for this development cycle. This will be enabled by default in the standard pipeline processing workflow.
- Start implementation of artefact rejection by warped image comparison.

02C.04.05 - Object Detection and Deblending

- Optimization and large-scale testing of the NMF deblender.

02C.04.06 - Object Characterization Pipeline

- Technical debt amelioration.

Recruitment update:

- Tim Morton joined the DRP team in Princeton at the beginning of February.
- Sophie Reed (Cambridge) accepted a postdoctoral position with the DRP team in Princeton. She is expected to join the project in September of 2017.

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 made second release of application IRSA Viewer using JavaScript based Firefly.
- Continued to work on SUIT requirements and resource estimates to work packages.
- Prepared Science Platform slides for JTM.

02C.05.01 Basic Archive Access Tools

- PDAC:
 - Time series data display with band filters and with image cutout.
 - Added all sky catalog search capability.
 - Worked with DAX team in API refinement.
 - 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.
- Replace the JS package manager npm with yarn.

02C.05.02 Data Analysis and Visualization Tools

- Remote API (Python) improvement and bug fixes.
- Enable FITS download for three-color image.
- Using stack task do to a forced photometry and Firefly to display the result, using Python to control the flow.
- Improvement and bug fixes, an empty image display area, warning message not going away.

02C.05.03 Alert/Notification Toolkit

- No new work done.

02C.05.05 User workspace

- Science platform design discussion.

Planned activities: (for March 2017)

02C.05.00

- Continue to work with IPAC IRSA group on collaboration in Firefly development, plan and schedule coordination.
- Everyone attends JTM, March 6-8, 2017.
- Finalize the work packages for SUIT.

02C.05.01 Basic Archive Access Tools

- Continue working on SUIT design and design document as part of science platform design.
- Junit tests for Java classes.
- Publish JavaScript Doc How-to guide.
- Publish the Firefly API docs in both JavaScript and Python.
- PDAC development:
 - Multi-object catalog search.
 - Improvement in time series data display UI with user feedback.
 - Start to work on adding WISE data to PDAC.

02C.05.02 Data Analysis and Visualization Tools

- Improvement to UI due to feedback from users.
- New functions: asymmetric error bars, More options for histogram.
- Support Camera visualization work by attend the weekly meeting.

02C.05.03 Alert/Notification Toolkit

- No work planned.

02C.05.05 User workspace

- Design as part of Science platform.

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 SUI integration efforts in the PDAC as necessary.
- Gaponenko provided “repaired” SDSS Stripe 82 dataset in PDAC (coverage for holes in overlap area between IN2P3 and NCSA processing).
- Gaponenko loaded and indexed available (Object and ForcedSource) WISE catalog data in PDAC. Some Qserv issues were subsequently uncovered when testing with this new dataset (some related to schema, and some related to partitioning parameters).
- Gaponenko completed load of 20% DR1 test dataset and IN2P3.
- Gates and Thukral began taking 20% DR1 KPMs.

02C.06.01.01 Catalogs, Alerts and Metadata

- Salnikov conducted parallel load experiment with L1/AP database prototype. Results indicate that partitioning does improve performance, and additionally, with partitioned data Postgres+NVM configuration performs best (pulls significantly ahead of MySQL+NVM configuration). Though performance is increased, still not enough to solve anticipated performance issues at scale. [DM-9301]

02C.06.01.02 Image and File Archive

- Lo provided calexp cutout support in imgserv. [DM-9115]
- Lo upgraded python Flask library in DAX services to latest 0.12. [DM-9268]

02C.06.02.01 Data Access Client Framework

- Pease refactored Data Butler init sequencing. [DM-9039]
- Pease added metadata access to wcs, visitInfo, and calib for calexp datasets. [DM-9060]
- Salnikov addressed pipe_supertask Python 3 compatibility issues. [DM-9352, DM-9548]
- Salnikov added minimal support for parallel execution of SuperTasks. [DM-9329]
- Salnikov updated the CommandLineActivator command line interface. [DM-8593]

02C.06.02.02 Web Services

- Van Klaveren implemented several containerization and build improvements for the DAX webservices. [DM-9557, DM-9566]

02C.06.02.03 Query Services

- Gates implemented fix for finicky ORDER BY parsing with table aliases. [DM-8426]
- Gates implemented fix for MarkCompleted exception related to job tracking. [DM-9315]
- Mueller updated XRootD package from upstream. [DM-9486]
- Jammes complete an evaluation of Kubernetes + OpenStack for use with provision-on-demand test clusters (outcome: recommended for use; significant improvement over previous sshmux scripted approach). [DM-8408]
- Jammes added Python static code analysis to lsst/qserv github repos, via landscape.io. [DM-8650]

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

- Mueller and Hanushevsky to continue review/improvement of sizing-model inputs.
- Team to continue improving robustness of DAX services and otherwise support SUIT integration efforts in the PDAC as necessary.
- Gaponenko to stage WISE images in PDAC.
- Gates and Thukral to complete 20% DR1 KPMs.
- Entire team to attend 2017 JTM in Glendale CA.

02C.06.01.01 Catalogs, Alerts and Metadata

- Salnikov to continue with L1/AP database prototyping work.

02C.06.01.02 Image and File Archive

- Lo to finish extending imgserv API to handle data from multiple surveys in preparation for accessing WISE data in the PDAC.

- Lo and Van Klaveren to update documentation of existing web service APIs, and also document future directions for these APIs.

02C.06.02.01 Data Access Client Framework

- Pease to continue work on Butler storage and format refactor.
- Salnikov to continue work on SuperTask MVP.

02C.06.02.02 Web Services

- Van Klaveren to reload and deploy metaserv in the PDAC.

02C.06.02.03 Query Services

- Gates to address various Qserv bugs uncovered by ongoing PDAC and KPM efforts.

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 activity.

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, and planning for the commissioning and operations phases. NCSA leads planning for operations of the Data Products Production (DPP) department.

For the DM-wide replanning effort, we refined the plan in the following ways: (1) refined costing and scheduling of all aspects of construction, service deployment, and ongoing service

operations; (2) reorganized the ITC component of the proposed WBS according to operational enclaves; (3) verified the completeness of the proposed WBS with NCSA IT groups, adding ITC elements needed by network-based security for processing intrusion detection logs; (4) made minor additions based on steering group discussions with technical areas of the LSST project at NCSA; (5) began investigating value engineering opportunities for selected areas of interest.

For operations planning, we refined the plan, including facility visits, updates to budget etc., needed to complete the LSST operations plan, which is a deliverable of the LSST MREFC. Specifics included analyzing content and structure of sizing model to model file handling and file volume for data retention investigation; holding meetings with CC-IN2P3 to discuss plans for coordinated operations, including data movement between sites and a role in disaster recovery; holding meetings with FNAL computing division representatives to explore interest in participation in DPP operations, including IT systems, database administration, storage and file system services, and networking; and verifying staffing needed to support north-south networking in DPP operations.

For near-term planning, we started discussions with AURA on requirements of ISPM 15 packaging materials, processes and procedures for information sharing between AURA and NCSA as items are shipped, as well as planning shipment procedures for NCSA equipment headed from NCSA to Chile.

DM-8517 Replanning, commissioning, and operations planning
DM-8512 Planning Deployment in Chile

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.

We continued refining the prototype Service Catalog and associated processes, incorporating additional project and internal NCSA services into the EA catalog, and formulating a three-tier methodology for mapping top-level services to the component level. We also evaluated several Service Management tools for potential use.

DM-8515 Service Management Definition and Refinement

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 work to design and implement the data backbone hardware, continuing meetings with various vendors to develop an operationally robust set of technologies, and starting a draft plan including rough dates, functionality, products, other information as necessary for discussions and planning. We also continued updating LDM-144 (Site Specific Infrastructure Estimation Model) to be consistent with planned architecture, including revising requirements tabs for initial feedback on redesign.

DM-8511 Degenerate Backbone Design and Implementation

DM-8506 Costing Model Redesign

02C.07.01 Processing Control

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 February, work for the current phase of building the Batch Service codebase with the ability to orchestrate and run more complex pipelines was completed, resulting in running a complete pipeline through the system including limited interaction with orchestration. We prepared for processing HSC data by running a subset of the HSC COSMOS dataset on the verification cluster. We also finished the previous phase of Batch Production Services construction by adding the final piece of system design documentation.

DM-627 Breakdown of Batch Production Services software

6

DM-8332 Run selected science pipeline using Pegasus

DM-8333 Run selected existing science codes with initial Batch Production Service façade

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 worked with OCS staff to refine the metadata telemetry stream, leading to change request 888. Continued improvements in testing by prepping the new test cluster. We finished work to make installation of the L1 message broker package portable. We also completed the port of OCS Bridge code from python to C++.

DM-8575 Deploy Mock for OCS with monitoring info

DM-8574 Confirm and Integrate OCS headers

DM-8320 Exercise DAQ-to-distributor portion of L1 prompt processing system

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.

Work in February involved improvements and fixes to common middleware code including logging and ctrl_* orchestration packages, as well as documenting data product sizing estimates and pipeline data product diagrams.

DM-8518 Emergent Middleware Work (S17a)

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 continued to work with SLAC, the EFD architect, and other parties to detail the operational requirements of hosting 60+ identified databases across the NCSA and Chilean sites, as well as provenance and metadata catalogs that are required for implementing file ingestion, distribution, and retention services within the Data Backbone. We also continued collecting detailed requirements and use cases of the Data Backbone internal file services and service endpoints.

These requirements will feed into a functional design which identifies specific software elements to be constructed.

DM-7645 Prototype bookkeeping and interfaces for the data backbone

DM-8331 Create design document for file portion of data backbone

02C.07.03 Environment and Tools

QA Environment

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

Work was delayed due to an unexpected staff absence. In March we will resume work to provide access to datasets and a Jupyter hub instance on the NCSA Nebula cluster to support upcoming QA activities.

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.

The move from NFS to GPFS file systems continued with response to user issues with quotas and file migration. Disaster Recovery design and implementation continued, with successful backup of all known datasets; monitoring of the system continues. We also completed updates of the hardware cost model and system data management policies.

DM-8503 Migrate Users from NFS

DM-8502 Disaster Recovery for Science Datasets

DM-8508 Finalizing / Publishing “Data Management” Policies

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.

Work for February included addressing user- and developer-driven requests and issues as the development systems continue to mature, most notably remedying issues with the GPFS file system and the GlusterFS file system underlying the Nebula OpenStack.

DM-8519 Service Management & Emergent Work (S17a)

Planned activities:

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

Planning and Management

For the DM-wide replanning effort, we will continue to refine the proposed WBS with resource estimates and detailed schedule sufficient for replan, investigation of value engineering options, and integration with commissioning and early operations plans. We will also break down the WBS into planning packages in preparation for the DM review. We will continue to refine the commissioning plan within the commissioning planning team as needed. For operations planning, we will finalize the operation plan for DPP as requested within the operations planning team.

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

DM-7632 Develop planning packages from DM replanning deliverables

Service Management and Monitoring

Development of the DPP services model within the LSST Enterprise Architect framework is ongoing. We assessed various tools for IT service management, and began prototyping the use of Service Now. We also began developing incident and request response processes. Work on service monitoring will continue with configuring and testing performance thresholds, and investigating/integrating prototype real-time metrics and key performance indicators.

DM-8515 Service Management Definition and Refinement

DM-8516 Enterprise Monitoring Integration – Phase 1

DM-9658 Enterprise Monitoring Design – Phase 2

DM-9657 Service Management Definition & Refinement (S17b)

Hardware acquisition and provisioning planning

We will continue work to design and implement the data backbone hardware, working with vendors and documenting the design. We will begin planning for hardware deployment in Chile that will occur later this year on which we will deploy project-wide network-based security

services, bringing together elements of computing hardware, networking, storage, security, and system administration.

DM-8511 Degenerate Backbone Design and Implementation

DM-8506 Costing Model Redesign

DM-8512 Planning Deployment in Chile

02C.07.01 Processing Control

Batch Production Services

In FY17 we plan to stand up the façade of Batch Production Services. In March, we will continue to build up this service façade with the ability to orchestrate and run more complex pipelines in the planned workload management framework using Pegasus and HTCondor, adding orchestration elements as they become available. This includes participating in ongoing work to detail the interface between the production system and SuperTask. Work also will continue in preparing a production-scale batch processing service for processing HSC data in the as-is software framework.

DM-8332 Run selected science pipeline using Pegasus

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 existing prompt processing system orchestration code with the newly developed front end elements for Level 1 services, and continue work on the OCS system, prototyping logging/monitoring as a first step in performance evaluation. We will also continue working with Telescope & Site developers to identify sources and contents of the EFD and OCS metadata available to build headers. We have proposed work on a design for acquiring header information from OCS in “catch-up” mode, in which archiving of camera data occurs asynchronously from data acquisition by the camera; if accepted, work will begin on this task,

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 March 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 finish work with SLAC and the DM architect to gather requirements about the operational model of hosting the 60+ identified databases, including estimated query loads, capacity, and other administrative concerns. We will also continue to understand the interface of the Data Backbone with responsibilities of the offline batch processing system related to file movement to and from compute sites, file management external to the custodial file store, and movement of data between storage tiers (e.g., staging from tape to disk) supporting production, as well as serving data in the DAC and through the bulk export service.

DM-7645 Prototype bookkeeping and interfaces for the data backbone

DM-8331 Create design document for file portion of data backbone

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 resume.

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

02C.07.04 Site Infrastructure

Hardware Acquisition, Deployment and Provisioning

Planned work includes finalizing the migration from NFS to GPFS file systems, continuing migration of services, and beginning the decommissioning of the NFS file system. Work on implementing disaster recovery procedures for datasets will be completed. We will begin planning and procurement activities for the systems to be used in raft-scale testing of the L1 Services.

DM-8503 Migrate Users from NFS

DM-8504 Migrate Services form 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 March 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 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

Recruitment update: No activity..

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: Continued work on the Summit Base ITC Design document 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>. We expect to have a draft of the document created for discussion at the Joint Technical Meeting in Glendale, March 5- 9, 2017.
- Summit and Base Networking and Computing: Many questions have been received and answered to the vendors participating in the RFP process. So far Arista have not answered the RFP request but we have Adexus/HP, Telefonica/Cisco, Dimension Data/Cisco, CLAdirect/Juniper, Brocade/EGS. IBM had been involved but were rejected

for the same reason as DWDM RFP objections. The date of reception was changed to March 15 in order to cater to the Chilean holiday calendar.

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: All the fusion splices were completed in February and it only remains to terminate the cable at the LSST telescope when we have occupancy of the computer room, which is expected to occur NLT September, 2017. Cobra/Telefonica are aware that this work will be done at some future date. Final measurements are still to be received.
- DWDM Equipment: We have been working with Coriant to purchase AURA equipment FOB, and owing to more administrative problems from the vendor, decided to purchase directly from Berlin. Work is being completed on the final Bill of Materials and prices. Space and power outlets were planned for the AURA and REUNA DWDM equipment in the current recinto computer room.
- Santiago-La Serena: REUNA received the “provisional delivery record” (acta de entrega inicial) for the whole path La Serena – Santiago, this is the milestone related to the formal reception of the fiber. REUNA is reviewing the information and clarifying some technical questions related to the measurement of the fiber.
- La Serena – AURA Gatehouse: The Telefonica fiber installation from D41 to Gatehouse is complete. There was a final problem with the fiber installation from D41 to the Gatehouse, which was solved by installing three more posts at the crossing point of D41 and the Observatory access road. The first set of trenches and ducts that will be required to bring the new fibers into the compound in La Serena have been completed. There are now ducts available to bring fibers into the compound to the existing data center. The only remaining activity prior to acceptance is the measurement of the fiber.

02C.08.03.02 International Chile - US WAN

- 100 Gbps Managed Ring: No planned activity in this period.
- Management and Coordination Contract: The LSST Network Engineering day (Jan 11th) report of the meeting results has been completed:

<https://confluence.lsstcorp.org/pages/viewpage.action?pageId=20284335&preview=/20284335/54854125/LSST%20Engineering%20Meeting%20Summary-0.7.docx>.

Dr. Julio Ibarra participated at the Quilt Winter Member meeting held in La Jolla, California. The Quilt is the national coalition of advanced regional networks for research and education, representing 36 networks across the country. Jeronimo Bezerra presented the latest AmLight ExP developments at the SDN All Hands Meeting hosted by SPRACE / Unesp's Scientific Computing Center (NCC). Dr. Heidi Morgan and Dr. Julio Ibarra participated in the ON*VECTOR 2017 Workshop is sponsored by NTT Network Innovation Laboratories and hosted by the Calit2's Qualcomm Institute at UC San Diego (UCSD/Qi).

- Spectrum Contract: The subaward from FIU to Angola Cables (AC) is drafted and pending the DUNS# from AC to fully execute the agreement. Co-PI Chip Cox has a meeting with AC scheduled on March 10th to iron out any remaining details. An initial payment of \$1M will be made on signing.
- US National WAN: PI Ibarra met with ESNet and received an initial proposal for the US National WAN.

Planned activities:

02C.08.01 Base Center

- Summit Base ITC Tiger Team: Continue work to complete draft of Summit - Base ITC Design Document by the completion of the Joint Technical Meeting in March.
- Summit and Base Networking and Computing: Continue planning of the network procurement and installation. Receive and review the proposals from vendors for Summit and Base networking. Clarify division of responsibilities between NCSA (02C.07) and AURA (02C.08) for procurement and installation of the Base Network.

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: The Purchase Order will be issued to Coriant for AURA/LSST DWDM equipment. REUNA will acquire from CORIAN/ RAYLEX the long haul DWDM equipment plus the installation services of the whole. To do this, they will execute the following steps:

- A letter from AURA (draft was prepared and received) to formally inform the evaluation committee of the tender process that it was accepted to award to CORIANT.
- REUNA will sign a Contract Amendment with AURA to purchase the equipment. A draft was developed and has been agreed.
- With the amendment REUNA will sign the contract with CORIANT/Raylex.
- Santiago-La Serena: REUNA to prepare the report related to the reception of the fiber, Delivery #4 of Contract 1 Annex II and send it to AURA.
- La Serena - AURA Gatehouse: Expect to receive the second run of ducting on the compound. Telefonica has local loops at the entrance of Colina El Pino Recinto AURA and will run fibers onto the compound to the existing computer room. The report from Telefonica with the measurements of the fiber is pending. As the fiber was fused in AURA's gatehouse before they did the measures, Telefonica will propose an alternative plan to do the final measure from La Serena to Pachon: activate an additional filament from La Serena to Gate just for measurements, once this is done the filament will be retired.

02C.08.03.02 International Chile - US WAN

- 100 Gbps Managed Ring: Next planned activities are scheduled for May 2017, when the Pacific 100G circuit will be opened in Chile.
- Management and Coordination Contract: Dr. Julio Ibarra is coordinating a kickoff meeting of the LSST Network Engineering Team (NET) for the week of March 20th, or the week of April 17.
- Spectrum Contract: We are working on the operations and maintenance agreement and payment timing. More information will be available to report next month.
- US National WAN: Negotiations to refine and improve the ESNet service and costs will continue during March-April.

Recruitment update:

- Advertisements for the new hires Network Engineer, IT Technician and Systems Administrator closed 15 February. Scoresheets were prepared for 25 Network Engineer and 25 IT Technician applicants. A short list of 6 Network Engineer applicants was developed for the next phase of phone/video interviews.
- Still expect hire date of May 31, 2017 for Network Engineer and IT Tech and June 30, 2017 for Systems Administrator.

